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OPERATION REDWING

1956

United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

Prepared by the Defense Nuclear Agency as Executive Agency
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Nuclear Test Personnel Review (NTPR)	LACROSSE	SEMINOLE	INCA	TEWA
REDWING	CHEROKEE	FLATHEAD	DAKOTA	HURON
Pacific Proving Ground	ZUNI	BLACKFOOT	MOHAWK	
Enewetak	YUMA	KICKAPOO	APACHE	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

REDWING was a 17-detonation atmospheric nuclear weapons test series conducted in the Marshall Islands at Enewetak and Bikini atolls in spring and summer 1956. This is a report of DOD personnel in REDWING with an emphasis on operations and radiological safety.

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7. Author(s) (continued)

P. Sturman, L. Berkhouse, S. Davis, H. DeSantis, P. Dean,
M.K. Doyle, D.S. Patterson

Shot ZUNI, Operation REDWING, viewed from Eneu Island.

FACT SHEET

REDWING was a 17-detonation nuclear weapon test series (see table) held at the Atomic Energy Commission's (AEC) Pacific Proving Ground (PPG) in spring and summer 1956. The PPG consisted principally of Enewetak* and Bikini atolls in the northwestern Marshall Islands in the Central Pacific Ocean.

REDWING test events, 1956[a]

Assigned Name	Location	Date (local time)
LACROSSE	Enewetak; surface on Runit Island	5 May
CHEROKEE	Bikini; airdrop near Nam Island	21 May
ZUNI	Bikini; surface on Eneman Island	28 May
YUMA	Enewetak; tower on Aomon Island	28 May
ERIE	Enewetak; tower on Runit Island	31 May
SEMINOLE	Enewetak; surface on Boken Island	6 June
FLATHEAD	Bikini; barge of Iroij Island	12 June
BLACKFOOT	Enewetak; tower on Runit Island	12 June
KICKAPOO	Enewetak; tower on Aomon Island	14 June
OSAGE	Enewetak; airdrop over Runit Island	16 June
INCA	Enewetak; tower on Lujor Island	22 June
DAKOTA	Bikini; barge off Iroij Island	26 June
MOHAWK	Enewetak; tower on Eleleron Island	3 July
APACHE	Enewetak; barge off Dridrilbwij Island	9 July
NAVAJO	Bikini; barge off Iroij Island	11 July
TEWA	Bikini; barge over Nam Island reef	21 July
HURON	Enewetak; barge off Dridrilbwij Island	22 July

Note:

[a]Yields not announced except: LACROSSE (40 KT), CHEROKEE ("several MT"), ZUNI (3.5 MT), SEMINOLE (13.7 KT), TEWA (5 MT). One kiloton equals the approximate energy release of the explosion of one thousand tons of TNT; one megaton equals the approximate energy release of the explosion of one million tons of TNT.

* The spelling of Marshall Island place names has changed in recent years in order to more accurately render the sounds of the Marshall Island names using English spelling.

HISTORICAL BACKGROUND

The REDWING series was held primarily to test high-yield thermonuclear devices that could not be tested in Nevada. The development and testing of these devices, which generate their explosive power through the fusion or joining of hydrogen atoms, began in 1950 and had advanced to the stage that one of these was dropped from a B-52 bomber in REDWING. This test drop, although of some scientific interest, was probably more a demonstration to the world of the deliverability of these weapons than an experiment. The drop was witnessed by a group of U.S. newsmen, the first such group invited to view a Pacific nuclear test since 1946.

The devices were tested at the PPG by a joint military and civilian organization designated Joint Task Force 7 (JTF 7). This was a military organization in form, but was populated by military personnel, Federal civilian employees, and contractor personnel of the Department of Defense (DOD) and the AEC. The commander of this force was the appointed representative of the AEC and reported also to the Joint Chiefs of Staff (JCS) and the Commander in Chief, Pacific (CINCPAC). The peak DOD numerical strength of REDWING was approximately as follows:

Uniformed military	9,710
DOD civil service	600
DOD contractors	140
Total DOD personnel	10,450

In addition, several thousand men from the AEC and its contractors, a few from other Government agencies, and some foreign observers were present.

Numerous technical experiments were carried out in conjunction with each of the 17 detonations. These experiments measured the yield and efficiency of the devices and attempted to gauge the military effects of the explosions. DOD personnel participated in this test operation as individuals whose duty stations were at the AEC design laboratories, as units performing separate experiments, and as units performing various support roles. The REDWING operations placed most of the Navy support group at Bikini, where its ships provided living space for personnel who were evacuated from the islands before each test.

An extensive radiological safety (radsafe) program was instituted whose objectives were:

1. Maintenance of personnel radiation exposure at the lowest possible level consistent with medical knowledge of radiation effects and the importance of the test series.
2. Avoidance of inadvertent contamination of populated islands or transient shipping.

The program established an organization to provide radsafe expertise and services to the separate components of the task force who were responsible for personnel safety within their commands. Personnel were trained in radiological safety, and standards governing maximum permissible exposures (MPE) were established. The MPE was set at 3.9 R for the series. Film badges were provided for all of the participating personnel. Persons likely to be exposed to radiation were often provided with additional badges for more complete recording of exposure. An extensive weather forecasting group was established in order to predict wind directions and areas of potential fallout. Personnel were evacuated from danger areas before each detonation, and reentry to radioactive areas was restricted to the personnel required to retrieve important data.

TEST OPERATIONS AND EXPOSURES

Tests were conducted at both Enewetak Atoll and Bikini Atoll some 190 nmi (352 km) to the east of Enewetak. The Marshall Islanders were evacuated from Bikini in 1946 and Enewetak in 1948. Enewetak served as a base of operations and the place where smaller-yield devices were tested, and Bikini was an advance camp where the larger-yield devices were tested.

Most of the U.S. Navy and Marine Corps personnel were on ships operating around Bikini providing supply, evacuation capability, and other support to the tests there. Most of the Army and Air Force personnel were on Enewetak. All the Services had personnel assigned to laboratory organizations whose operations were conducted on both atolls as well as other locations in the Pacific area.

The operations ran smoothly except for two incidents. The airdropped demonstration test, CHEROKEE, was considerably off target; and the edge of the cloud from the last event fired at Bikini, TEWA, passed over Enewetak causing fallout there. The missed airdrop caused no exposure of personnel to ionizing radiation as the entire Bikini Atoll had been evacuated, and the miss was in the direction of the open sea. But the TEWA fallout on the Enewetak base camp did lead to the exposure of the personnel there. The incident occurred toward the end of the series when some personnel had already returned to the United States, but the remaining Enewetak personnel received about an additional 1.5 R exposure from this incident. The overall average exposure for the series was approximately 1.7 R. The highest exposures were recorded by Air Force flight officers whose aircraft penetrated the nuclear clouds on scientific missions. The recorded REDWING exposures are summarized in the table below by service affiliation. Civilians employed by the Services have been included with the uniformed personnel. Other participants included personnel from other U.S. Government agencies including the AEC, AEC contractors, and foreign military and U.S. media observers.

Summary of REDWING Exposures

	No. of Persons Badged	Exposure Ranges (roentgens)							High Recorded (R)
		Not Available	0	0.001-0.999	1.000-2.999	3.000-4.999	5.000-9.999	Over 10	
Army	1,612	0	19	398	500	650	45	0	7.2
% of Total		0	1	25	31	40	3	0	
Navy	5,638	23	312	3,674	1,474	147	8	0	6.2
% of Total		<1	5	65	26	3	<1	0	
Air Force	2,780	0	220	823	1,010	638	77	12	16.4
% of Total		0	8	30	36	23	3	<1	
Marine Corps	249	17	2	116	108	6	0	0	3.6
% of Total		7	<1	47	43	2	0	0	
Other Military	379	2	23	126	143	74	11	0	7.4
% of Total		<1	6	33	38	19	3	0	
DOD Contractors	138	1	4	58	66	9	0	0	4.7
% of Total		<1	3	42	48	7	0	0	
Other Participants	3,847	78	426	1,237	844	1,038	224	0	6.8
% of Total		2	11	32	22	27	6	0	
Total	14,643	121	1,006	6,432	4,145	2,562	365	12	16.4
% of Total		<1	7	44	28	18	2	<1	

PREFACE

From 1945 through 1962, the U.S. Atomic Energy Commission (AEC) conducted 235 atmospheric nuclear weapon tests at sites in the United States and in the Pacific and Atlantic oceans. In all, about 220,000 Department of Defense (DOD) participants, both military and civilian, were present at the tests. Of these, approximately 142,000 participated in the Pacific test series and approximately another 4,000 in the single Atlantic test series.

In 1977, 15 years after the last aboveground nuclear weapon test, the Center for Disease Control (CDC) of the U.S. Department of Health and Human Services noted more leukemia cases than would normally be expected among about 3,200 soldiers who had been present at shot SMOKY, a test of the 1957 PLUMBBOB Series. Since that initial report by the CDC, the Veterans Administration (VA) has received a number of claims for medical benefits from former military personnel who believe their health may have been affected by their participation in the weapon testing program.

In late 1977, the DOD began a study that provided data to both the CDC and the VA on potential exposures to ionizing radiation among the military and civilian personnel who participated in the atmospheric testing 15 to 32 years earlier. In early 1978, the DOD also organized a Nuclear Test Personnel Review (NTPR) to:

- Identify DOD personnel who had taken part in the atmospheric nuclear weapon tests
- Determine the extent of the participants' exposures to ionizing radiation
- Provide public disclosure of information concerning participation by DOD personnel in the atmospheric nuclear weapon tests.

This report on Operation REDWING is one of many volumes that are the product of the NTPR. The DOD Defense Nuclear Agency (DNA), whose Director is the executive agent of the NTPR program, prepared the reports, which are based on military and technical documents reporting various aspects of each of the tests. Reports of the NTPR provide a public record of the activities and associated radiation exposure risks of DOD personnel for interested former participants and for use in public health research and Federal policy studies.

Information from which this report was compiled was primarily extracted from planning and after-action reports of Joint Task Force 7 (JTF 7) and its subordinate organizations. What was desired were documents that accurately placed personnel at the test sites so that their degree of exposure to the ionizing radiation resulting from the tests could be assessed. The search for this information was undertaken in archives and libraries of the Federal Government, in special collections supported by the Federal Government, and by some discussion or review with participants.

For REDWING, the most important archival source is the Washington National Records Center in Suitland, Maryland. The Naval Archives at the Washington Navy Yard also was helpful, as was the collection of documents assembled by the Air Force Special Weapons Center Historian, the collection now being housed in the Air Force Weapons Laboratory Technical Library at Kirtland Air Force Base, Albuquerque, New Mexico. Other archives searched were the Department of Energy (DOE) archives at Germantown, Maryland, its Nevada Operations Office (DOE/NV) archives at Las Vegas, and the archives of the Test Division of the Los Alamos National Laboratory.

JTF 7 exposure records were retrieved from the Records Center, and an additional file of exposure-related documents that had been microfilmed by the Reynolds Electrical and Engineering Company, Inc., support contractor for DOE/NV, was also useful.

There is little primary documentation of personnel movement in areas of potential radiation exposure. This has been compensated for, where possible, with inferences drawn from secondary sources and the exposure records themselves.

The work was performed under RDT&E RMSS B350079464 U99 QAXMK 506-09 H2590D for the Defense Nuclear Agency by personnel from Kaman Tempo and subcontractor R.F. Cross Associates. Guidance was provided by Mr. Kenneth W. Kaye of the Defense Nuclear Agency.

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CHAPTER 1
OVERVIEW

INTRODUCTION

Purpose

REDWING was a test series in which 17 nuclear devices were detonated at the Atomic Energy Commission's (AEC) Pacific Proving Ground (PPG) at Enewetak* and Bikini atolls in spring and summer of 1956. Table 1 lists the detonations.

This report documents the participation of Department of Defense (DOD) personnel who were active in this atmospheric nuclear test series. Its purpose is to bring together the available information about this series pertinent to the exposure of DOD personnel, both uniformed and civilian employees. The report explains the reasons why DOD personnel were present at these tests, lists the DOD organizations represented, and describes their activities. It discusses the potential radiation exposure involved in these activities and the measures taken to protect personnel in the participating DOD organizations. It presents the exposures recorded by the participating DOD units. The information is limited to these points.

Historical Perspective

REDWING was the sixth nuclear test series to be conducted by the United States in the Marshall Islands. During the fifth series in 1954 a serious fallout contamination incident occurred that involved not only U.S. personnel but Marshall Island residents and Japanese fishermen as well.

Because of the unfavorable effect of this incident on world opinion, the government recognized the need to issue a statement that specifically addressed the health and safety concerns. A joint DOD-AEC press release of April 27, 1956, presented the precautions being taken in REDWING (Reference B.0.8). The

* A better understanding of the Marshall Islands language has permitted a more accurate transliteration of Marshall Island names into English language spelling. These newer transliterations are used in this report with few exceptions. Appendix C is a list of the names and their variant spelling.

Table 1. REDWING detonations, 1956.

Local Date	Assigned Name	Location	Yield[a]
5 May	LACROSSE	Enewetak; surface	40 KT
21 May	CHEROKEE	Bikini; airdrop	Several megatons
28 May	ZUNI	Bikini; surface	3.5 MT
28 May	YUMA	Enewetak; tower	Not announced
31 May	ERIE	Enewetak; tower	Not announced
6 June	SEMINOLE	Enewetak; surface	1.37 KT
12 June	FLATHEAD	Bikini; barge	Not announced
12 June	BLACKFOOT	Enewetak; tower	Not announced
14 June	KICKAPOO	Enewetak; tower	Not announced
16 June	OSAGE	Enewetak; airdrop	Not announced
22 June	INCA	Enewetak; tower	Not announced
26 June	DAKOTA	Bikini; barge	Not announced
3 July	MOHAWK	Enewetak; tower	Not announced
9 July	APACHE	Enewetak; barge	Not announced
11 July	NAVAJO	Bikini; barge	Not announced
21 July	TEWA	Bikini; barge	5 MT
22 July	HURON	Enewetak; barge	Not announced

Note:

[a]One kiloton (KT) equals the approximate energy release of the explosion of one thousand tons of TNT; one megaton (MT) equals the approximate energy release of the explosion of one million tons of TNT.

release described the improved fallout prediction capability available and the extensive monitoring that was to be done both at the PPG and beyond. It also described programs for surveying marine life in the Pacific. The release stated that the yields of the devices to be tested were expected to be lower than the largest of those detonated in 1954.

Press observers were invited to view part of the series. These were the first to observe a PPG test series since 1946. The 15 press observers, along with 17 invited civil defense officials, viewed the LACROSSE and CHEROKEE detonations. The latter was the detonation of a multimegaton-yield device dropped from an operational B-52 bomber, the first such event conducted by the United States. Although CHEROKEE provided the opportunity to make some unique measurements, its purpose was primarily a demonstration of the ability of the United States to deliver large-yield thermonuclear weapons.

REDWING was the first test series in the PPG in which dosimeters that would record exposure to ionizing radiation were provided for all joint task force personnel.

Report Organization

Subsequent sections of this overview chapter discuss the form of experimental nuclear weapon test programs with the emphasis on the potential radiation exposure of participating DOD personnel. The experimental activities are considered first without particular reference to the geographic location of the testing, and are then related to the geographic limitations on such activities at the PPG. The portion of the experimental program of heaviest DOD participation is emphasized.

The chapter concludes with a description of Joint Task Force 7 (JTF 7), the organization that conducted Operation REDWING, and indicates how the DOD elements within JTF 7 functioned.

Chapter 2 is concerned with the radiological safety (radsafe) aspects of the tests. These chapters document the procedures, training, and equipment used to protect participants from the radiation exposure potential inherent in the test operations.

Chapter 3 focuses on the role of the DOD in the experimental program of REDWING in general, leading to a discussion of the DOD operations for the test events in Chapters 4 and 5. Chapter 4 discusses the Bikini detonations, and Chapter 5 the Enewetak detonations.

Chapters 6 through 9 report participation by the Army, Navy, Air Force, and Marine Corps, respectively. Chapter 10 summarizes the participation of other government agencies and contractors. A listing of participating units and a statistical characterization of their personnel exposures are included in these chapters. The personnel exposures are discussed in Chapter 11.

NUCLEAR TESTS AND RADIATION EXPOSURES

Nuclear testing before 1963 usually consisted of the unconfined detonation of nuclear devices (usually not weapons) in the atmosphere. The devices might be placed on a platform or a barge on the surface, placed atop a tower, supported by a balloon, dropped from an airplane, or flown on a rocket. On occasion devices were detonated underwater or buried in the earth, or in underground tunnels and shafts.

In theory, personnel could be exposed either by the radiation emitted at the time of explosion and for about 1 minute thereafter -- usually referred to as initial radiation -- or the radiation emitted later (residual radiation). In the PPG there was no direct exposure of personnel to initial radiation during testing. This is part of the violent nuclear explosion process itself, and to be close enough for initial radiation exposure would place an observer within the area swept by lethal blast and thermal effects.

The neutron component of initial radiation did indirectly contribute to the possibility of personnel exposure. Neutrons are emitted in large numbers by nuclear weapon explosions. They have the property of altering certain nonradioactive materials so that they become radioactive. This process, called activation, works on sodium, silicon, calcium, manganese, and iron, as well as other common materials. Activation products thus formed are added to the inventory of the radioactive products formed in the explosion process. The radiation emitted by this inventory more than 1 minute after detonation is referred to as residual radiation.

The potential for personnel exposure to residual radiation was much greater than the potential for exposure to initial radiation. In the nuclear explosion process, fissioning atoms of the heavy elements, uranium and plutonium, split into lighter elements, releasing energy. These lighter atoms are themselves radioactive and decay, forming another generation of descendants from the original fissions. This process is rapid immediately after the explosion but slows later and continues for years at very low levels of radioactivity.

Overall radioactivity of all the fission products formed decays at a rate that is closely approximated by a rule that states that for each sevenfold increase in time the intensity of the radiation will decrease by a factor of ten. Thus, a radiation rate of 1 roentgen per hour (R/hr) at 1 hour after the detonation would be expected to be 0.1 R/hr after 7 hours and 0.01 R/hr after 49 hours. This rule seems to be valid for about 6 months following an explosion, after which the observed decay is somewhat faster than that predicted by this relationship. Activation products, in general, decay at a faster rate than the fission products.

Fission products and the activation products, along with unfissioned uranium or plutonium from the device, are the components of the radioactive material in the debris cloud, and this cloud and its fallout are the primary sources of potential exposure to residual radiation.

In a nuclear airburst in which the central core of intensely hot material, or fireball, does not touch the surface, the device residues (including the fission products, the activation products resulting from neutron interaction with device materials, and unfissioned uranium and/or plutonium) are vaporized. These vapors condense as the fireball rises and cools, and the particles formed by the condensation are small and smoke-like. They are carried up with the cloud to the altitude at which its rise stops, usually called the cloud stabilization altitude. Spread of this material then depends on the winds and weather. If the detonation is small, the cloud stabilization altitude will be in the lower atmosphere and the material will act like dust and return to the Earth's surface in a matter of weeks. Essentially all debris from detonations with yields equivalent to kilotons of TNT will be down within 2 months (Reference A.1). Areas in which this fallout material will be deposited will appear on maps as bands following the wind's direction. Larger detonations (yields equivalent to megatons of TNT) will have cloud stabilization altitudes in the stratosphere (above about 10 miles [16 km] in the tropics); the radioactive material from such altitudes will not return to Earth for many months and its distribution will be much wider. Thus, airbursts contribute little potential for radiation exposure to personnel at the testing area, although there may be some residual and short-lived radiation coming from activated surface materials under the burst if the burst altitude is sufficiently low for neutrons to reach the surface.

Surface and near-surface bursts pose larger potential radiation exposure problems. These detonations create more radioactive debris because more material is available for activation within range of the neutrons generated by the explosion. In such explosions the extreme heat vaporizes device materials and activated Earth materials as well. These materials cool in the presence of additional material gouged out of the burst crater. This extra material causes the particles formed as the fireball cools to be larger in size, with radioactivity embedded in them or coating their surfaces. The rising cloud will lift these particles to altitudes that will depend on the particle size and shape and the power of the rising air currents in the cloud, which in turn depend on the yield of the detonation. The largest particles will fall back into the crater or very near the burst area with the next largest falling nearby. It has been estimated that as much as 80 percent of the radioactive debris from a land-surface burst falls out within the first day following the burst (Reference A.1).

Bursts on the surface of seawater generate particles consisting mainly of salt and water drops that are smaller and lighter than the fallout particles from a land burst. As a consequence, water-surface bursts produce less early fallout than similar devices detonated on land. Large-yield surface bursts in the PPG over relatively shallow lagoon waters or on very little truly dry land probably formed a complex combination of land-surface- and water-surface-burst particle-size characteristics.

Several surface detonations at the PPG were of such a large size that they formed underwater craters. These craters retained a fraction of the device's radioactive debris and activated materials. Water that overlay these craters acted as a shield to protect surface operations from the radiation from this material, but it also provided a means for the material to move from the craters into the general circulation system of the lagoon waters. Craters were subject to washing, and silt plumes were observed to come from them for long periods after the shots; it is reported that plumes from the MIKE crater (Operation IVY, 1952) were visible a year after the detonation (Reference D.4).

Detonations on towers may be considered as low airbursts or ground bursts, depending upon whether the fireball touches the ground. A larger burst will create more fallout than a smaller burst on equal-height towers not only because of the additional fission products and device debris, but also because it will pull up more Earth materials, or even form a crater. In addition, the materials of the tower itself provide a source of easily activated materials. Particles of the tower material may also act as centers for the debris vapors to condense on to form the larger particles that lead to heavier early fallout. Devices that fission uranium or plutonium inefficiently will cause more of these radioactive components of the device residue to be dispersed.

EXPERIMENTAL PROGRAM

Central to the test series was the experimental program. This program and its requirements dictated the form of the test organization and the detail of personnel participation. Like most of the preceding nuclear test series, REDWING's experimental program incorporated two aspects, the most important of which was the development of the weapons themselves; the secondary experiments involved the measurement of the explosive and radiation effects.

These two aspects can serve as a rough measure of differentiation of interest between the major participants: the AEC interest in weapon development, and the DOD interest in the military application of the effects of the explosions. The several parts of the weapon development and the effects studies each had particular features that led to the possibility of radiation exposure.

Weapon Development

In testing devices, weapon designers are interested in two classes of measurements: the total energy release of the device, and the rate of release. Total energy release measurements are called yield measurements, and the rate of release measurements are called diagnostic measurements.

YIELD MEASUREMENTS. Device yield is usually determined by several methods, two of which involve photo-optical techniques. Growth of the intensely hot and radiating mass of device debris and air that constitute the nuclear fireball varies with its yield. Very-high-speed cameras were therefore used to record this growth, and film records subsequently analyzed to infer yield. Duration and intensity of the energy pulse in the optical-thermal spectral region also vary with yield; thus, light detectors coupled to recorders were used to derive yield.

In addition, yield may be determined by collecting and analyzing a representative sample of the device debris. Inferences are then drawn regarding the yield, based on knowledge of the materials in the unexploded device.

Construction, instrumentation placement, and data recovery for the photo-optical yield determinations did not usually require personnel to be in areas with a high potential for exposure to radiation. Cameras and light detectors need only a clear field of view of the burst point and enough breadth of view to encompass the fireball. Camera placement did not involve personnel activities at times and places of high radiation levels. Film recovery generally did not involve high exposure potential, as the photo stations (see Figure 1) were usually at ranges and in directions not heavily contaminated by fallout.

Sampling of device debris, however, necessitated much closer contact with higher levels of radioactivity. The technique used in REDWING and most atmospheric tests was to fly aircraft with collectors directly through portions of the radioactive cloud, although for some shots during some tests rockets and drone aircraft were used. About 90 percent of the fission debris was usually considered to be in the upper or cap portion of the mushroom cloud (Reference A.1). Several aircraft were used to obtain a representative sample. Aircrews were exposed to the radiation emitted by the radioactive particles in the cloud as they flew through. Aircraft flying these sampling missions picked up significant amounts of radioactive material on their surfaces, posing additional and continuing radiation exposures to the aircrews as they returned to base, as well as to decontamination ground crews. Samples collected were radiologically "hot" and required special handling as they were taken from the aircraft and prepared for shipment to the laboratory for analysis.

DIAGNOSTIC MEASUREMENTS. The explosion of a nuclear device is a progressive release of increasing amounts of nuclear radiation, some of which directly escapes the device. The rest of the radiant energy interacts with the associated material of the device itself and is converted into differing forms of radiation and into the kinetic energy of the remaining materials in a small fraction of a second. The intensely hot core then reradiates, heating the surrounding air and creating a shock wave that propagates outward from the burst point.

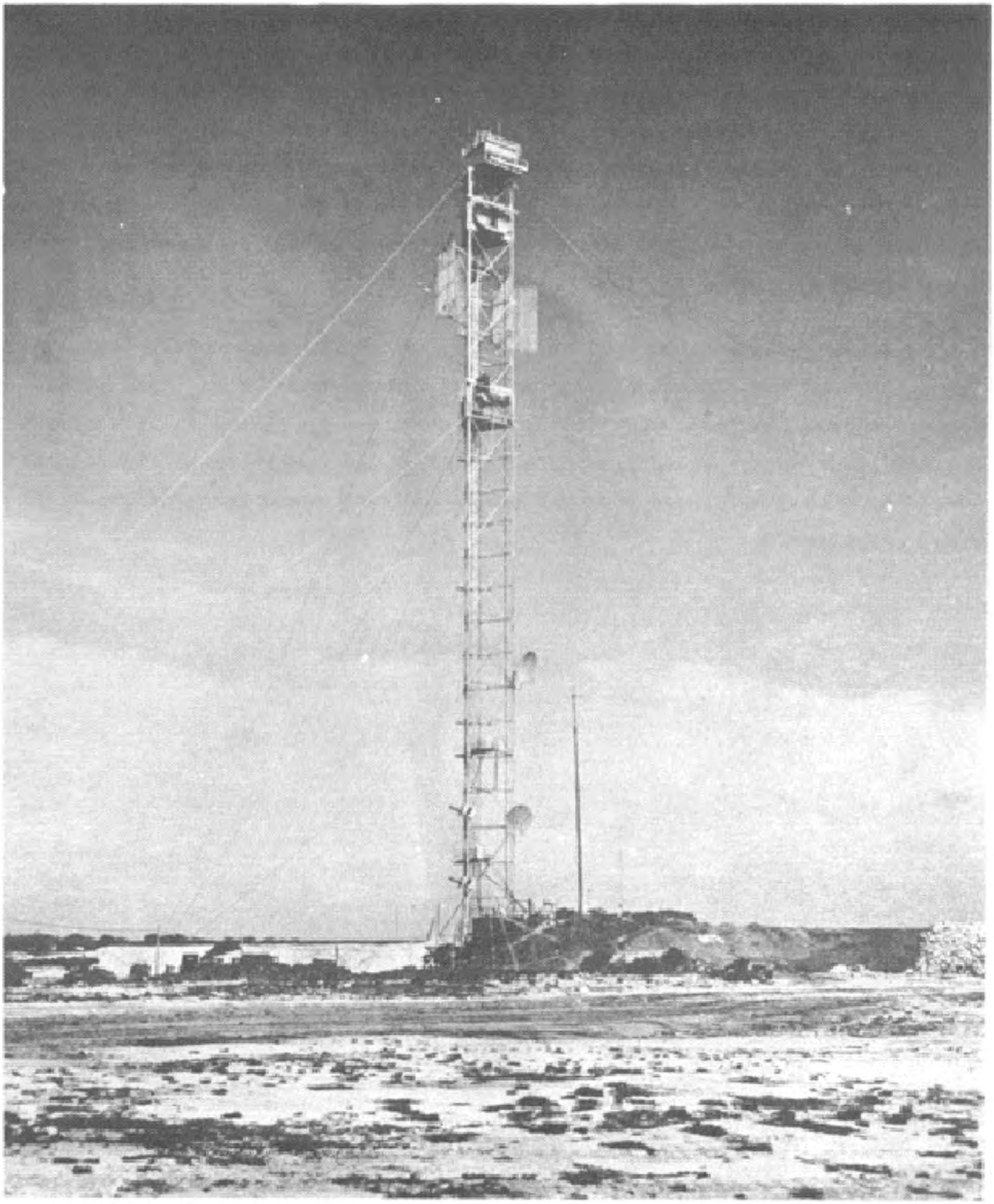

Figure 1. Camera tower on Eneu, Station 70 in background, REDWING.

The weapon diagnosticians used sophisticated techniques to follow the processes that occur during the device explosion. Detectors and collectors were run up to, and sometimes inside, the device case so that the radiation being sampled could be directly channeled some distance away and there be recorded by instrumentation designed to survive the ensuing blast. To enhance its transport, radiation was conducted through pipes, often evacuated or filled with special gases (see Figure 2), from the device to stations where recording instrumentation was located or where the information could be retransmitted to a survivable recording station.

Radiation measurements are based upon the effects that result from the interaction of the radiation with matter. Fluorescence is one such effect. Materials that fluoresce with radiation exposure were placed in view of cameras or light detectors to provide a record of the variation of fluorescent intensity with time, thereby providing an indirect measurement of the radiation environment.

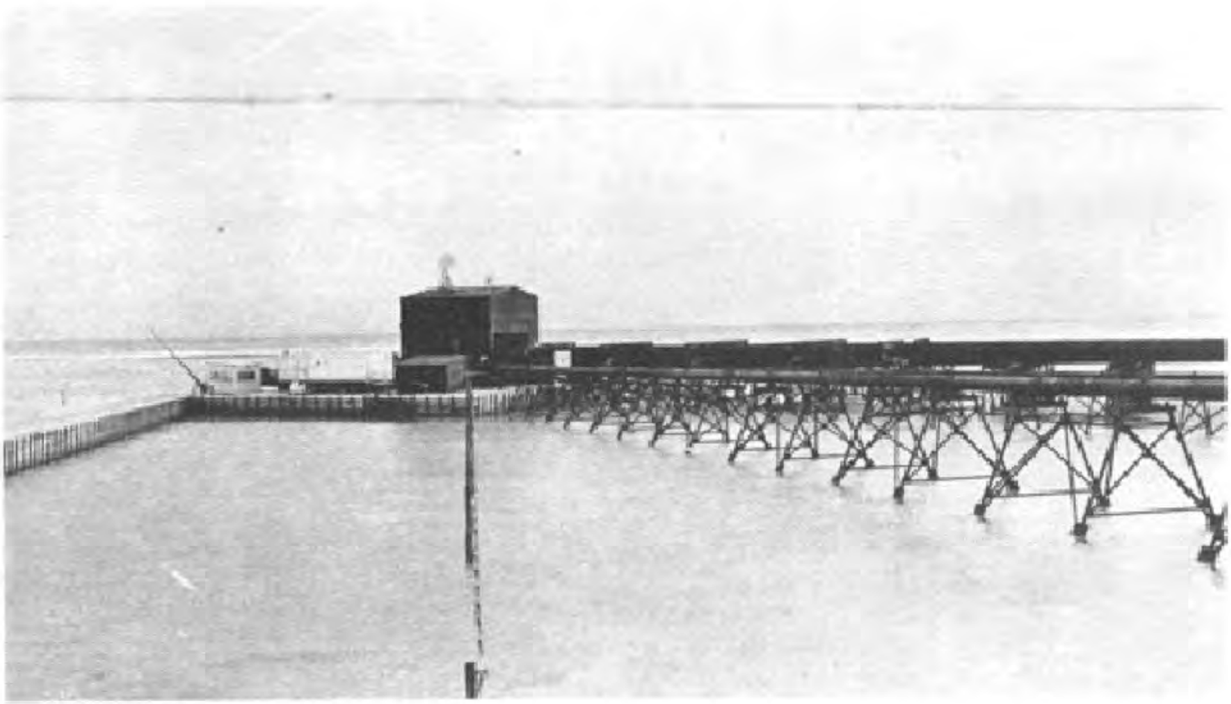

Figure 2. Surface detonation cab, showing pipe array for diagnostic experiments, REDWING.

Other methods of detecting radiation involve the shielding (attenuation) properties of Earth materials, water, and other substances. These materials are also used to baffle or collimate radiation to ensure that radiation is directed toward the detecting instrument.

Radiofrequency energy produced by the explosion can be detected by radio receivers and, with the addition of filtering and processing circuitry, can also provide information about the energy flow from the explosion. Such measurements permit remote placement of receiving and recording instruments.

Preshot preparation included the hazards normally associated with heavy construction, and some exposures of workers to radiation occurred in areas contaminated by earlier tests.

The potential for radiation exposure of personnel associated with weapon diagnostic experiments depended upon the proximity of the measurement or data recovery point to ground zero and the time lapse between the detonation and the data collection.

The primary radiation hazard is from fission* products and materials made radioactive by neutron activation of device and Earth materials in the vicinity of ground zero. Thus, the distance from ground zero is a principal factor in assessing exposure to persons engaged in the experimental program.

Since radioactive material decays with time, the time lapse between the explosion and exposure is a critical factor in dose assessment. Primary recording media for these experiments were photographic films from oscilloscope, streak, or framing cameras located in survivable bunkers near the detonation point. Because radiation fogs film in time, these films and other time-sensitive data were removed from the bunkers by helicopter-borne personnel within hours of the detonation to minimize damage by fogging. This recovery constituted the main potential for exposure of weapon diagnostics participants.

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* Although many of the REDWING devices were thermonuclear, or fusion, devices, a significant portion of their energy release resulted from fission processes.

Effects Experiments

All REDWING shots except CHEROKEE tested new weapon developments. Priorities of time and space and go or no-go considerations favored the weapon development experiments over the effects experiments. Although the effects experiments were clearly secondary, they directly involved a relatively large number of DOD organizations and individuals and are therefore of prime importance for this report.

The effects experiments were intended to acquire urgently needed military data that could not be obtained from the smaller yield tests at the Nevada Test Site. These experiments may be classed into two general kinds. The first class of measurements was made to document the hostile environment created by the nuclear detonation. The second class of effects experiments documented the response of systems to the hostile environment; these measurements are termed systems response experiments.

ENVIRONMENTAL MEASUREMENTS. The purpose of environmental measurements was to gain a comprehensive view of the hostile environment created by a nuclear detonation to allow military planners to design survivable military hardware and systems and train personnel to survive. Examples of environmental measurements include static overpressure (crushing) and dynamic pressure (blast wind) in the blast wave, heat generated by the detonation, and fallout radiation. The measurement techniques employed for REDWING varied with the effect being measured, but usually measuring devices or gauges were placed at a variety of ranges from ground zero and their measurement recorded in some way. A wide variety of gauges and data recording techniques was used. In some cases, measurements were similar to those being made by the weapon designers, but at greater distances or longer after the detonation, which simplified the recording of the data, although the recovery problems were by no means trivial.

Rugged, self-recording gauges had been developed for blast and thermal radiation measurements before the REDWING series so that complete loss of data from a project would not occur if instrument recovery were delayed, for example, by heavy fallout. For nuclear radiation measurements, however, prompt data recovery was still desirable as the gauges used might be thin foils of some material that would be made radioactive by the burst-time neutrons; hence early observation was necessary, before the information contained in the induced radiation pattern decayed away.

The potential for radiation exposure of personnel responsible for environmental measurements in general depended on the proximity of the instruments to the device and the time that elapsed between detonation and instrument recovery, as was the case for weapon development experimentation: the nearer in space or time to the detonation, the greater the potential for exposure.

SYSTEMS RESPONSE EXPERIMENTS. To document the response of systems to the hostile environment, military hardware (such as aircraft or naval mines) was exposed to the effects of nuclear detonations.

Techniques used for the systems response experiments were conceptually simple: exposure of the system of interest and observation of its response. Actual conduct of the experiments was far more complex. The level of the threat to which the system was exposed almost always required documentation so that the response could be properly understood, necessitating an environmental experiment along with the systems response experiment. It was often not enough to know whether the system survived or not, but rather the response of the component parts and their interactions was required, entailing the placement of sophisticated instrumentation and recording devices.

While the potential radiological exposure for these systems response experiments was governed primarily by the closeness in space or time, an additional problem arose. Often, when the subject of the exposure itself was recovered for closer examination, it could be contaminated by device debris or even be radioactive because of the activating effects of the device's neutron output.

SUMMARY OF RADIATION EXPOSURE POTENTIAL

The potential for personnel radiation exposure can be categorized by the activity performed:

1. Construction or preplacement of an experiment in a radioactive area
2. Manning an experimental location within a fallout field
3. Obtaining a sample or recovering an experiment

4. Sample handling for shipment or onsite analysis
5. Maintenance or cleanup of contaminated aircraft and other equipment.

In addition, two other potential exposure possibilities are related to the geographical location of the PPG and the resultant requirement for shipboard operations. These are:

1. Fallout on inhabited atolls or ships participating in or servicing the tests
2. Radiation exposure of ships passing through contaminated water.

Ships operating in contaminated waters might collect and concentrate radioactivity in seawater intake systems.

OCEANIC TESTING OPERATIONS

Implications of oceanic testing have only incidentally been remarked upon. These are now discussed, especially as they relate to DOD operations leading up to and during REDWING.

Marshall Islands Setting

The Marshall Islands are in the easternmost part of the area known as Micronesia ("tiny islands"). The Marshalls spread over about 770 thousand mi^2 (2 million km^2) of the Earth's surface but, the total land area is only about 70 mi^2 (180 km^2). Two parallel chains form the islands: Ratak (or Sunrise) to the east, and Ralik (or Sunset) to the west; both Enewetak and Bikini are in the Ralik chain at its northern extreme. Figure 3 shows these islands in the Central Pacific, Figure 4 is a map of Enewetak Atoll, and Figure 5 is a map of Bikini Atoll.

Typical atolls, Enewetak and Bikini are coral caps set on truncated, submerged volcanic peaks that rise to considerable heights from the ocean floor. Coral and sand have gradually built up narrow islands into a ring-like formation with open ocean on one side and a relatively sheltered lagoon on the inside. Both atolls have two passages, a wide passage and a deep one, that permit access to their lagoons from the sea. Enewetak also has a third. All the islands are low-lying, with elevations seldom over 20 feet (6 meters) above high tide.

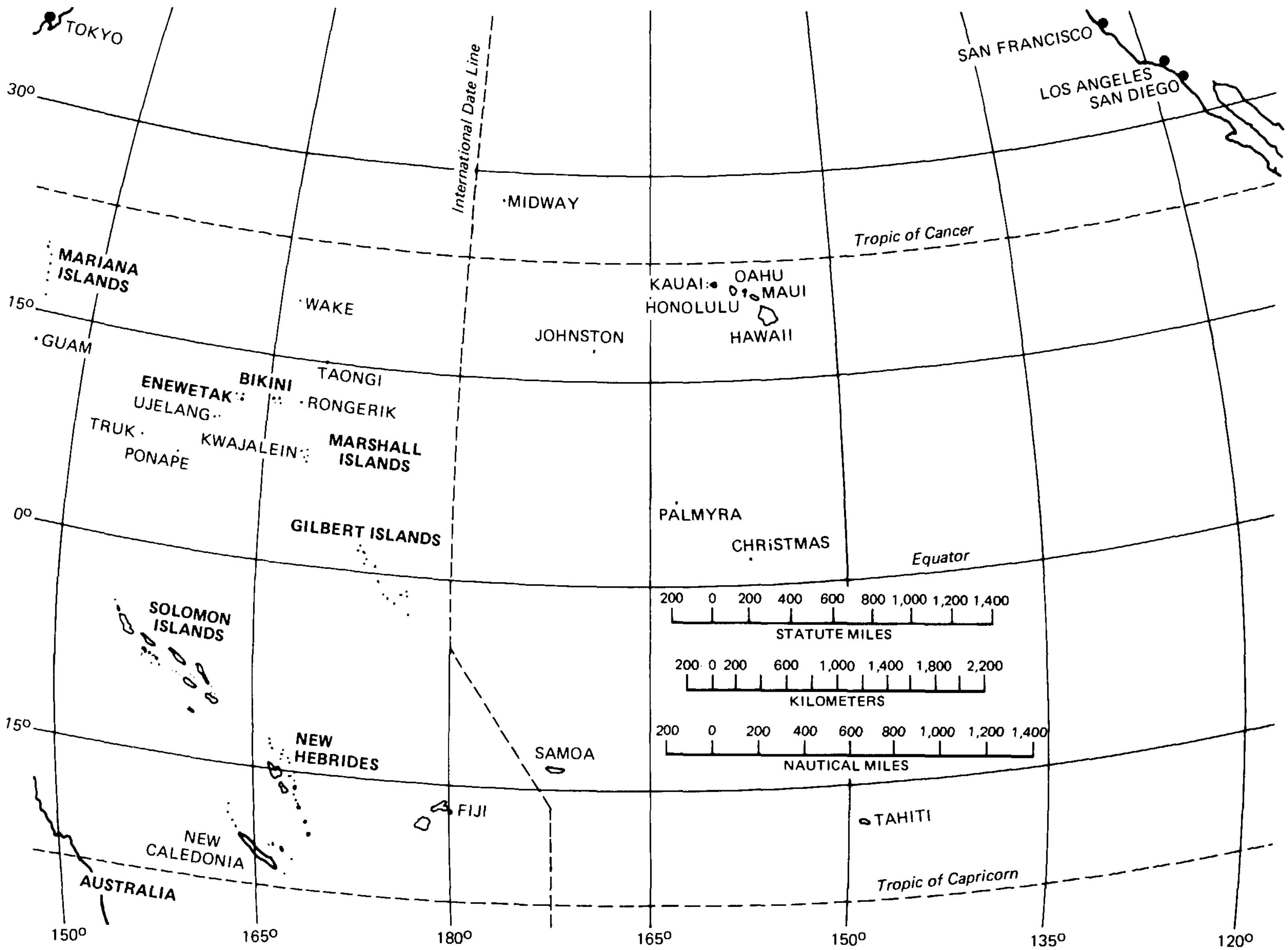

Figure 3. The Central Pacific.

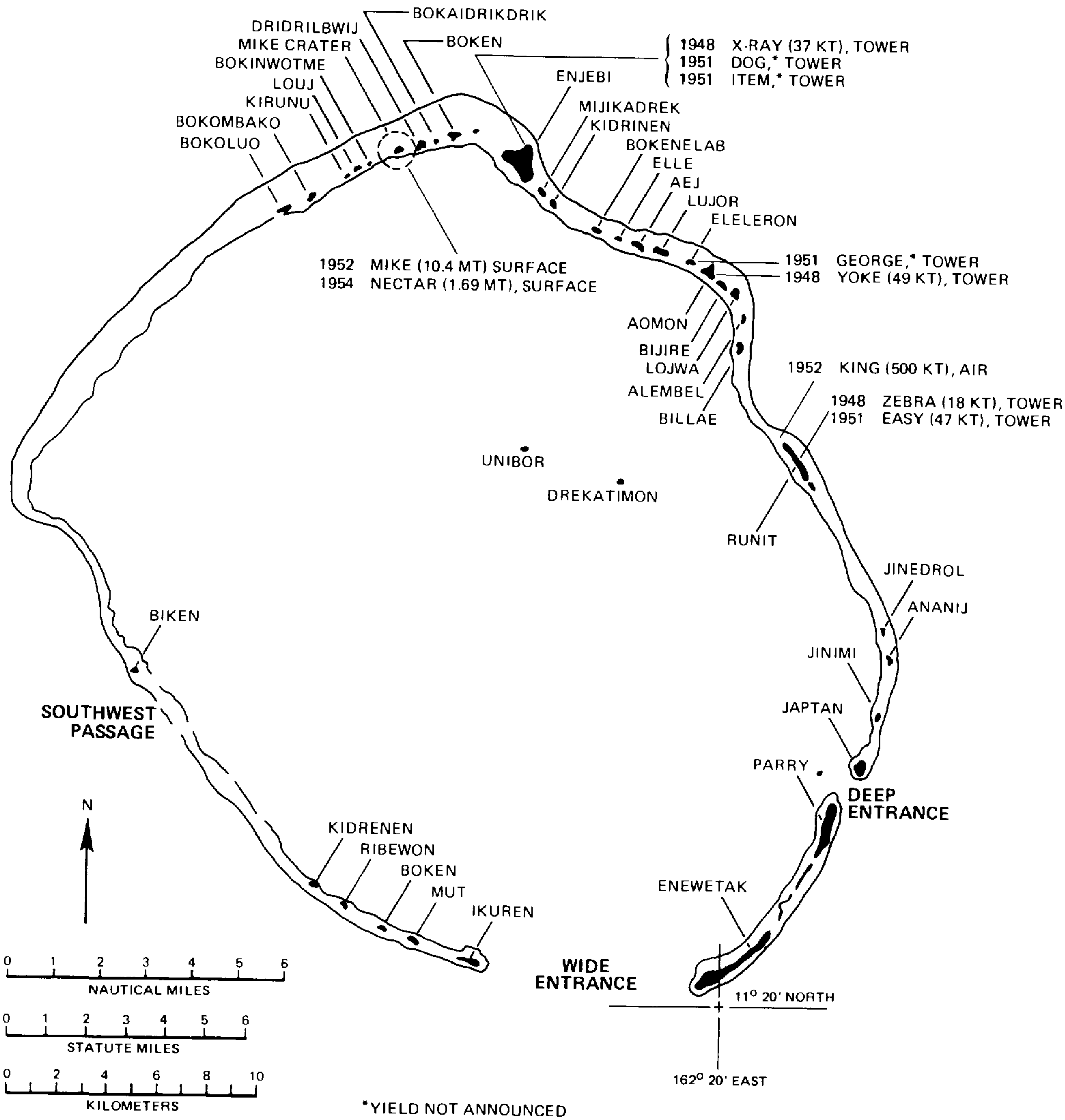

Figure 4. Enewetak Atoll, 1956, with pre-REDWING detonation sites.

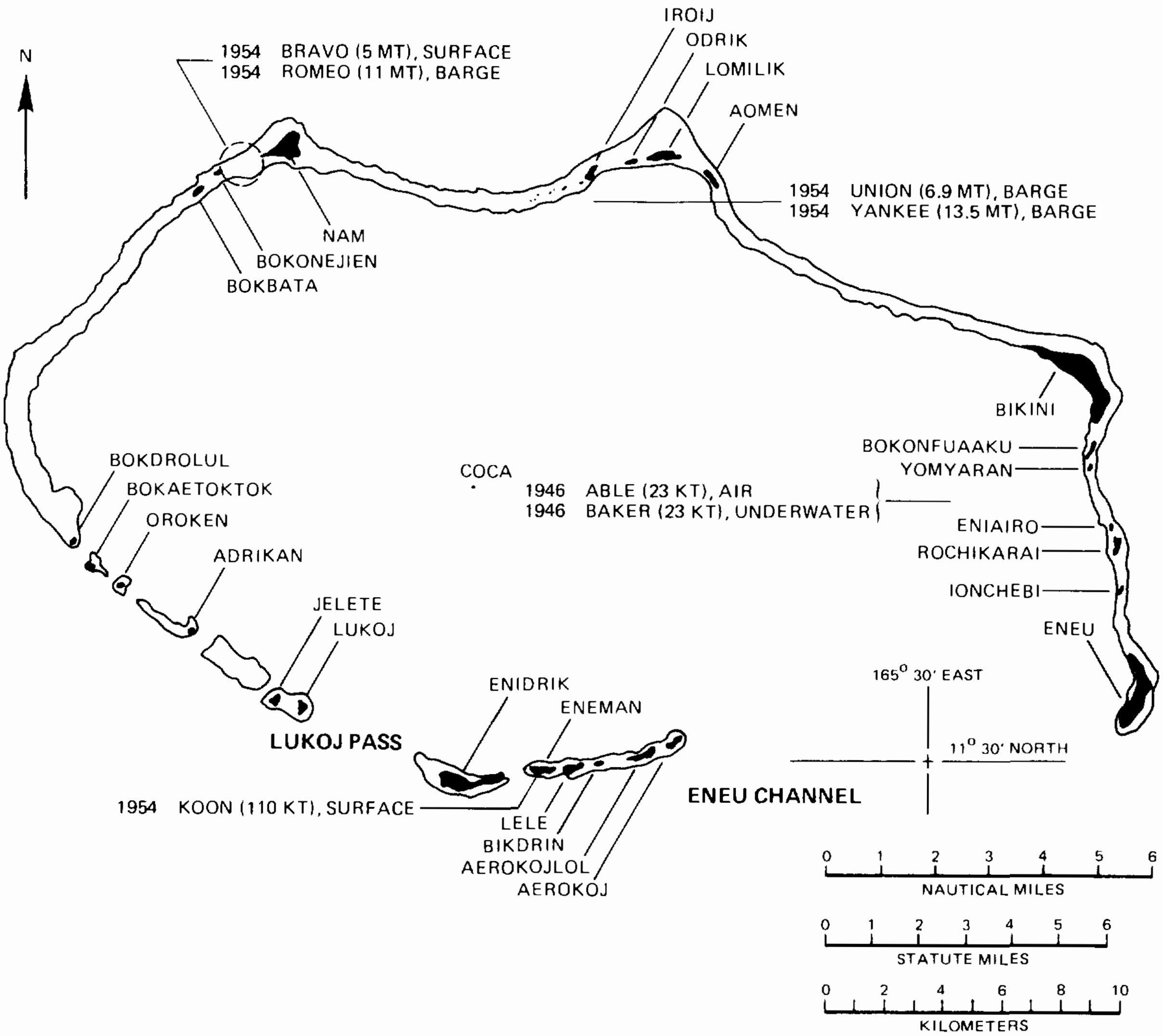

Figure 5. Bikini Atoll, 1956, with pre-REDWING detonation sites.

During nuclear testing, the more populated, support-oriented sections were the south and southeast areas of the atolls where the larger islands exist. Devices were detonated on the northern islands and over the northern reefs. The western sections of the atolls were not involved in test activities except for limited use as instrumentation sites.

Elliptically shaped, Enewetak is approximately 550 nmi (1,020 km) southwest of Wake Island and 2,380 nmi (4,410 km) southwest of Honolulu. It encloses a lagoon 23 miles (37 km) in diameter and has a total land area of 2.75

mi^2 (7.12 km^2), with elevations averaging 10 feet (3 meters) above mean sea level. The support section of Enewetak (Enewetak, Parry, and Japtan islands) constitutes about 34 percent of the atoll's land surface. The string of islands from Runit to Bokoluo, the detonation area, constitutes about 32 percent. The various names used for the islands of the atoll are listed in Appendix C, "Island Synonyms."

Bikini is 189 nmi (350 km) east of Enewetak. Its islands consist of about 2.7 mi^2 (7 km^2) of surface area and encircle a lagoon that is 25 miles (40.2 km) long and 15 miles (24.1 km) wide, with a maximum depth of about 200 feet (61 meters). The land area is concentrated in the eastern islands, from Bikini to Eneu islands, which form about 53 percent of the land total, with 24 percent taken up by the southern section of Enidrik to Aerokoj. The detonation area in the north occupies about 19 percent of the land area.

The climate of Enewetak and Bikini is tropical marine, generally warm and humid. Temperature changes are slight, ranging from 70° to $90^{\circ}F$ (21° to $32^{\circ}C$). Rainfall is moderate, and prolonged droughts may occur. North of both atolls is open ocean for a thousand miles, with the only inhabited island being Wake. Storms are infrequent, although typhoons occur; nevertheless, both wind and sea are continuous erosional agents. Although possible at any time, most tropical storms occur from September to December. Cumulus clouds are abundant in the area.

The Enewetak-Bikini region incorporates three basic wind systems. Northeast trade winds extend from the surface to 25,000 to 30,000 feet (7.6 to 9.1 km), the upper westerlies from the top of the trades to the base of the tropopause at 55,000 to 60,000 feet (16.8 to 18.3 km), and the Krakatoa easterlies from the tropopause up into the stratosphere. These systems are all basically east-to-west or west-to-east currents. Day-to-day changes reflect the relatively small north-south components, which are markedly variable. Greatest variation occurs in the upper westerlies, particularly during late summer and fall.

The steady northeast trade winds in the lower levels cause the water at the surface of the lagoons to flow from northeast to southwest, where it sinks to the bottom and returns along the lower levels of the lagoons, rises to the surface along the eastern arc of the reefs and islands, and is moved by the winds to the southwest again. Lagoon waters moving in this closed loop also mix with those of the open ocean, resulting in a flushing action.

At Bikini, ocean water flows in over the northern and eastern reefs and flows out of the western portion of Eneu Channel. The water exchanges over the western reefs with the tides, ocean water flowing in and mixing with flood and lagoon water that flows out with the lows. The net rate of flushing of Bikini waters is such that half of the lagoon waters are replaced by ocean water in 22 days and the original volume will account for only 10 percent of the lagoon volume after 2½ months.

At Enewetak, the flushing is more rapid and has two major routes. The first is directly through the eastern reefs to the western reefs; the second is through Deep Entrance between Japtan and Parry and out Wide Entrance west of Enewetak. These two routes also function to keep the waters of the northern part of the lagoon separate from the southern waters.

The land areas of Enewetak and Bikini atolls, their lagoons, and the waters within 3 miles (4.8 km) of their seaward sides constituted the PPG. These islands are part of the Trust Territory, a strategic area trusteeship of the United Nations, administered by the United States. The U.S. agency in charge of the PPG itself was the AEC.

The Test Division of the AEC Division of Military Applications administered the test site through its Enewetak Branch Office, which supervised engineering, construction, maintenance, operation, and management activities performed by its contractor, Holmes & Narver, Inc. (H&N).

PHYSICAL CONDITIONS IN 1956. Enewetak had been the site of nuclear testing since 1948: the islands in the southeast quadrant served as the base for the task forces, and the islands from north through east-northeast were used for the tests themselves. The test islands had been graded extensively. The principal base islands were Enewetak, which bordered Wide Entrance, and Parry, northeast of Enewetak, which bordered Deep Entrance. These two islands constitute about 30 percent of the atoll's land area.

Parry and Enewetak had been densely populated during the CASTLE tests, serving as the home and working facilities for JTF 7 except for those living aboard ships. Included in the working facilities was an airfield occupying the southern end of Enewetak. Shops, warehouses, laboratories, and living space occupied most of the rest of the island's area.

During the preparation for REDWING, a number of construction projects were undertaken in the PPG. These projects can be divided into two broad categories: expendable test facilities, and improvements to the permanent camps on Enewetak and Parry islands. Some of the test facilities and improvements that existed during REDWING are shown in Figures 6 through 9.

Expendable test facilities included several classes of projects:

1. Scientific stations for measuring test data and ground zero facilities for housing devices at detonation. These structures were on islands of the two atolls, on manmade islands, or in shallow water near the natural islands. On Enewetak Atoll the following islands were used: Billae, Dridrilbwij, Bokaidrikdrik, Boken, Enjebi, Lujor, Eleleron, Aomon, Bijire, Lojwa, and Runit. On Bikini

Figure 6. Recording bunker, Bikini Atoll, REDWING.

Figure 7. Construction on Runit Island, Enewetak Atoll, construction camp in foreground; REDWING.

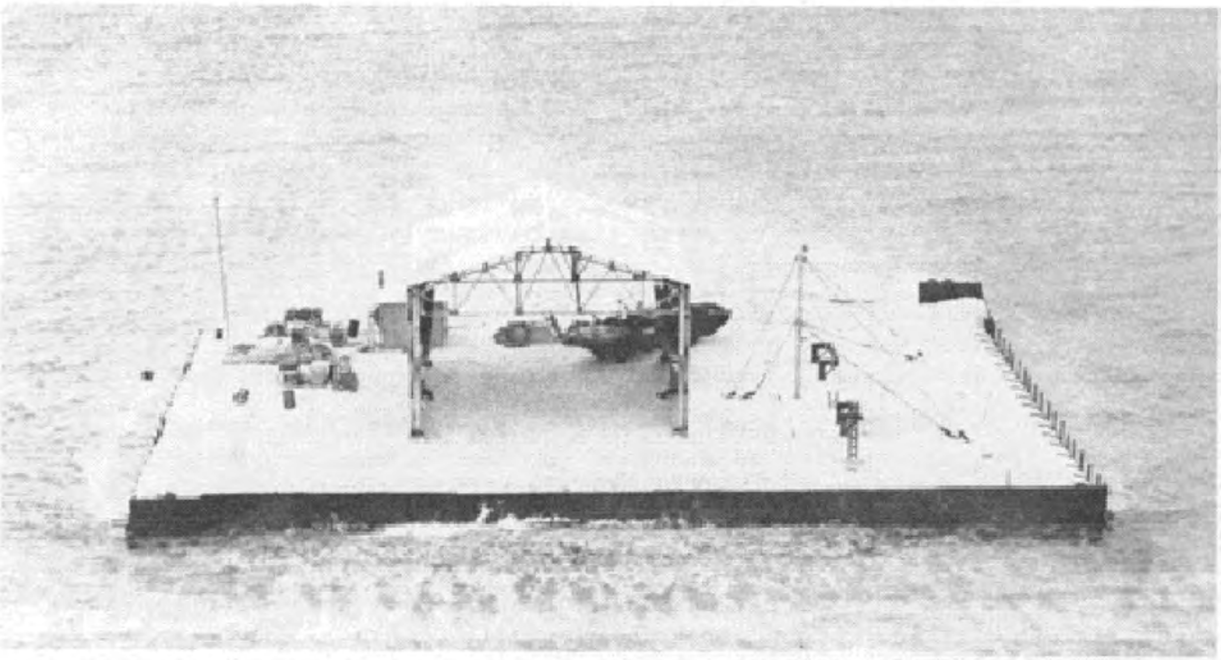

Figure 8. Manmade island on Bikini Atoll constructed for REDWING showing structures response experiment.

Figure 9. Smoke rocket launch platform on reef, REDWING.

Atoll, Bokbata, Nam, Iroij, Odrik, Lomilik, Aomen, Aerokoj, Aerokojlol, Eneman, Lele, Bikdrin, Enidrik, Jelete, and Lukoj were used.

2. Causeways and manmade islands. Existing causeways (between Dridrilbwij, Bokaidrikdrik, and Boken; between Aerokojlol, Bikdrin, Lele, and Eneman; and between Iroij, Odrik, Lomilik, and Aomen) were refurbished. Three islands were built on the reef between Iroij and Nam. An island and two causeways were built offshore from Runit, and an island with connecting causeway was built offshore from Aomen.

3. Interatoll communications. An interatoll communications system was set up with 17 very-high-frequency (VHF) circuits between communications centers on Parry and Eneu.

4. Cable installations. Over 2 million feet (600 thousand meters) of various sizes of land and submarine coaxial, telephone, and signal cables were laid.

5. Temporary camps, airstrips, and helicopter pads. Temporary camps were built on Eneman and Dridrilbwij. Airstrips on Bijire, Enjebi, and Runit were repaired and modified. A new airstrip was built on Dridrilbwij, and helicopter pads were built at eleven sites.

Numerous improvements were made to the two permanent camps during buildup. On Enewetak Island, these included a guest house, a chapel, three quartermaster warehouses, an operations and administration building, three field maintenance shops, an electronics and communications building, a crash fire station, an ordnance warehouse, a naval warehouse, and an addition to the laundry. Also, physical improvements to Air Force facilities in the PPG were made by H&N.

The Operations and Administration Building was constructed, which housed the Air Force task unit headquarters, the aircrew briefing room, and a personal equipment room. Five other buildings were erected for the Air Force support group, an electronics maintenance shop, an engine buildup facility, and three warehouses. Lack of sheltered working space was solved through loan of seven Complete Assembly Shelters from the Armed Forces Special Weapons Project (AFSWP).

Runway arrest barriers to accommodate emergency landings for jet aircraft were installed at the northeast end of the runway on Enewetak and at the southeast end of the runway on Eneu; in addition, a Navy-type net barrier was added at Enewetak. Other barriers were installed on the emergency landing strips at Enjebi and Aerokoj-Aerokojlol.

To avoid electrical noise on Enewetak Island and to allow more space for antennas, H&N built a high-frequency (HF) and Loran receiving station on Japtan, lying just across Deep Entrance from Parry, for joint use by the Air Force, the Army support group, and the Coast Guard. Although this required new construction, the record is unclear on whether any of the buildings already on the island were refurbished and used for the supporting camp or only new buildings were used. The island also had a joint task force recreational facility under Navy control, and still contained a considerable stand of coconut palms, pandanus, scaevola, and other tropical vegetation.

RADIOLOGICAL CONDITIONS. No radiological survey report has been found that details the radiological conditions on Enewetak in 1955 before the REDWING series. Enewetak had been used for nuclear tests in 1948, 1951, 1952, and 1954. The Operation SANDSTONE (1948) detonations on Enjebi, Aomon, and Runit left portions of these islands radioactive. In October 1948, an H&N reconnaissance party described areas of radioactivity with radii of about 1,000 feet

(305 meters) around each shot tower. Radioactivity within each area would have resulted in exposure beyond the then-accepted daily limit of 0.1 R/hr.

The GREENHOUSE (1951) detonations were on Enjebi, Eleleron, and Runit and left these islands and other areas contaminated. The DOG and ITEM tower residues were left in place on Enjebi after GREENHOUSE. Shot GEORGE of GREENHOUSE left a large crater on Eleleron that had readings of 0.050 to 0.095 R/hr in February 1953.

MIKE, the first thermonuclear device, was detonated on Eluklab, Enewetak Atoll, in 1952 during Operation IVY, destroying the island and leaving an underwater crater. Eluklab had been located just west of Boken, at the northernmost extension of the atoll. A large, airdropped device was exploded over the reef just off Runit as the second event of the IVY series. In 1954, a large-yield device was detonated on a barge in the water overlying the MIKE crater. Locations of the pre-REDWING detonation sites at Enewetak are shown in Figure 4.

Bikini was the location of the first postwar nuclear detonation. In July 1946, the CROSSROADS tests were conducted in the lagoon. Two 23-KT devices were detonated: an airburst over a target fleet, and an underwater burst in the lagoon about 2 miles (3 km) west of Bikini Island. No continuing radiological exposure of personnel on the surface at Bikini occurred from these tests, although the lagoon bottom had very-low-level contamination.

Bikini was not used again for testing until the CASTLE Series in 1954, when five devices were detonated there. The first of these was the 15-MT BRAVO device that spread radioactive contamination over the entire atoll and well beyond, but especially in an easterly direction from its detonation point, which was a manmade island on the reef near Nam Island in the northwest corner of the atoll. Three other large-yield devices were detonated on barges at Bikini in 1954, one in the BRAVO crater and two in the lagoon about a mile (1.5 km) south of Iroij, near the center of the string of islands on the atoll's northern perimeter. These formed an underwater crater, usually called the UNION crater after the name of the first of the two tests.

The western end of Eneman Island on the southern perimeter of Bikini Atoll was the site of a 110-KT surface detonation, also in 1954. This lower-than-planned yield may have resulted in the deposit of fissionable materials (uranium and plutonium) near the burst point.

The locations of the pre-REDWING detonation sites at Bikini are shown in Figure 5.

Special Problems in Oceanic Testing

Testing in the Marshalls offered a large uninhabited area for test activities and for the favorable disposition of the test debris if the winds were in the right direction. However, the area was almost all water, offering little land for shot towers, instrumentation shelters, support structures, and housing. At Enewetak Atoll, the total land area is only about 1,800 acres (730 hectares), and the prime acreage in the southeastern quadrant (about one-third of the total) housed that part of the task force not based on ships. The land area of Enewetak Island, the largest of the atoll, is only about 320 acres (130 hectares), and about half of this was occupied by an airstrip and associated activities. Furthermore, the land suitable for testing was not necessarily distributed in the appropriate directions and sizes for instrument placement. Lack of land area was one of the factors necessitating the use of both Bikini and Enewetak atolls, starting in 1954 with CASTLE. The addition of Bikini also precluded damage to the Enewetak facilities by very large devices.

The lack of land was compensated for in part by civil engineering projects. Causeways were constructed that linked strings of islands to support the long pipe runs of some experiments over thousands of feet. These also permitted the land transportation from construction camps to proposed zero points, thus allowing more time during the workday to be expended on the job rather than in commuting by water from base islands. Some artificial islands were created as shot points and instrument locations.

Floating data-collection stations compensated for the lack of land area. These were used extensively in the nuclear radiation program. Anchored rafts and buoys, serving as fallout-collection stations, were placed in the lagoon and in the open sea. Ships also acted as fallout collectors. These offered the advantage of moving to the most desirable collection areas, that is, areas of heaviest fallout, and following the fallout within the limits of their speed. Three ships were modified for remote operation and control from other locations or below decks, where heavily shielded quarters protected skeleton crews and scientific parties.

Barge-mounted test devices, a technique first used in 1954, also compensated for the lack of land at the PPG. This allowed the available land area to be used for the placement of measurement instrumentation and reuse of the same burst point without the long delays required for radiological decay and expensive or long decontamination procedures. Reuse of zero points also allowed use of instrument locations and recording shelters for multiple tests, saving construction costs and time and increasing test-scheduling flexibility.

The use of shot barges, however, precluded acquisition of some weapon development data that required a precise line of sight between the test device and the recording instrumentation. Barge movement by lagoon currents was minimized by special mooring techniques, but not to the degree necessary for some measurements. The barges also precluded the use of the pipe runs required for some other diagnostic measurements.

Shot barges fitted well into the two-atoll testing scheme that had been developed for the PPG, and barges were used at both Bikini and Enewetak for six REDWING shots. Enewetak was the base of operations and Bikini was like another shot island, except that its remoteness allowed very-large-yield tests without endangering the permanent facilities at Enewetak or requiring its evacuation. Bikini was without permanent facilities and depended on Enewetak for its overhead support. Part of this support was the combination of personnel, equipment, and materials required to assemble the test devices themselves. The device assembly area at Enewetak and the barge-zero stations allowed most of the support function to remain at Enewetak.

JOINT TASK FORCE 7

JTF 7 was established as a permanent organization in 1953 to conduct nuclear weapon testing in the Pacific. It existed through 1958 when it conducted HARDTACK, the last test series before the nuclear test moratorium of

1958-1961. JTF 7 was the successor to JTF 132, which had conducted the IVY test series in 1952.

The joint task force incorporated into its organization elements of the four services, other governmental agencies including the AEC, and civilian organizations. The AEC, charged with responsibility for nuclear energy development by the Atomic Energy Acts of 1946 and 1954, designated CJTF 7 as its representative. JTF 7 was also a subordinate command of the Commander in Chief of the Pacific (CINCPAC), who provided overall security and logistic support. The Chief AFSWP exercised technical direction of the weapon effects tests of primary concern to the Armed Forces. The complexity of these relationships is illustrated in Figure 10.

The resulting organization, though complex, had worked well enough in 1954 (CASTLE), as it conformed with the realities of the situation. The realities in 1956 were the same as in 1954: the tests were being conducted to develop

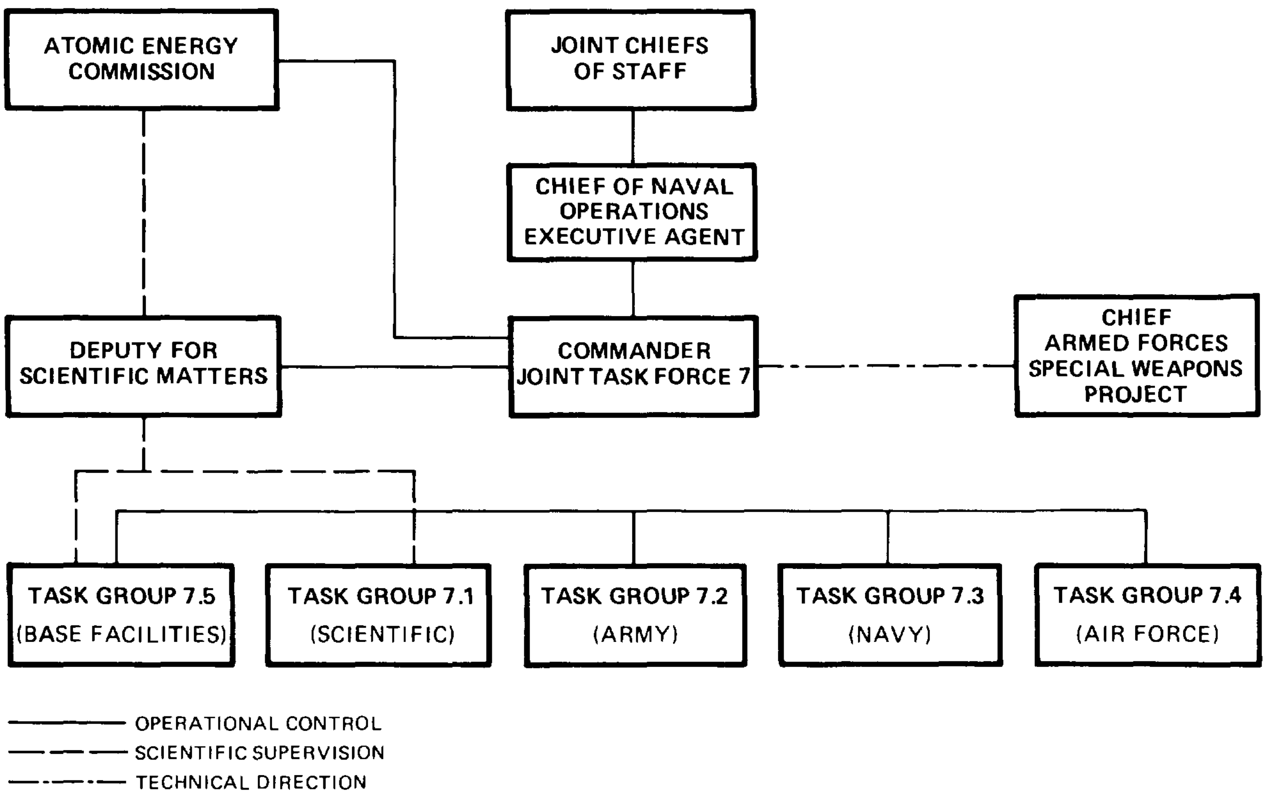

Figure 10. Joint Task Force 7 organization chart, REDWING.

nuclear weapons, an activity limited by law to a civilian agency, the AEC. The tests were being conducted in an area that came under the jurisdiction of the AEC (in the sense that the AEC was the U.S. government agency primarily responsible for the islands that were included in the PPG). The United States, however, did not actually own the territory being used but rather held it in trust. Furthermore, the territory was remote from the United States and required special supply and security arrangements appropriate to military operations. Finally, the organization for which the weapons were being developed was the U.S. military establishment.

DOD requirements for nuclear weapons came to the AEC weapons laboratories through the Military Liaison Committee. The AEC laboratories then designed the devices that were tested at the appropriate proving ground, either the Nevada Test Site or the PPG. The special location of the PPG required a military operation to conduct the tests. The JTF 7 Scientific Director actually directed the tests and CJTF 7 enforced his decisions.

The task force was composed of a headquarters group and five task groups (see Figure 10). Three were organized by service -- the Army as Task Group 7.2 (TG 7.2), Navy (TG 7.3), and Air Force (TG 7.4) -- and two along functional lines. The latter were TG 7.1 (Scientific) and TG 7.5 (Base Support). The basic mission of the headquarters and all task groups was to execute or support the experimental program. The way task groups carried out this mission varied with the special capabilities of the organizations in each group. All five task groups contributed to alleviating common task force concerns such as security and safety. Radsafe activities are the subject of Chapter 2.

Headquarters elements were located at Parry during REDWING, but there were small contingents at Eneu as well as many other offsite locations. Composition of the headquarters staff was almost entirely military. Total headquarters personnel numbered 202, with 146 of these at the test site.

Task Group 7.1 (Scientific)

TG 7.1 was made up of AEC laboratory personnel, DOD agency personnel, service laboratory personnel, other government agency civil servants, and civilian contractors. Peak strength was approximately 1,630 persons. The function of this group was to conduct the experiments. This included the following task responsibilities:

1. Position, arm, and detonate the atomic devices
2. Make technical diagnostic measurements of the detonations
3. Integrate the AEC and DOD measurement programs
4. Provide technical assistance during loading, interatoll movement, and positioning of the experimental devices
5. Be responsible for the removal of all TG 7.1 personnel and necessary equipment from the destruction area for each detonation
6. Integrate into TG 7.1 a task unit (TU 3) representing AFSWP to conduct weapon effects measurements for the DOD
7. Conduct postshot damage and radiological contamination surveys and recommend to CJTF 7 a reentry schedule
8. Provide special communications required for the conduct of scientific test programs and voice countdown for all elements of the task force
9. Provide radiological laboratory services, ground monitoring, and technical assistance for all elements of the task force.

The organization of the scientific task group is shown in Figure 11. TG 7.1 was divided into several staff and administrative units and twelve task units that corresponded with each of the AEC laboratories or the DOD's experimental program, or that provided a key element of support for the scientific programs such as timing, firing, and radiological safety. The task units were quite unequal in size, varying from nearly 800 personnel for TU 3 (DOD Programs), to a half-dozen for TU 6 (Firing).

TASK UNITS 1, 2, 8, 9, 10, 11, AND 12 -- WEAPON LABORATORIES. The first two task units were from the weapon laboratories, Los Alamos Scientific Laboratory (LASL) (TU 1) and University of California Radiation Laboratory (UCRL) (TU 2). These task units manned the weapon development experiments conducted by each laboratory in conjunction with the tests of the devices each laboratory provided. Each laboratory had small support groups that actually assembled the weapons (TU 10 for LASL, and TU 11 and TU 12 for UCRL) and provided specialized documentary photographic services (TU 8 for LASL and TU 9 for UCRL).

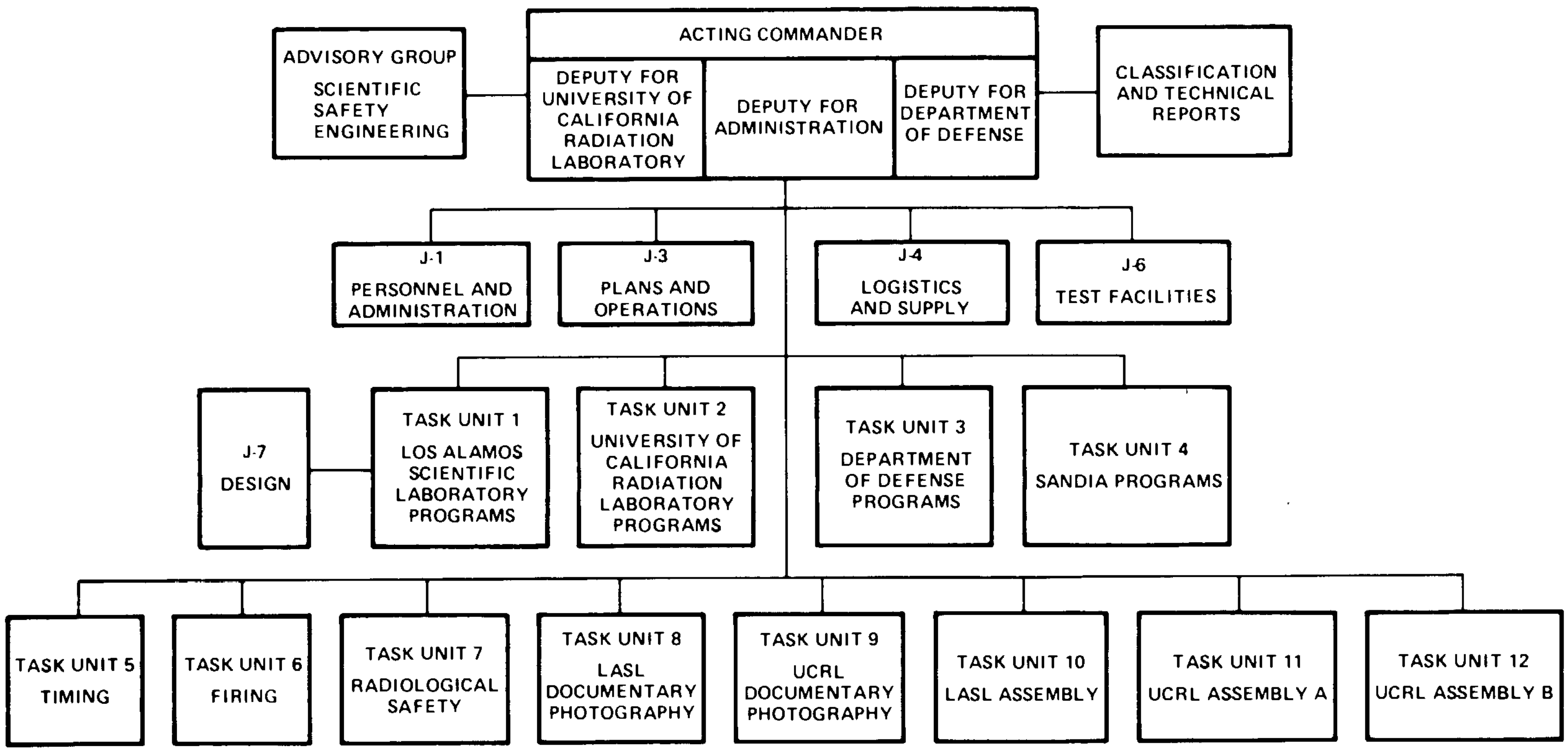

Figure 11. Task Group 7.1 organization chart, REDWING.

TASK UNIT 3 -- DOD PROGRAMS. The DOD effects program was subdivided into programs focused in areas such as blast, nuclear radiation, thermal radiation, etc. These programs were subdivided into projects, whose composition is described in Chapter 3.

TASK UNIT 4 -- SANDIA CORPORATION. The Sandia Corporation, a subsidiary of the Western Electric Company, operated Sandia Laboratory for the AEC. Sandia's function in nuclear weapon development activities was to design and coordinate the transformation of the devices designed by the weapon laboratories into the operational weapons for the DOD. Sandia conducted several experiments appropriate to this activity as TU 4. TU 4 was composed entirely of Sandia Corporation employees.

TASK UNITS 5 AND 6 -- WEAPON EXPERIMENT SUPPORT. These two task units performed special activities that were directly connected with the conduct of the tests. TU 5 (Timing) provided the circuitry that connected the nuclear device and the firing center and carried the detonation signal to the device. TU 6 (Firing) was a small group that activated the firing mechanism through circuits leading from the firing center. For Bikini events, except ZUNI, firing was initiated from a bunker on Eneu.

TASK UNIT 7 -- RADIOLOGICAL SAFETY. TU 7 was the basic radsafe unit for the entire task force. TU 7 did not provide monitors for all activities in radiological exclusion (radex) areas, as these were usually provided by the project or activity itself. TU 7 did provide monitors in radiological survey activities. The activities of TU 7 are described in Chapter 2.

Personnel for TU 7 were provided by an Army unit, the 1st Radiological Safety Support Unit (RSSU) of Fort McClellan, Alabama, supplemented by a few Air Force and Navy personnel and civilians from naval shipyards throughout the United States.

Task Group 7.2 (Army)

TG 7.2 consisted of Army units, the largest of which was permanently stationed at the PPG. This group provided certain housekeeping functions at the Enewetak base camp and special services such as long-range communications.

Peak strength was approximately 1,280 persons. The group was charged with the following tasks during REDWING:

1. Provide communications and cryptographic facilities for all elements of the task force on Enewetak Island and for Hq JTF 7 on Parry Island to major ships in the PPG and to terminals at Oahu and Kwajalein
2. Operate communication facilities on Japtan Island and all base facilities at Enewetak Island, except those specifically allocated to CTG 7.4 and CTG 7.5
3. Provide, in coordination with CTG 7.5, for security of exclusion areas, and security at ports of entry at Enewetak and Bikini atolls
4. Be prepared to conduct emergency postshot evacuation of all personnel based on Enewetak and Japtan islands.

The organization of TG 7.2 is shown in Figure 12. During the interim phase between CASTLE and REDWING (June 1954 to June 1955), TG 7.2 was the primary operational military unit within the PPG under CJTF 7 control.

7126th ARMY UNIT. This organization provided most of the personnel for TG 7.2. It was the permanent garrison force at Enewetak between CASTLE and REDWING. Except for its military police detachment and several mail clerks on Eneu and Parry, the 7126th was stationed on Enewetak Island. Military police were used throughout the atoll. Personnel strength is listed in Table 2.

To accommodate the buildup to REDWING's operational phase, the 7126th AU was reorganized into the following four detachments: Headquarters, Service, Transportation, and Military Police (see Table 3). TG 7.2 was, in effect, a housekeeping unit, providing garrison and support elements for the joint task force in the PPG. The 7126th AU operated base facilities on Enewetak Island for tenant units and its own components. It provided security and ground defense for the atoll, operated the military communications system, and conducted radsafe functions on Enewetak Island.

505th MILITARY POLICE BATTALION COMPANY C. This organization was brought in to supplement the military police detachment of the 7126th AU. They were part of TG 7.2 and reported to the TG 7.2 Provost Marshal. The personnel arrived in three groups in February and March. They were stationed throughout both Bikini and Enewetak atolls and in early April were distributed as follows:

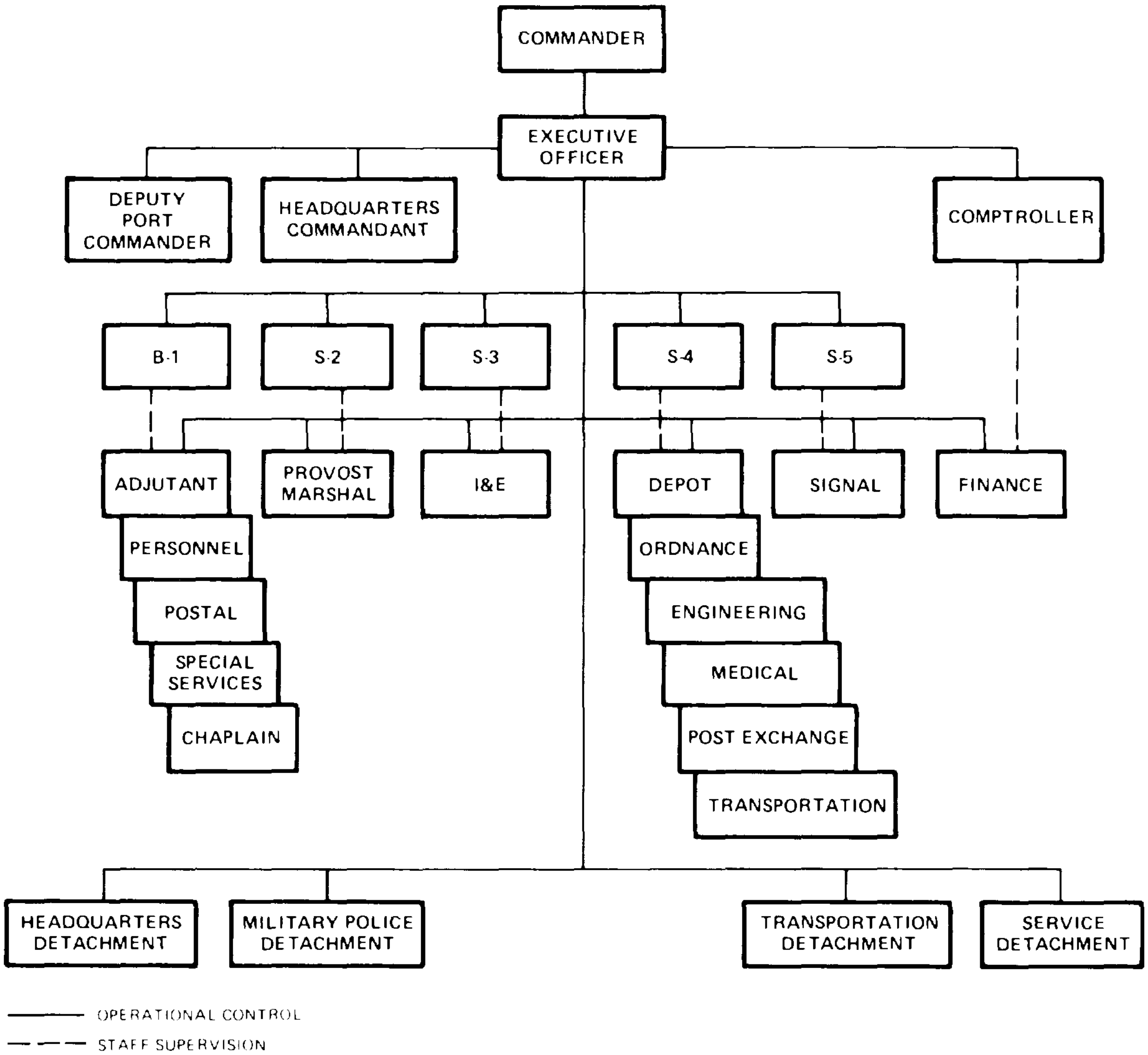

Figure 12. Task Group 7.2 organization chart, REDWING.

Table 2. 7126th Army Unit personnel strength at Enewetak, 1955-1956.

Date	Officers	Enlisted Men	Temporary Duty Officers	Temporary Duty Enlisted Men
31 Jul 55	53	567	---	4
31 Aug 55	52	565	---	4
30 Sep 55	52	578	1	3
31 Oct 55	62	654	1	6
30 Nov 55	60	640	1	17
31 Dec 55	64	671	1	20
31 Jan 56	66	698	3	21
29 Feb 56	65	759	3	44
31 Mar 56	67	769	6	40
30 Apr 56	70	784	3	36
31 May 56	66	806	3	38
30 Jun 56	66	791	1	34
31 Jul 56	71	719	2	23

Table 3. Task Group 7.2 personnel strength, REDWING buildup phase.

	Officers	Enlisted Men	Total
7126th Army Unit (by detachment)[a]			
Hq & Hq Detachment	39	348	387
Service Detachment	15	235	250
Military Police Detachment	3	38	41
Transportation Detachment	6	147	153
Total	63	768	831
Company C 505th Military Police Battalion[b]	8	229	237
8600th Administrative Area Unit, 2nd Army Security Agency Detachment[c]	4	38	42

Notes:

[a]Assigned authorized strength.

[b]Assigned actual strength (March 1956).

[c]Assigned actual strength (January 1956).

Enewetak Atoll			Bikini Atoll		
	Enewetak Island	17		Eneu	39
	Runit	20		Lomilik	16
	Lojwa	20		Eneman	30
	Dridrilbwij	29			

An additional guard post was set up on 27 June at Ananij, Enewetak Atoll. The policy of the CTG 7.2 was to rotate the personnel among the guard posts (Reference C.2.2).

As the advance camps were progressively closed, the requirements for guard posts were reduced, and as early as June 1956, 71 of these Company C MPs had been withdrawn. Following HURON, all but 24 were returned to the United States. The last group left about 1 August.

8600th ARMY UNIT, 2nd ARMY SECURITY AGENCY DETACHMENT. This detachment provided communications transmission security support for CJTF 7. The detachment, which consisted of four officers and thirty-eight enlisted men, arrived at Enewetak in January 1956. It established monitoring stations on Enewetak Island that month and one on Eneu in February.

The Enewetak Detachment consisted of three officers and twenty-six enlisted men. This unit discontinued operations on 14 July. The Eneu Detachment of one officer and twelve enlisted men discontinued Eneu operations 10 July. The entire group was evacuated from Enewetak to the United States by air on 15 July.

Task Group 7.3 (Navy)

TG 7.3 was composed of naval ships and units whose functions included evacuating Bikini at shot time, manning ships and aircraft bearing experimental teams, and sealift support. This group also contained a Marine Corps helicopter unit. TG 7.3 peak strength was approximately 6,600 persons, primarily based aboard ships at Bikini. Tasks specified for this group were:

1. Before each shot conduct aircraft patrols of significant sector(s) of the danger area to detect, report, and warn surface shipping; be prepared to escort shipping out of the danger area
2. Provide support for Navy and Air Force aircraft at Kwajalein in connection with the operation

3. Provide a boat pool to augment existing interisland transportation at Enewetak and Bikini atolls
4. Provide an interatoll surface transportation system to support joint task force elements in the PPG area
5. Operate a ship-to-shore and interisland helicopter lift system at Bikini to support preshot operations and postshot flights for damage and radsafe surveys and for recovery of scientific data; be prepared to assist CTG 7.4 in the conduct of this activity at Enewetak
6. Provide surface transportation for radioactive samples from Bikini to Enewetak as required
7. Provide capability for emergency postshot evacuation of personnel where preshot evacuation is not conducted
8. Transport devices on barges between Enewetak and Bikini atolls
9. Provide shipboard assembly facilities on USS Curtiss for the experimental devices and laboratory, shop, office, and stateroom space for TG 7.1
10. Provide space on USNS Fred C. Ainsworth as required by TG 7.1 for the radsafe operation center, a mobile radiochemistry laboratory, and a photodosimetry laboratory; provide space on USS Badoeng Strait for a radsafe checkpoint and radsafe briefing, and on USS Estes and Curtiss for radsafe checkpoints
11. Provide command, communication, and cryptographic facilities for CJTF 7 and staff afloat and intra-TG 7.3 communications as required
12. Provide shipboard facilities to accommodate the joint task force while afloat at Bikini during those shots requiring preshot evacuation of personnel
13. Provide facilities aboard Estes for Joint Task Force Weather Central and communications security monitoring personnel
14. Provide for the radiological safety of embarked task force personnel during the period when the joint task force is afloat
15. Be responsible for all aircraft decontamination at Bikini
16. Provide decontamination crews for TG 7.3 aircraft at Enewetak Atoll, under supervision of the TG 7.4 decontamination officer, in the event any TG 7.3 aircraft must be decontaminated there
17. Assist in positioning and mooring barges involved in the test programs
18. Assist TG 7.1 in placement and recovery of floating devices for pressure and fallout measurements

19. Control harbor operations of TG 7.3 vessels at Enewetak and Bikini

20. Assist CTG 7.4 in search and rescue (SAR) operations as required.

TG 7.3 was organized into ten units, several of which were subdivided into elements (see Figure 13). The ten main units were: Flagship Unit, Carrier Unit, Utility Unit, Surface Patrol and Transport Unit, Patrol Plane Unit, Naval Station Unit, Radiological Support Unit, Boat Pool Unit, Special Devices Unit, and Accommodation Ship Unit.

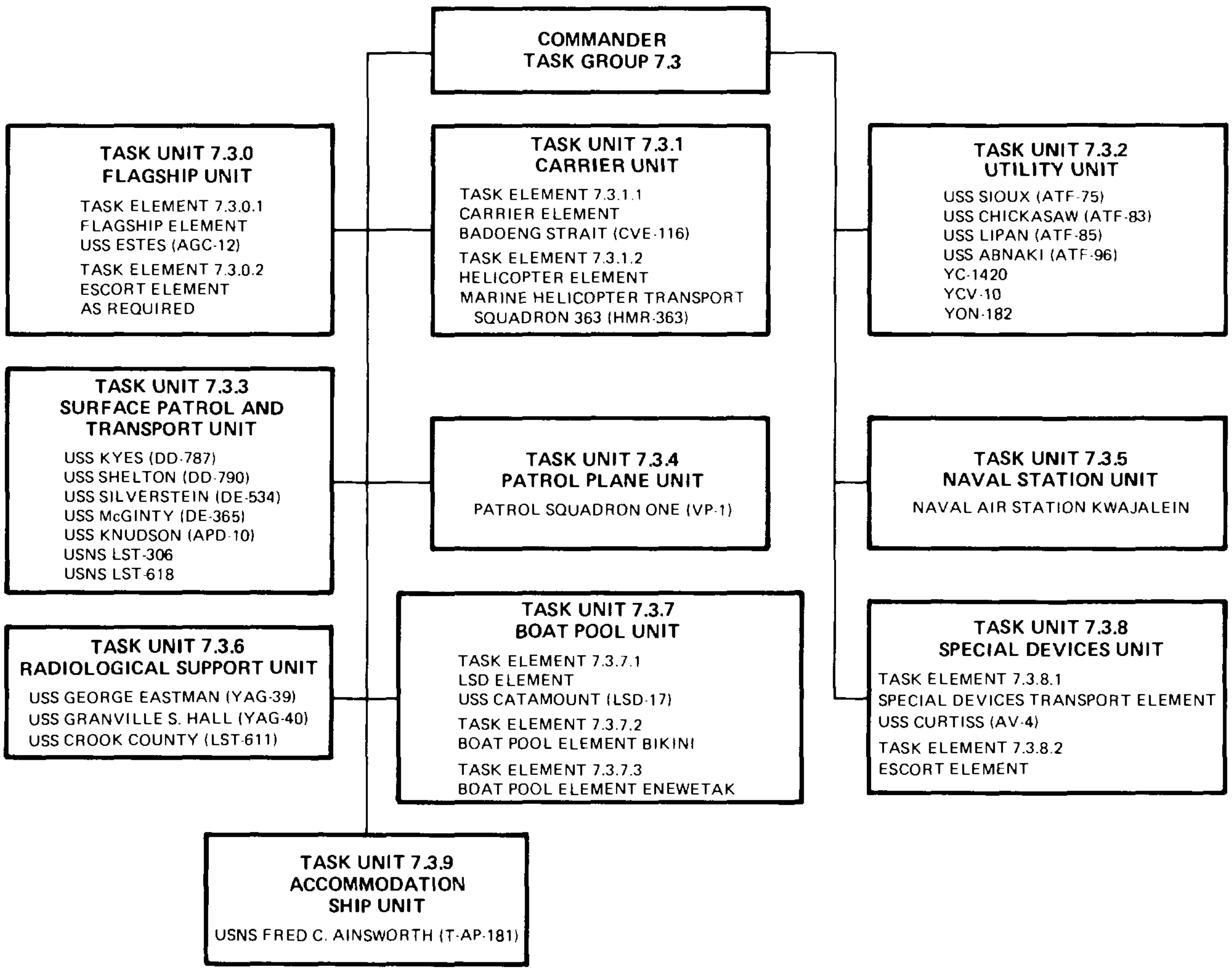

Figure 13. Task Group 7.3 organization chart, REDWING.

FLAGSHIP UNIT (TU 7.3.0). As the name implies, the Flagship Unit provided the element (Estes) that was the command center for TG 7.3 (in addition to serving as the flagship for the CJTF 7 and CTG 7.3). Estes also functioned as Program 2 (Nuclear Radiation and Effects) control center, the Joint Operations Center (JOC), and the Combat Intelligence Center (CIC) for Bikini operations. An escort element provided destroyers as required.

CARRIER UNIT (TU 7.3.1). The Carrier Unit consisted of a carrier element and a helicopter element. The Carrier Element was Badoeng Strait and operated the ship-to-shore and interisland helicopter airlift at Bikini, in addition to supporting several projects with the Raydist navigation system master unit installed on its forward flight deck. Decontamination facilities were another aspect of the carrier element.

The Helicopter Element was Marine Helicopter Transport Squadron (HMR-363) and provided ship-to-shore and interisland airlift at Bikini. This element was also assigned certain radiological survey and aerial probe missions.

UTILITY UNIT (TU 7.3.2). The Utility Unit consisted of four fleet tugs and three unmanned service craft; in addition, the unit operated three other unmanned service craft and four nonpropelled rafts that were not formally part of the task unit. The tugs assisted in mooring ships and other seacraft, provided towing services, and positioned skiffs in support of scientific projects.

SURFACE PATROL AND TRANSPORT UNIT (TU 7.3.3). The Surface Patrol and Transport Unit performed several tasks. Four of its ships escorted the Special Devices Unit during shipment of device materials from the United States to the PPG. The unit also collected meteorological information, acted as barrier and antisubmarine patrol, and assisted in radiological surveys. Interatoll surface transportation was provided by this unit, as were lifeguard and personnel evacuation services.

PATROL SQUADRON UNIT (TU 7.3.4). This unit incorporated 15 P2V-5 aircraft based at Kwajalein. The aircraft conducted preshot patrol and scientific project flights to determine dispersion of radioactive material.

NAVAL STATION UNIT (TU 7.3.5). In addition to being the base for Patrol Squadron One (VP-1), the Naval Air Station at Kwajalein provided facilities for Military Air Transport Service (MATS) aircraft supplying the task force. The unit also served amphibious aircraft on supply trips to outlying weather islands.

RADIOLOGICAL SUPPORT UNIT (TU 7.3.6). This unit supported the scientific projects of Program 2. The three ship elements involved carried extensive instrumentation for fallout sampling and had previously undergone substantial modifications to allow operation from shielded control rooms.

BOAT POOL UNIT (TU 7.3.7). Three elements constituted this unit: the Landing Ship Dock (LSD) Element and the Bikini and Enewetak Boat Pool Elements. The LSD Element, USS Catamount, resupplied and maintained the Bikini Boat Pool and assisted in evacuation at Bikini Atoll. In addition, this element transported some devices from Enewetak to Bikini and served as a radsafe checkpoint.

The Bikini Boat Pool Element shared responsibility for intra-atoll surface transportation with the TG 7.5 boat pool, in addition to providing scientific project support.

The Enewetak Boat Pool Element was responsible for intra-atoll surface transportation of JTF 7 personnel.

SPECIAL DEVICES UNIT (TU 7.3.8). This unit consisted of two elements: transport and escort. The Transport Element (Curtiss) had the important mission of carrying a number of devices from the United States to the PPG, escorted by ships from the Surface Patrol and Transport Unit. The Transport Element was also a major communications control center for the task group and during operations afloat served as CTG 7.1 flagship.

ACCOMMODATION SHIP UNIT (TU 7.3.9). This unit, composed of a Military Sea Transportation Service (MSTS) ship, Ainsworth, assisted in evacuating TG 7.5 personnel from Bikini before all shots there. In addition, it was prepared to support some evacuations at Enewetak, if necessary. The unit also provided radiological situation data and acted as a radiological checkpoint.

Task Group 7.4 (Air Force)

TG 7.4 was made up of Air Force units whose function was to provide airborne data collection platforms for the experiments and airlift for scientific personnel. This included operation of the air traffic control system. General air support for the task force, including operation of the main PPG airbase at Enewetak and forward airstrips, was furnished. This group also conducted most of the weather reconnaissance work for the task force. Peak strength was about 2,140 persons. The group was charged with the following specific tasks:

1. Exercise air traffic control over all aircraft and be responsible for the safe positioning of test and other aircraft at shot time
2. Provide and operate terminal facilities for MATS operations at Enewetak
3. Operate and resupply task force weather stations
4. Provide resupply services and required airlift for task force personnel on Ujelang, Utirik, and Wotho
5. Conduct weather reconnaissance flights for the joint task force
6. Provide personnel for Joint Task Force Weather Central
7. Provide, maintain, and operate aircraft in support of the following diagnostic and weapon effects test missions:
   a. Cloud sampling, cloud tracking, and early cloud penetration
   b. Measurement of blast, gust, and thermal effects
   c. Documentary and certain technical photography
   d. Drop aircraft
   e. Hq USAF indirect bomb damage assessment (IBDA), and ionospheric studies
   f. Radsafe survey
8. Install, operate, and maintain an Air Operations Center (AOC) at Enewetak Island and provide air controller personnel for the joint task force AOC afloat
9. Provide air-to-ground, aircraft movement and positioning, and navigational and weather communications facilities required at Enewetak and Bikini atolls
10. Provide and operate aircraft decontamination facilities at Enewetak
11. Provide decontamination crews for TG 7.4 aircraft at Bikini Atoll under the supervision of the TG 7.3 decontamination officer in the event any TG 7.4 aircraft must be decontaminated there

12. Be responsible for removal of radiological samples from sampler aircraft and provide personnel to assist in placement of samples aboard sample-return aircraft

13. Operate an interatoll air transportation system at Enewetak, Bikini, Kwajalein, and other atolls as required

14. Operate an interisland liaison and helicopter airlift system at Enewetak Atoll

15. Provide SAR service in the air control area, with assistance by CTG 7.3 and within the cognizance of the SAR area commander; operate and maintain a rescue boat at Enewetak and a rescue boat at Bikini for SAR missions

16. On Enewetak Island, operate petroleum, oil, and lubricants (POL) facilities and all firefighting facilities, provide share of kitchen police, and provide orderlies in barracks assigned to TG 7.4; in addition, assist TG 7.2 with vehicle maintenance.

TG 7.4 was organized into a headquarters section and three subordinate units: Test Aircraft Unit (TAU), Test Services Unit (TSU), and Test Base Unit (TBU). Each subordinate unit was comprised of several elements as shown in Figure 14.

HEADQUARTERS TASK GROUP 7.4. Hq TG 7.4, located at Enewetak, was manned by personnel from the Air Force Special Weapons Center (AFSWC), Kirtland AFB, New Mexico. The headquarters activity was organized into staff sections for the supervision of the major areas shown in Figure 14 and included an Air Control Element.

TEST AIRCRAFT UNIT. The TAU was responsible for the maintenance and operation of all test aircraft assigned to TG 7.4; these test aircraft were the aerial platforms for TG 7.1 and other scientific projects. All the TAU aircraft operated from the Enewetak airstrip, and the personnel of all the TAU elements were billeted there except for a few on Parry. The aircraft in the TSU (see below) were used in support operations. The nine subordinate elements of the TAU performed the following tasks:

- Sampling and Decontamination Element. Operated and maintained six B-57B and ten F-84G aircraft that served as sampler aircraft. Personnel and aircraft were from the 4926th Test Squadron.
- Early Penetration Element. Operated and maintained the five B-57B aircraft that flew into the nuclear clouds for

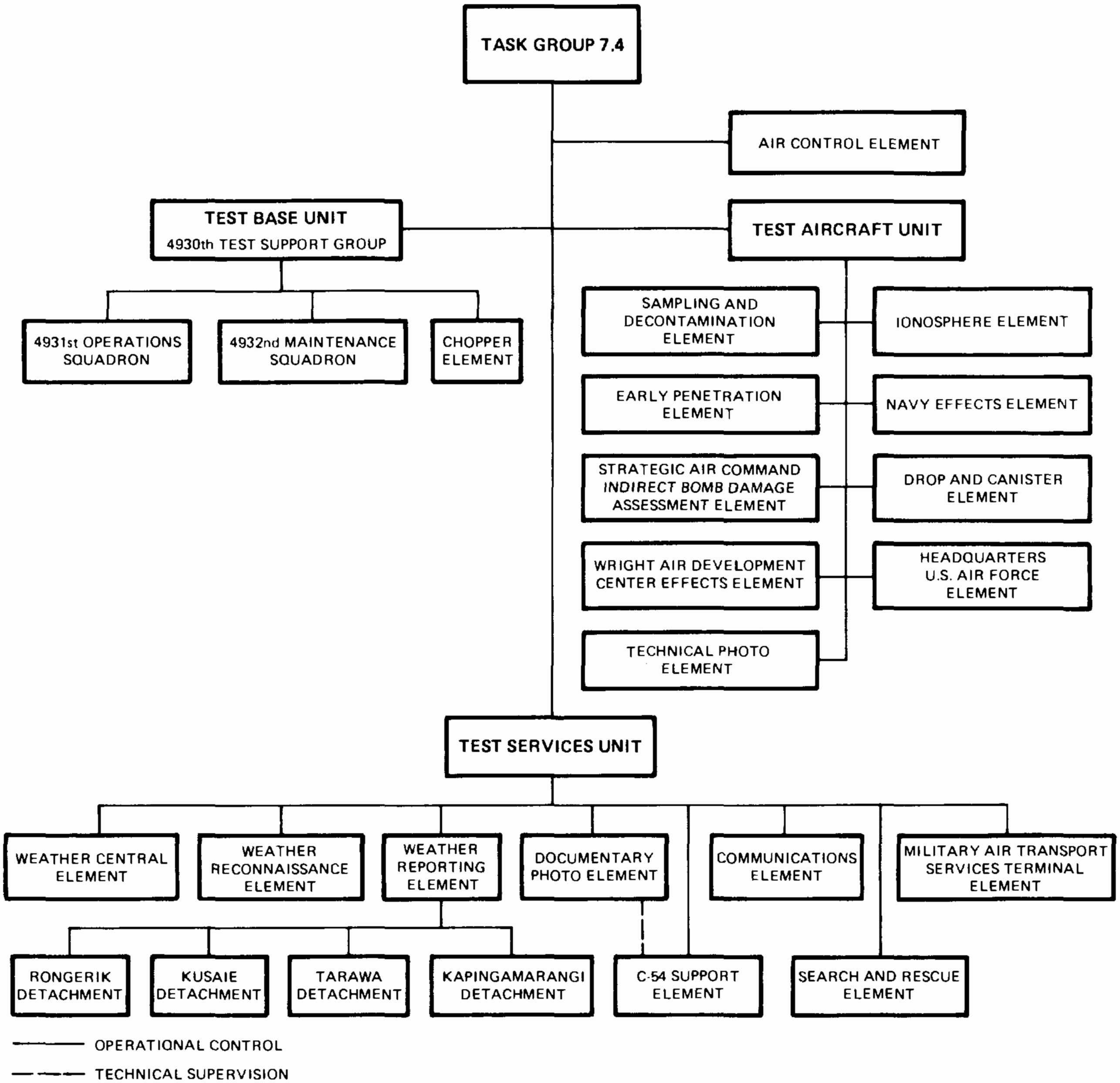

Figure 14. Task Group 7.4 organization chart, REDWING.

TG 7.1 Project 2.66. Tactical Air Command aircraft and crews were used from Langley AFB, Virginia (345th Group, 498th and 499th Squadrons), and from Blytheville AFB, Arkansas (764th, 765th, and 766th Squadrons).

- Wright Aeronautical Development Center (WADC) and Navy Effects Elements. Operated and maintained the aircraft used in Program 5 of TG 7.1. This included a B-52, a B-47, a B-57, a B-66, two F-84Fs, and an F-101, as well as a Navy A3D. The Navy crew and maintenance crews were from the

Naval Air Special Weapons Facility, Kirtland AFB, New Mexico. Personnel from the Aircraft Laboratory of WADC were involved in the other Program 5 aircraft effects experiments.

- Ionospheric Element. Operated and maintained the C-97 aircraft used by TG 7.1 Projects 6.1 and 6.3. Project personnel were from the Air Force Cambridge Research Center (AFCRC), Bedford, Massachusetts.

- Drop and Canister Element. Operated and maintained the B-52 aircraft used to drop the CHEROKEE device, and the B-36 used to drop the OSAGE device. A B-36 from this element was also used to deploy airblast instrumentation canisters for Project 1.5 in the CHEROKEE event. Aircraft personnel were from the 4928th Test Squadron, Kirtland AFB, New Mexico, and other personnel for the Project 1.4 experiment were from AFCRC.

- Indirect Bomb Damage Assessment (IBDA) Element. Operated and maintained the three B-47 aircraft that took long-range radar scope photos of the bursts to ascertain if such a technique would be valuable to measure burst yield. Aircraft and personnel were from the 301st Bombardment Wing, 2nd Air Force, Barksdale AFB, Louisiana.

- Hq USAF Element. Consisted of a small group from Hq USAF conducting that agency's experimental program.

- Technical Photograpy Element. Operated and maintained three B-50E aircraft for technical and cloud measurement photography in support of TG 7.1 Project 1.8 (Crater Survey) and Project 9.1 (Cloud Photography). Aircraft and personnel were from the 6091st Reconnaissance Squadron, Far East Air Force (FEAF), according to TG 7.4 Final History (Reference C.4.2).

TEST SERVICES UNIT. The TSU had eight elements that performed the following functions:

- Search and Rescue Element. Operated and maintained seven SA-16 amphibious aircraft for rescue operations and for weather and project island resupply and support missions. The aircraft and personnel were from the 49th Air Rescue Squadron, Selfridge AFB, Mississippi.

- Weather Reporting Element. Performed weather reporting functions on Enewetak Island and operated remote reporting detachments at Rongerik, Kusaie, Tarawa, and Kapingamarangi. Personnel were from the 6th Weather Squadron, Tinker AFB, Oklahoma.

- Weather Reconnaissance Element. Operated and maintained ten WB-50 aircraft for weather and typhoon reconnaissance and for postshot cloud tracking. This element also was prepared to support backup sample controller aircraft operations. Personnel and aircraft were from the 55th and 57th Air Weather Squadrons.

- Communications Element. Provided airways and air communications services and navigational aids to the joint task force. Personnel from many Airways and Air Communication Service (AACS) organizations contributed personnel to augment the 1253rd AACS Squadron, which was a part of the permanent force at Enewetak. Most personnel were located at Enewetak, but a few were at Parry, Eneu, and on the weather islands.
- Weather Central Element. Provided weather forecasts and gave preshot weather briefings to air crewmen.
- MATS Terminal Detachment. Operated the terminal at Enewetak with personnel drawn from the Pacific Division of MATS.
- Documentary Photography Element. Provided documentary photo services for JTF 7, except that LASL and UCRL had special documentary photo units for their TG 7.1 programs. Personnel for this element were from the 1352nd Motion Picture Squadron from Lookout Mountain Air Force Station, Hollywood, California.
- C-54 Support Element. Operated three C-54 aircraft for documentary photographic missions and for radio-telephone relay, augmenting TG 7.4 airlift missions to Tarawa, Wake, Majuro, Truk, Bikini, Guam, and Hawaii. Aircraft and personnel were from the 1371st Mapping and Charting Squadron, Palm Beach AFB, Florida.

TEST BASE UNIT. The 4930th Support Group (Test) (SG[T]) and its component squadrons, the 4931st (Operations) and 4932nd (Maintenance), were permanent elements at Enewetak, operating the airfield there. During the testing phase at REDWING, these units were designated the TBU.

The TBU also operated the airstrip on Eneu. In conjunction with the operation of the airfield at Enewetak, the TBU operated the POL-dispensing facilities and the firefighting facilities at Enewetak, as well as a crash boat. Similar services were provided by the TBU at Bikini.

The TBU operated the interatoll air service and the interisland fixed wing (L-20) air service. Helicopter service at Enewetak was provided by the Lift Element, and this service at Bikini was provided by HMR-363 (Marine Corps). The Lift, or Chopper, Element was manned by 310th Troop Carrier Squadron personnel with ten H-19B helicopters from the Tactical Air Command, Pope AFB, North Carolina, which were not permanent elements at the PPG.

Task Group 7.5 (Base Facilities)

TG 7.5 consisted of a small number of AEC civil servants and a large number of H&N contractor personnel. This company was responsible for practically all construction in the PPG. The PPG was administered by the AEC and was operated by the company under supervision of an AEC field office. Peak strength was approximately 2,800 persons, located mostly at Parry, but with contingents at other sites on both atolls. Responsibilities of this group were to:

1. Operate camp facilities for personnel ashore at Bikini Atoll and on all islands of Enewetak Atoll except Enewetak and Japtan islands, including food services, housing, laundry, medical and recreational services, and stevedoring and trucking operations
2. Furnish camp facilities at Wotho, Ujelang, Utirik, Ailinginae, Kapingamarangi, Kusaie, Rongerik, and Tarawa
3. Operate all utilities in the PPG, except the POL farm on Enewetak Island
4. Provide internal communications for TG 7.1, TG 7.5, and interatoll communications service for all elements of the task force; in addition, provide telephone facilities at Enewetak and Bikini atolls (except on Enewetak Island) for all elements of the task force
5. Operate and maintain a TG 7.5 boat pool at Enewetak and Bikini atolls
6. Operate decontamination facilities for TG 7.1 and TG 7.5 equipment; on Parry Island, operate the radsafe barge; and on Eneu Island, operate laundries for contaminated clothing in support of all task force elements, except for such services performed by TG 7.3 on certain vessels and by TG 7.2 at the TG 7.2 laundry on Enewetak Island
7. Be prepared to conduct emergency postshot evacuation of TG 7.5 personnel from Enewetak and Bikini atolls.

As the agent for the AEC, H&N built and maintained all base facilities except those on Enewetak Island, where the engineers of the TG 7.2 7126th AU did some light construction and maintenance work. H&N ran a large boat pool that both supported the company's programs and provided, in cooperation with resident naval units, marine transportation within the proving ground.

Task Force in Place

The geographic distribution of personnel on 10 May 1956 is given in Table 4.

Table 4. Geographic distribution of Joint Task Force 7 personnel on 10 May 1956.

Location	Headquarters	Task Groups 7.1	7.2	7.3	7.4	7.5
Enewetak Atoll						
Enewetak	12		888	381	2,015	160
Parry	133	1,597	120		76	1,313
Lojwa			23			170
Runit			23			348
Japtan			9		6	4
Dridrilbwij			8			130
Bikini Atoll						
Shipboard				4,120		
Eneu	1		51	194	52	344
Lomilik			16			200
Eneman			29			110
Weather Islands						
Rongerik		6			23	
Kusaie		6			20	
Kapingamarangi		6			22	
Tarawa		6			22	
Other Off Atoll						
Wotho		4				3
Ujelang		2				3
Utirik						3
Palmyra		1				
Johnston		1				
Kwajalein	3					
Hawaii	60	12				
Totals	209	1,641	1,167	4,695	2,236	2,788

To understand better the day-to-day functioning of the 13,000-man force at this remote site, several of the important services provided for the task force are discussed below.

SUPPLY. Overall responsibility for provisioning rested with CINCPAC, acting through the commanders of the Navy Service Force (ComServPac) and Naval Air Force Pacific (ComAirPac). ComServPac was the principal logistics agent and scheduled resupply of fresh provisions and fuel. ComAirPac ensured that necessary supplies were available for operations at the Naval Air Station, Kwajalein. All other scheduling and coordinating of provisions were the responsibility of Commander Western Sea Frontier (Reference C.3.2).

Two refrigerated cargo ships, USS Karin (AF-33) and USS Merapi (AF-38), operated from Pearl Harbor, carrying fresh and frozen provisions to the PPG approximately every 3 weeks. Generally, the ships steamed first to Bikini, a trip of about 10 days. Unloading there took about 36 hours. The ships then steamed to Enewetak, taking 2 days. Average unloading time at Enewetak was 2½ days. After departing Enewetak, the ships proceeded to Kwajalein, thence to Pearl Harbor.

A cargo ship, USS Sussex (AK-213), carried dry goods, medical supplies, and spare parts to the PPG at 6-week intervals. In addition, two MSTS ships, USNS Pvt Joe E. Mann (T-AK-253) and USNS Sgt Archer T. Gammon (T-AK-243), provided cargo and logistic support during REDWING. When necessary, MATS flights handled priority cargo for the joint task force (Reference C.3.2, p. 141).

Cargo unloading at both atolls followed a consistent and similar pattern during REDWING. When a cargo ship anchored at Bikini, the representative of CTG 7.3 assigned a liaison officer to coordinate the activities with the ship. Both CTG 7.3 and the ship's crew supplied men for the working parties, which operated on continuous 8-hour shifts. During daylight unloading operations, TG 7.5 supplied winchmen and hatch captains from Enewetak if scheduling permitted. Otherwise the ship supplied these men. Boat pool LCMs transferred goods either to TG 7.3 ships or to shore.

A major difference in Enewetak operations was the cargo pier at Parry, which allowed the cargo ship to dock alongside. TG 7.5 supplied stevedore services and also sorted, routed, and, if necesssary, stored arriving cargo.

Four fleet oilers, USS Mispillion (AO-105), USS Navasota (AO-106), USS Caliente (AO-53), and USS Cimarron (AO-22), supplied diesel oil, naval standard fuel oil, and aviation gasoline to the task force. Only Cimarron, which arrived in August after the final shot (HURON), was not present during the operational phase of REDWING. Each oiler remained in the PPG for about 6 weeks, with 7 days between its departure and arrival of a replacement. In addition, six small gasoline tankers supplied the task force with motor gasoline. Each made frequent brief trips into the PPG, none lasting more than a week.

Major differences between fuel-handling operations at Bikini and Enewetak reflected the marked contrast between activities at the two atolls. Fleet oilers spent protracted periods at Bikini because of the presence of most TG 7.3 ships. The oilers refueled most units at anchor. There was also a H&N POL barge at Bikini, which stored both diesel oil and aviation gas, the latter for HMR-363 and TG 7.4 aircraft. Generally, only smaller ships stayed at Enewetak long enough to require refueling. YON-182, the fuel oil barge at berth L-4, carried enough to meet this requirement.

HOUSING AND MEALS. TG 7.2 housed and fed its own personnel and those of other task groups stationed on Enewetak and Japtan islands. This included a large Air Force contingent and a smaller Navy group that included the Enewetak Boat Pool and the seamen assigned to operate YON-182. TG 7.2 also provided temporary lodging and meals for personnel passing through to other locations in the PPG. H&N provided food and lodging at Parry and all other camps. The Navy units afloat took care of their own crews, and the Bikini Boat Pool lived aboard Catamount.

TRANSPORTATION. TG 7.3 supplied interatoll surface transportation to the task force, mainly through ships of the Surface Patrol and Transport Unit, TU 7.3.3. The two MSTS LSTs, USNS Bernalillo County and T-LST-618, regularly scheduled trips at 3- to 4-day intervals between the atolls, carrying light freight and passengers. USS Knudson was originally assigned the early transfer of Bikini shot data to Enewetak if contamination rendered the Eneu airstrip unusable. This situation did not arise; nevertheless, Knudson made several trips to Enewetak for other reasons.

The only other ship that made regularly scheduled trips to Enewetak was Catamount. In addition to supporting the Bikini boat pool, Catamount transported shot devices to Bikini from Enewetak.

Other ships, such as Ainsworth, Curtiss, and Estes, as well as the destroyers and destroyer escorts, made occasional trips from Bikini to Enewetak and would have been available to a limited number of passengers. Finally, USS

Mount McKinley (AGC-7), as the press and observer ship, carried its passengers between the atolls a number of times in May before LACROSSE and CHEROKEE.

The major function of the Navy boat pools at both atolls was intra-atoll surface transportation. TG 7.5 had a large boat pool -- about 100 vessels -- that provided service both between Enewetak and Bikini atolls and among the camps at each atoll. In addition, the crews of this boat pool assisted in laying marine cables, moved and moored shot barges, and provided houseboats when land camps could not be used because of contamination. Vessels from the TG 7.3 boat pool assisted with operations at Bikini Atoll.

Control and administration of surface transportation were conducted similarly at both atolls. Overall authority for surface transportation rested with the TG 7.5 Transportation Control Agent, assisted by a TG 7.3 Control and Dispatch Officer. At Enewetak Atoll, this activity was located on Parry, and at Bikini it was located on Eneu.

Interatoll air transportation was provided regularly by TG 7.4, with departures at the same time from each atoll. These flights were made with C-47s, but a 4-engine R5D was available to transport CJTF 7 to Bikini in preparation for Bikini shots. These flights were designated Reflector flights.

Intra-atoll air transportation was provided by Air Force helicopters and light planes at Enewetak and at Bikini in the early stages of the operation. After certain equipment problems were resolved, the Bikini intra-atoll lift was provided by the HMR-363 helicopters.

The considerable coordination required of this airlift capacity was another assignment of the TG 7.5 Transportation Control Agent, through whom priorities and scheduling were resolved.

TG 7.2 ran the motor pool and bus line on Enewetak. The pool had 275 vehicles, including 4 buses and several trucks used as buses. The motor pool maintained about 30 TG 7.1 vehicles on the island. TG 7.5 performed the same services on Parry and had 233 vehicles. TG 7.5 also maintained the TG 7.2 military police vehicles used in the forward camps.

COMMUNICATIONS. Coordinating the movement of large groups of ships and aircraft for evacuation, scientific support, and logistics required a considerable communications network.

In summary, TG 7.4 controlled aircraft throughout the PPG Air Control Area. The AOC was located on Enewetak with complete communications capability. A CIC on Estes assumed primary control during Bikini shots. Control of the fleet was also centered on Estes in the Flag Message Center. Long-range communications were handled by the TG 7.2 Joint Relay Center on Enewetak.

TG 7.5 had responsibility for all TG 7.1 and TG 7.5 communications. The TG 7.5 Communications Department ran communications centers on Parry and Eneu and aboard Curtiss and Ainsworth. From the Parry communications center, much of the task group's overseas traffic was routed through the Army Administrative and Command Network via relay stations in Enewetak, Hawaii, and San Francisco.

TG 7.5 provided both Enewetak and Bikini with telephone service. The main switchboard on Parry was joined by submarine cable to switchboards at Dridrilbwij, Lojwa, and Runit and with the Army-operated switchboard on Enewetak Island. The TG 7.5 main switchboard at Bikini was on Eneu and was connected to switchboards on Lomilik and Eneman.

The communications center for the headquarters of JTF 7 was on Parry, with the receiver station located on Japtan. The transmission station, the relay and cryptography center, the facilities control center, and TG 7.2's headquarters communications center were all on Enewetak Island.

SECURITY. Aspects of security were off-atoll patrol, ground defense, control of personnel movement, and communications. Security of the nuclear devices themselves is covered in Chapter 3, which discusses DOD participation in device placement.

Off-atoll patrol was chiefly a Navy function. VP-1, based on Kwajalein, was primarily responsible with support from ships of the Surface Patrol and Transport Unit of TG 7.3.

Ground defense was never required. It was to be provided for by personnel of the 7126th AU, which formed a battalion-level combat organization with a defense plan that was sharpened by occasional target practice with light infantry weapons (Reference C.2.1, Installment 3).

Control of personnel movement was a more substantial activity. TG 7.2 military police guarded sensitive areas and regulated movement of personnel by enforcing a security badge system, replacing H&N guards used in the interim phase at Eneu and Parry. Apparently, all islands in both atolls were considered controlled areas. Within these controlled areas were limited regions, requiring clearances, and exclusion areas. Exclusion areas, requiring special access permits, were the sites of nuclear device assembly or storage and areas immediately surrounding points where nuclear devices had been detonated. No badges were required for "Joint Task Force Recreational Islands," a term probably referring to the Navy-controlled recreational areas on Japtan and Eneu. For access to limited and exclusion areas, a system of badges and lists was employed. Military police posts were established at all airstrips and marine ramps where badges of personnel in transit were checked.

Communications security (crypto guard facilities) was a TG 7.2 function (Reference B.0.3). Circuits were monitored by the 8600th ASA Detachment from facilities on Enewetak and Eneu.

MEDICAL. The 7126th AU of TG 7.2 maintained a 30-bed hospital on Enewetak Island that provided medical care for military and civilian personnel living or working on the island. All personnel from elsewhere in the PPG were referred to the hospital if they could not be treated locally. During the operational period, the hospital was staffed by three doctors, three dentists, and 27 enlisted men. TG 7.4 contributed one Air Force doctor and several enlisted men to the medical staff. Patients requiring more elaborate treatment than that available were flown to Hawaii.

A Staff Medical Officer supervised general health care for personnel of TG 7.3. Six medical officers and three dentists were attached to various task group units. Badoeng Strait had a senior medical officer and complete surgical facilities aboard; the medical officer on Catamount was a specialist in internal medicine; and the medical officer from the staff of Destroyer Squadron Three served at the TG 7.5 Infirmary on Parry to care for Navy personnel ashore. Moreover, the Navy medical staff was responsible for entering personnel radiation exposures into individual medical records. In compliance with this assignment (Reference C.3.2, p. 169):

> . . . a uniform method of recording exposure of personnel to ionizing radiation, in health and medical records as required by NavMed P-1325, was issued as CTG 7.3 Instruction 6150.1.

Concurrently, the medical staff assisted the Department of Biophysics, Walter Reed Institute of Research, in a study of internal radiation hazards. The staff collected 24-hour urine specimens from 10 volunteers, 2 from each of five ships, over a 20-week period for radiochemical analysis (Reference C.3.2, p. 170).

TG 7.5 maintained a 10-bed infirmary on Parry, an 8-bed infirmary on Eneu, and first-aid stations at all its other camps. The medical staff consisted of three doctors, two dentists, and a number of laboratory technicians and first-aid men. The doctors and dentists were stationed at Parry and Eneu. At least one first-aid man was assigned to each first-aid station. In an emergency, a doctor could be helicoptered to an aid station. The TG 7.5 medical staff worked closely with the Army medical staff at the Enewetak hospital and serious cases were sent there or flown to Hawaii.

RECREATION. Because of the duty station's isolation, TG 7.2's leadership gave considerable attention to recreational activity for task group personnel. Enewetak Island had two movie theaters, a TV station, a hobby shop, a swimming pool and beach areas designated for swimming, a skeet range, playing fields, basketball and handball courts, and a service club with snack bar, library, game room, and rooms for adult education classes and clubs. Competitive leagues were organized for many sports.

Both TG 7.2 and TG 7.5 personnel participated in shell-gathering and fishing trips during the interim and buildup phases. However, exact locations involved are unknown (Reference C.2.1, Installment 1; Reference C.5.2, pp. 3-19).

Recreational facilities under Navy control were at Camp Blandy on Eneu and at Camp Parsons on Japtan. Neither was ready for use when the task group arrived. Consequently, crewmembers from Estes and construction battalion personnel from Kwajalein worked at Camp Parsons so it could open on 10 April 1956. Working parties from Badoeng Strait worked at Camp Blandy prior to its opening on 13 April (Reference C.3.2, p. 38).

The Navy facilities at Camp Blandy could accommodate as many as 600; those at Camp Parsons as many as 250. Both had swimming beaches and boating areas. Camp Parsons remained accessible throughout REDWING, whereas the Camp Blandy swimming area had to be closed for several days following Bikini shots (Reference C.3.2, pp. 37-38). Finally, after NAVAJO, the Camp Blandy swimming beach was closed for the rest of the operation (Reference C.3.1, Installment 12, p. 12).

> This decision was based on the philosophy that exposure to radiological hazards should be kept to a minimum in the absence of reliable exposure criteria. Swimming was prohibited when radiation levels at one foot above the surface were greater than background or when contaminants were present in amounts greater than 1 times 10 to the minus 5 microcuries per millimeter, depending on the age of the contaminants.

To supplement shore-based recreation, Badoeng Strait operated an Armed Forces television station aboard ship, broadcasting to ships and installations capable of receiving programs. The programming presented not only live entertainment and commercial shows, but also educational broadcasts, including radsafe presentations.

MISCELLANEOUS SERVICES. Laundry service was provided by TG 7.5 at its camps and by TG 7.2 at Enewetak. Contaminated laundry was brought from outlying camps to Parry for cleaning (Reference C.5.2). Contaminated clothing at Enewetak was laundered in a mobile laundry van maintained by TG 7.2 (Reference C.2.1).

During the garrison phase and most of the buildup phase, the 7126th AU Postal Section, operating as APO 187 on Enewetak Island, served all units in the PPG, including the AEC and H&N. In April 1956, three additional Army Post Offices (APO) were established: APOs 435 and 437 on Parry and APO 436 on Eneu. The organizational positions of these post offices is not clear, but APO 187 acted as the central post office. APO 435 was manned by H&N personnel. Although APO 437 also was on Parry, no information has been found on who staffed it. TG 7.2 supplied the personnel for APO 436. The Navy boat pool delivered and collected mail for the ships.

SECTION 2
RADIOLOGICAL SAFETY

A substantial program was organized in Operation REDWING to protect people from initial and residual radiation exposures resulting from the tests themselves or from residual radioactive material from previous operations at the Pacific Proving Ground (PPG).

This protection was accomplished in three ways. First, specific radiological safety (radsafe) responsibilities were delegated early, and accountability for radiological safety was specified as a duty of each task group commander. Units within each task group were charged with radiological safety and personnel training. This training included informing all project participants of the potential dangers of radioactivity and instructing certain personnel about radiation-measuring equipment used to perform radiation monitoring.

Second, safety criteria, based on existing recognized standards, were established by Commander, Joint Task Force 7 (CJTF 7). The environment was monitored and personnel activities controlled to preclude, to the extent possible, exceeding these standards. State-of-the-art techniques were employed to predict the extent and intensity of radioactive fallout from the tests. Assessments, reflecting relationships between these predictions and the safety criteria, were incorporated in the decision to conduct a particular test.

Finally, laboratory services for radioactivity analyses, personnel dosimetry, and decontamination for people and equipment were provided.

The emphasis on safety was apparent in early planning and stressed throughout the operation. Radsafe planning proceeded with the concurrence of other agencies when required. For example, preliminary plans for improved offsite monitoring, new meteorological techniques to assist in fallout prediction, and advanced fallout forecasts were presented to the Department of State on 10 February 1956 (see Appendix A). Covering all phases of Operation REDWING, safety measures were designed to protect both test participants and native populations.

RADIOLOGICAL SAFETY PLANNING

Organization and Responsibilities

Since radiological safety was a command responsibility, elements of control existed through all command levels, and operational control through normal command channels (Reference B.0.2, Annex C). CJTF 7 established a Radsafe Office under J-3 of the headquarters staff (see Figure 15). Acting for CJTF 7, this office assigned responsibilities to each task group and issued directives specifying safety regulations and requirements. The Radsafe Office was also responsible for weather data necessary for fallout prediction models, a fallout prediction unit, technical advisory assistance to Trust Territory personnel, and radiological monitoring stations on certain populated islands of the Trust Territory.

The Radsafe Office, composed of the Task Force Radsafe Section and the Fallout Prediction Unit (FOPU), operated as the task force staff agency

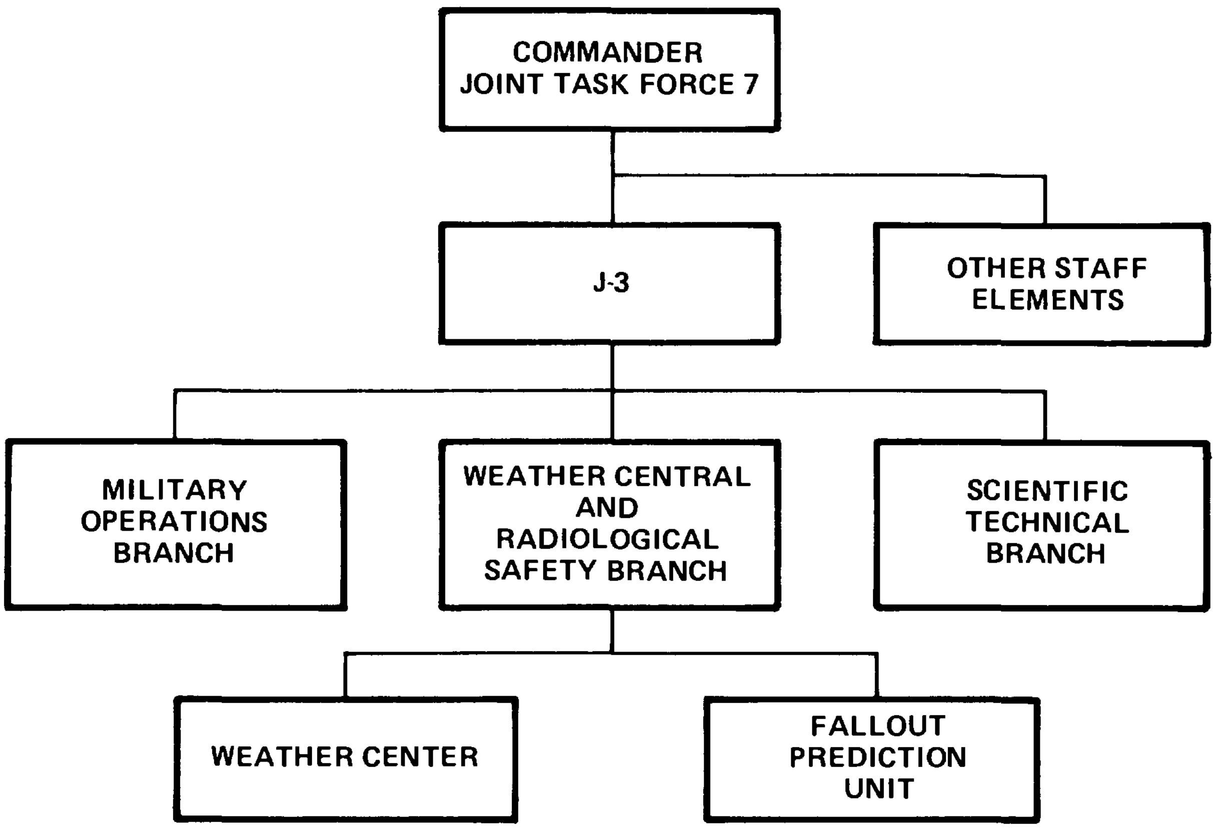

Figure 15. Joint Task Force 7 Radsafe Office organization chart, REDWING.

responsible for the presentation of radiological shot briefing materials and the operation of the radsafe program.

The Radsafe Office disseminated the forecast air and surface radiological exclusion (radex) areas before shot time and transmitted messages after detonations to announce reentry hour, radiological clearances of previously closed areas, radiological directives to task groups, advisories to commands external to the task force, and revisions of the air and surface radex areas as required.

The FOPU prepared the radsafe forecast information (fallout plot and surface and air radex areas) for each shot. The Fallout Plotting Center (FOPC) maintained displays of radiological information pertinent to the test area, in addition to radiation levels on atoll islands and lagoons, radex information, cloud trajectories and their relation to occupied atolls, air and surface routes within the danger area, ship movements in the danger area, and the results of water sampling tests. The Bikini Atoll Radsafe Office was on the command ship (USS Estes), and the Enewetak Atoll Office was in the Operations Division (J-3) JTF 7 Headquarters Building, Parry Island.

JTF 7 also staffed 16 ground stations outside the PPG with persons trained in radiological detection. Stations periodically reported radiation readings, and in the event of contamination, personnel were qualified to assist in decontamination procedures.

These radsafe ground stations were located at eight primary and eight auxiliary sites. Primary sites -- on the atolls of Wotho, Ujelang, Utirik, Kwajalein, Rongerik, Tarawa, and Kapingamarangi, and the island of Kusaie -- were linked to the JTF 7 Radsafe Office by direct two-way radio; Wotho, Ujelang, and Utirik, regarded as perhaps more vulnerable to fallout, were staffed by U.S. Public Health Service (USPHS) radiologists. Auxiliary stations at Wake, Majuro, Ponape, Truk, Guam, Midway, Johnston, and Iwo Jima employed the weather-reporting net for their communications.

In order to carry out its responsibilities to provide radiological services, monitoring, and technical assistance to all elements of the task force, Task Group 7.1 (TG 7.1) set up the Radsafe Center. The Radsafe Center maintained radiological situation data for lagoon waters and islands of the shot atoll. Based on air and ground surveys provided by monitors' reports, this information was the foundation of periodic situation reports, maps, and briefings furnished to task force and task group commanders. Information was also provided for planning TG 7.1 radsafe operations and for disposition of all working parties within contaminated areas. Radsafe checkpoints were established, and operations tables were designed for all groups who entered contaminated areas. Included in the operations planning tables were the names of monitors, destinations, project mission number, and departure and return times.

In addition to providing special clothing to designated recovery personnel, the Radsafe Center arranged the working schedules for the radiochemical laboratory, photodosimetry developing facilities, decontamination facilities, and radiac (radiation detection, indication and computation) instrumentation repair stations of TG 7.1. The Radsafe Center for the Bikini shots operated from USNS Fred C. Ainsworth; the Enewetak Center operated from the radsafe building on Parry (Reference B.0.3, Annex K).

Within each task group was a radsafe office assigned to the group headquarters staff, or, in the case of TG 7.1, an entire task unit, responsible for the radiological safety of the group. This office wrote and disseminated the implementing directives from CJTF 7, in addition to regulations particular to the task group or the service it represented.

Each task group was responsible for its own radiological safety. This included radiation monitoring, decontamination of equipment, radiac instrumentation and repair, protective clothing, issuing film badges, and maintaining exposure records for all personnel.

In addition, each task group provided some general support to the joint task force. Responsibilities for each task group are summarized below.

TASK GROUP 7.1. As the major technical radsafe unit, Task Unit 7 (TU 7) of TG 7.1 performed the following tasks:

- All ground and aerial monitoring services associated with the scientific program except those in conjunction with aircraft and airborne collection of data
- Radiological laboratory services for all groups

- Maintenance of radsafe plotting centers to apprise all groups of the radiological situation at each atoll
- Personnel decontamination facilities at Enewetak
- All official dosimetry services.

The maintenance of a simultaneous firing capability at both Bikini and Enewetak atolls necessitated that TG 7.1 provide two complete and independent radsafe organizations, as shown in Figure 16. Overall control was assigned to the CTU 7 of TG 7.1. Each organization contained the following sections:

1. Monitoring -- for providing all monitoring services and manning checkpoints
2. Plotting and briefing -- for conducting all aerial surveys and briefing personnel entering radex areas
3. Supply -- for maintenance of radsafe supplies, including laundry (facilities furnished by TG 7.5)
4. Instrument repair -- for maintenance of radsafe instruments
5. Laboratory -- for determining radioactivity in soil and water samples
6. Decontamination -- for operating personnel and equipment decontamination.

CTU 7 directly controlled the official Dosimetry and Records Section, a procedure necessitated by the double-badge system (permanent and mission) used throughout the operation. A small photodosimetry section was maintained at Bikini for processing mission film badges used at that atoll. All permanent badges were processed at Enewetak, where the master record file for all JTF 7 personnel was kept.

The majority of the TU 7 staff was from the Army's 1st Radiological Safety Support Unit (RSSU), a Chemical Corps unit stationed at Fort McClellan, Alabama. Some were from the Navy and the Air Force. The Army provided 102 officers and enlisted men; the Navy, 8 officers and enlisted men and 30 civilians; and the Air Force, 12 officers and enlisted men. Los Alamos Scientific Laboratory (LASL) provided 4 advisors.

Scientific projects in TG 7.1 and contractor groups in TG 7.5 provided their own monitors for recovery and construction missions. Most were trained by members of TU 7 at either Fort McClellan, Alabama, or the PPG.

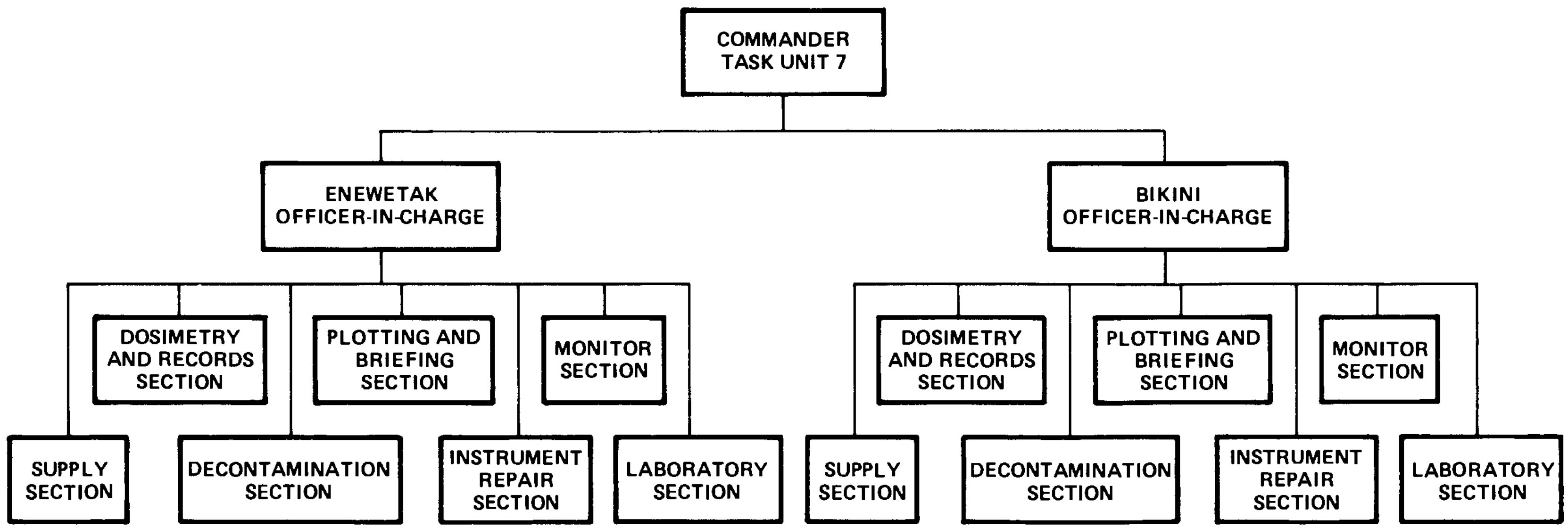

Figure 16. Radiological safety organization of Task Group 7.1, REDWING.

TASK GROUP 7.2. TG 7.2 organized radiological safety under its operations staff (see Figure 17). Specific responsibilities included:

- All monitoring services at Enewetak except those assigned to other task groups
- Availability to all task groups of military radiac equipment and spare parts, high-density goggles, and special clothing, including shoes
- Contaminated clothing laundry facilities for TG 7.4
- Contaminated miscellaneous equipment storage area with the necessary security.

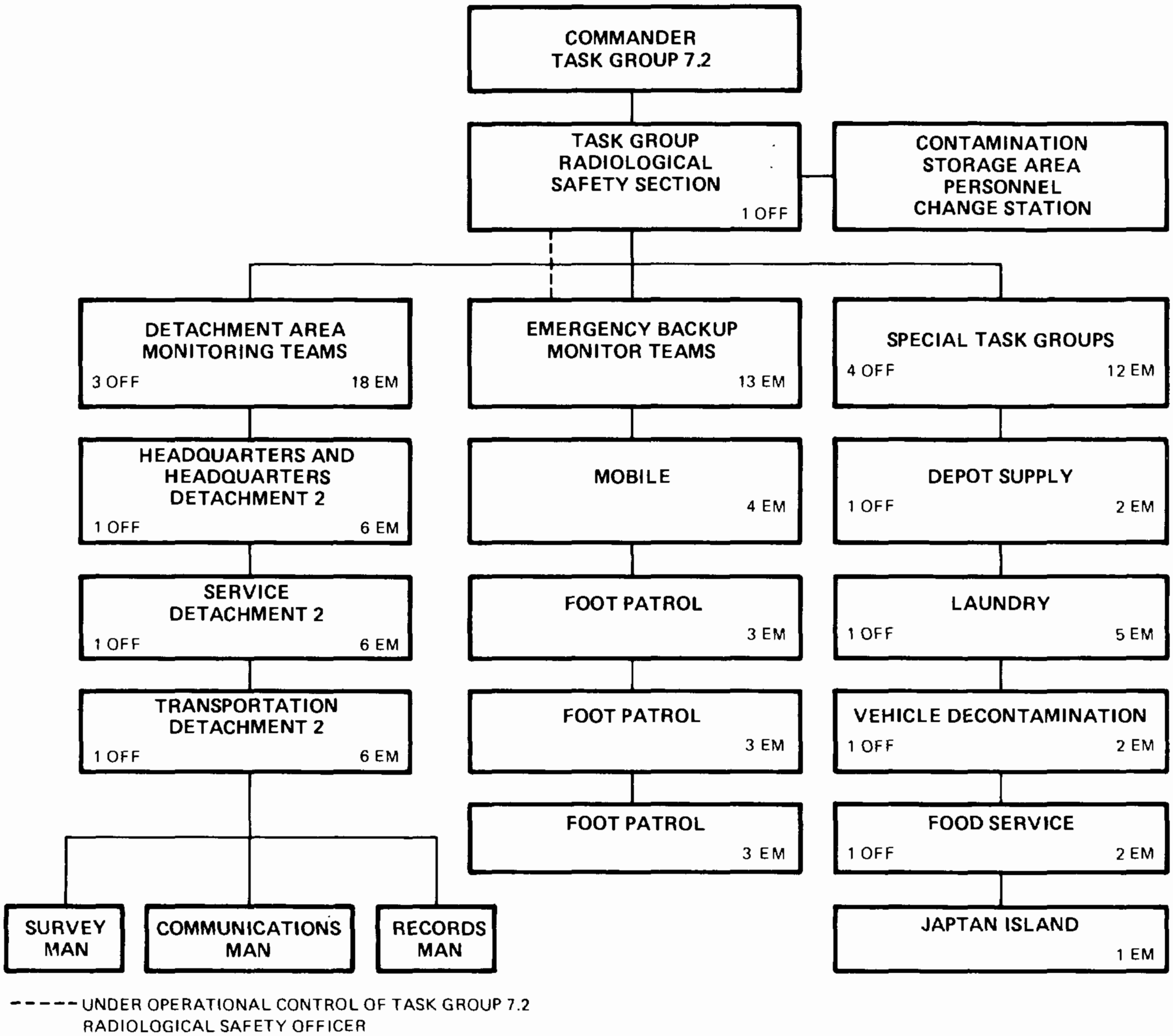

Figure 17. Radiological safety organization, Task Group 7.2, REDWING.

TASK GROUP 7.3. Planning was done by the Assistant Plans and Operations Officer (Atomic Defense). At the working level, the organization of TG 7.3 radiological safety was based on existing damage control and atomic, biological, and chemical defense organizations for each ship and unit. Special responsibilities of TG 7.3 included:

- Helicopters for radiation surveys and postshot recovery at Bikini
- Decontamination of all aircraft at Bikini
- Personnel decontamination facilities on selected ships
- Collection of lagoon-water samples for radiation analysis
- Aerial reconnaissance in the vicinity of the task force and shot atoll after detonation
- Transportation of supplies to joint task force monitors on remote islands.

Certain TG 7.3 units had specific radsafe assignments:

- USS Curtiss -- headquarters afloat for TG 7.1; served as the Bikini weather-reporting station and contained a personnel decontamination station
- USNS Fred C. Ainsworth -- Radsafe Center for Bikini shots; contained a radsafe laboratory and personnel decontamination station
- USS Badoeng Strait -- personnel and helicopter decontamination station
- USS Mount McKinley (AGC-7) -- personnel decontamination station
- USS Shelton -- high-altitude rocket weather soundings
- USS McGinty and USS Silverstein -- conducted surface fallout surveys
- USS Sioux -- tended moored fallout collecting stations
- USS Crook County (LST-611), YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall) -- equipped for prolonged operation in heavy fallout areas
- Patrol Squadron One (VP-1) -- conducted preshot patrol and search in forecast fallout areas and postshot fallout surveys.

TASK GROUP 7.4. The headquarters organization of TG 7.4 included a radsafe office reporting to the Director of Operations. This function was probably managed by the Nuclear Research Officer who monitored all TG 7.4 technical operations and advised CTG 7.4 on radsafe matters. It is not clear whether this position was an extra assignment or a specific position with prime duty responsibilities. In contrast to the CJTF 7 directive that all task groups provide themselves with radsafe units, no reference to such a TG 7.4 unit can be found. Nevertheless, as shown in Figure 18, the radsafe responsibilities of the test units were clearly defined. A unique group requirement was that one airborne monitor be provided for each multiengine aircraft crew assigned to TG 7.4.

The ground radiological monitoring assigned to the Test Aircraft Unit (TAU) was only for the Enewetak airfield; sample transportation pertained to movement from the recovery area to the sample-return, or flyaway, aircraft. The TAU personnel control responsibility was as follows (Reference B.4.5, Annex A):

> Establish a badge system to control the access of personnel to the Sample Recovery Area, Decontamination Area, and such other areas in which a serious radiation hazard is felt to exist.

No record of such a badge system, separate and distinct from the regular badge system being used, can be located. Decontamination crews were composed

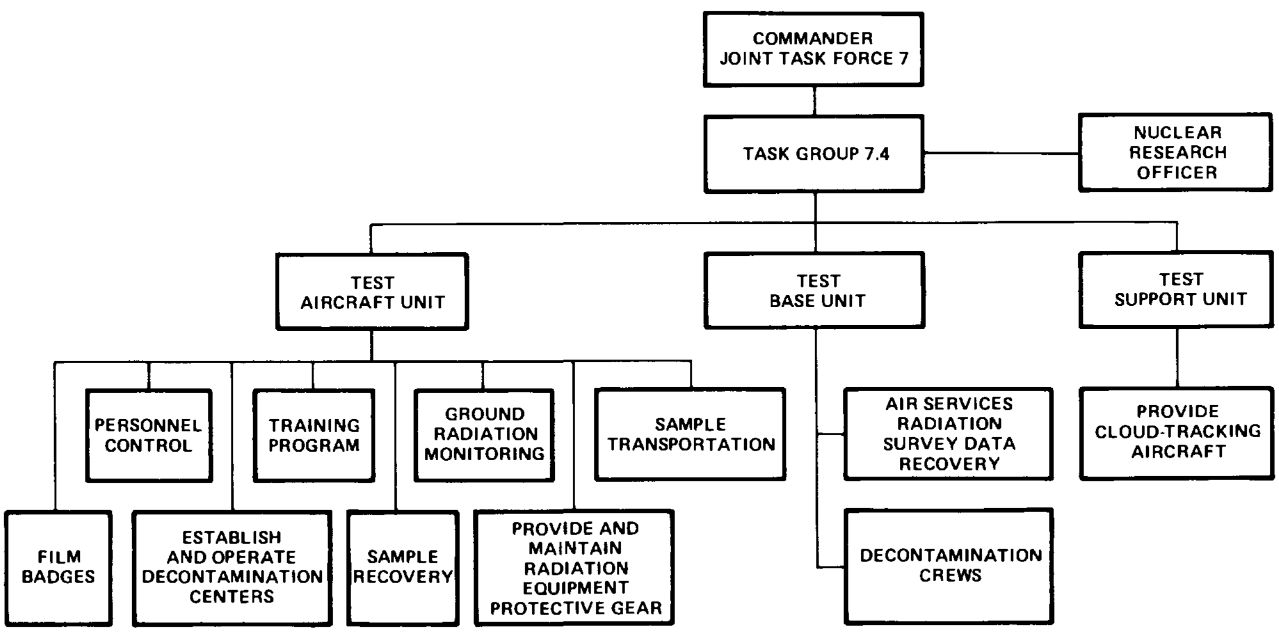

Figure 18. Radiological safety organization, Task Group 7.4, REDWING.

of personnel throughout TG 7.4, with each major subunit providing a pro rata share depending on the number of airmen allotted. The Test Base Unit (TBU) maintained a duty roster of these personnel and made assignments for decontamination requirements from the duty roster.

Specific TG 7.4 responsibilities included:

- Aircraft decontamination at Enewetak
- Helicopter sample recovery at Enewetak (monitors provided by TG 7.1)
- Postshot radioactive cloud tracking
- Postshot aerial radiometric survey of the northern Marshall Islands
- Establishing the air radex area for each shot
- Off-atoll weather stations and weather reconnaissance flights
- Administration of JTF 7 Weather Central
- Training of weather island monitors.

TASK GROUP 7.5. CTG 7.5 was directly responsible for the safety of TG 7.5 personnel and implementing the directive of CJTF 7. During the operational phase of REDWING, the Holmes & Narver (H&N) radsafe monitoring unit was integrated into the TG 7.1 radsafe unit (TU 7), which provided radiological safety for TG 7.5.

TG 7.5 provided to JTF 7:

- Decontamination facilities and laundry services for contaminated clothing
- Facilities for the TG 7.1 radsafe centers including the radsafe barge and decontamination areas and equipment (except for specific facilities provided by TG 7.1 and TG 7.3).

Training

Radsafe training was designed to educate and train personnel to work more effectively reducing the potential for radiological exposure. Each task group was responsible for training its own radsafe monitoring personnel. Additionally, TG 7.2, TG 7.3, and TG 7.4 provided information on radiological safety to project participants.

TASK GROUP 7.1. Project radsafe monitors were trained at Fort McClellan, Alabama, during the week of 9 January 1956. The 4½-day course was conducted by members of the 1st RSSU, LASL, and the University of California Radiation Laboratory (UCRL). Moreover, during the operation itself several courses were conducted by TU 7 to provide additional project monitors. Five chemical laboratory technicians were trained in basic radiochemistry and photodosimetry techniques at LASL, and four members of TU 7 were trained in alpha monitoring at LASL and the Nevada Test Site (NTS). The Naval Radiological Defense Laboratory (NRDL) trained 30 individuals from various naval shipyards to be TU 7 monitors for NRDL experiments. The JTF 7 Radsafe Officer (Reference C.1.7.1) reports that all Navy civilians employed by the task units received 4 weeks of instruction at NRDL before departure for the PPG. It is not clear if this referred to the monitor training itself or was in addition to it. Six men were trained in radiac instrument repair at Treasure Island and LASL.

TASK GROUP 7.2. Two general levels of training were required for TG 7.2: basic indoctrination and technical training.

Basic indoctrination included primary, nontechnical instruction in radsafe measures and techniques. All personnel of the task group received this instruction.

Technical training was given to the majority of personnel who staffed the task group radsafe organizations. This instruction was designed particularly to train radiological defense monitors, decontamination personnel, and radiological instrument repairmen.

In September 1955, the TG 7.2 Radsafe Officer attended classes in radsafe monitoring at the Fleet Training Center, Pearl Harbor, Hawaii. He also attended a 3-day conference on radiological safety held at Hq JTF 7, Washington, D.C., and later presided over a 4-hour Radsafety Instructor's Refresher Course for officers and noncommissioned officers engaged in detachment instruction duties.

In February 1956, a course was held for all personnel expected to be actively engaged in radsafe monitoring and decontamination during REDWING. Ten 3-man monitoring teams and twenty replacement monitoring personnel were trained.

In addition, the laundry decontamination team and some personnel of the Japtan Island receiver station successfully completed the TG 7.2 radsafe course.

Initial radsafe training was given by the task group Radsafe Office to officers and enlisted personnel who were to become instructors for the program. The second phase was conducted in February and March, for all monitor personnel of TG 7.2 and included 24 hours of conference and practical work in radsafe theory, instrument use, and monitoring techniques. The third and final phase involved orientation of all task group personnel on radsafe matters. Two training films, "Operation GREENHOUSE" and "The Effects of an Atomic Bomb," were shown to enhance radsafe training and stimulate interest for the operational phase. Continued training consisted of weekly practice monitoring surveys and make-up classes on individual orientation.

Four TG 7.2 officers received specialized training at a 5-day course at Tripler Army Hospital, Hawaii, on the subject of "Treatment of Traumatic Injuries and Thermo Nuclear Burns."

Routine radiological surveys provided excellent monitor training. The surveys were conducted within 2 hours following detonation of each shot on Enewetak Atoll and within 8 hours following shots on Bikini. Although these surveys were a precautionary measure in the event of unplanned fallout, they were not a postshot requirement. Fallout detected during this period never exceeded 0.002 R/hr on Enewetak and Japtan islands.

TASK GROUP 7.3. A radsafe training program was initiated early during planning and continued throughout the operational phase.

The Assistant Plans and Operations Officer (Atomic Defense) organized the program in October 1955. After consulting NRDL and Naval Schools Command, Treasure Island (NSC, TI), he met with radsafe officers of CJTF 7, CTG 7.1, and CTG 7.4 at LASL and discussed TG 7.4 participation in the TG 7.3 radsafe training program at Kirtland AFB (Reference C.3.1, Installment 3, p. 12).

Meanwhile, in December 1955 the commanding and operations officers of VP-1 discussed air operational and radiological safety with CTG 7.3 staff in Washington (Reference C.3.1, Installment 5, p. 11). In the same month, a radiological safety training officer from NSC, TI, a chief damage controlman, and a civilian head of Health Physics Division, NRDL, were assigned to CTG 7.3 to supervise a radsafe and indoctrination program for all naval units at the PPG. This training team reported to the flagship Estes in March 1956 (Reference C.3.1, Installment 4, p. 4; Installment 7, pp. 4-5; Installment 8, pp. 13-14; Installment 9, p. 15). Before embarking, the team proceeded "to develop course curriculum, prepare and obtain training aids, and conduct unit training" (Reference C.3.2, p. 108). The team also adopted the manual, "Radiation and Contamination Control," prepared by the Health and Physics Division, NRDL, for use in TG 7.3 training courses and prepared a booklet entitled, "Field Notes on Radiological Safety," for radsafe officers. These publications were distributed to all units contacted (Reference C.3.2, p. 108; Reference 7.3.1, Installment 8, p. 14).

The radiological training team performed limited instruction before departure of units from the U.S. west coast, but held courses on board Estes en route to the PPG and on Badoeng Strait and other ships after their arrival. Altogether, 24 sessions involving 1,036 personnel were conducted. Table 5 displays this training by ship or unit, class date(s), class size, and location. These full-day sessions were designed to provide a concentrated radsafe briefing to key officers, chief and leading petty officers, monitors, and decontamination team members, who in turn were expected to provide instruction to all hands as appropriate. It is not clear, however, to what extent this information was disseminated to the crews. Although exact course content is not known, the curriculum did include the following:

1. A Resume of Nuclear Weapon Phenomena
2. Nuts and Bolts of Nucleonics
3. The Bomb, Its Effects, and You
4. Basic Radiological Safety
5. How to Monitor and the Use of Radiac Instruments
6. Principles of Radiation and Contamination Control (an introduction to the manual)
7. General Discussion: Questions and Answers.

Staff personnel also held practical exercises on monitoring, decontamination, use of personnel decontamination stations, and other duties aboard USS Chickasaw,

Table 5. Task Group 7.3 radiological safety training, REDWING.

Ship or Unit	Date	Number Attendees	Course Presented on/at
YAG-39 (USS George Eastman) YAG-40 (USS Granville S. Hall) USS Grook County (LST-611)	2/8-9	95	Naval Radiological Defense Laboratory
Patrol Squadron One	2/27 to 3/2	322	Whidbey Island NAS
USS Estes (AGC-12)	3/19 to 3/21	20	USS Estes
Staff CTG 7.3 & Officers USS Estes	3/26 to 3/30	30	USS Estes
USS Lipan (ATF-85)	4/4 to 4/5	15	Enewetak
USS Chickasaw (ATF-83)	4/4 to 4/5	19	Enewetak
USNS Bernalillo County (T-LST-306)	4/10	20	USNS Bernalillo County
Marine Helicopter Transport Squadron 363	4/16	42	USS Badoeng Strait (CVE-116)
USS Knudson (APD-10)	4/17	30	USS Badoeng Strait
USS Badoeng Strait	4/18 and 4/21	48	USS Badoeng Strait
USS Silverstein (DE-534) and USS McGinty (DE-365)	4/19	17	USS Badoeng Strait
CTG 7.3 Boat Pool Bikini	4/20	34	USS Badoeng Strait
USS Sioux (ATF-75)	4/23	15	USS Badoeng Strait
USS Chickasaw	4/23	10	USS Badoeng Strait
USS Catamount (LSD-17)	4/24	36	USS Badoeng Strait
USS Abnaki (ATF-96)	4/26	16	USS Badoeng Strait
USS Silverstein	4/30	19	USS Badoeng Strait
USS Curtiss (AV-4)	4/30	35	USS Curtiss
Marine Helicopter Transport Squadron 363	5/3	18	USS Badoeng Strait
USS Badoeng Strait	5/3	21	USS Badoeng Strait
USNS Fred C. Ainsworth (T-AP-181)	5/4 and 5/7	28	USNS Fred C. Ainsworth
USS Shelton (DD-790)	5/8 and 5/15	25	USNS Fred C. Ainsworth
USS James E. Kyes (DD-787)	6/28 and 6/29	30	Kwajalein Naval Air Station (NAS)
Kwajalein NAS	7/5 and 7/6	55	Kwajalein NAS
Total		1,000	

Sioux, USNS Bernalillo County, Badoeng Strait, and Curtiss at the PPG during April.

As indicated previously, radsafe training continued into the testing period. "Prior to the first shot all units not previously participating in CTG 7.3 radsafe courses were given a 1-day briefing by staff personnel" (Reference C.3.1, Installment 9, p. 14). Moreover, shortly before the shots began, films and interviews on radiological safety were presented over the television network from Badoeng Strait. From 5 through 14 May, the radsafe training officer was assigned aboard Mount McKinley, the press and observers' ship. He worked with the ship's personnel on radsafe organization, briefed the officers and press representatives on radiological safety, and conducted monitoring and decontamination drills with the ship's repair parties (Reference C.3.1, Installment 10, p. 15).

Training exercises aboard ships during the operational phase proved to be impractical: crews were preoccupied with test preparations, and the unpredictability of ship movements hindered organized training. Assignment of radsafe personnel to ships during the Bikini shots was "discontinued since very little can be accomplished with the ships during such periods when they are more concerned with operational commitments" (Reference C.3.1, Installment 11, p. 15). In any case, radiological training personnel were needed to oversee radsafe operations and to assist the radsafe officer in "effecting liaison and coordination with project personnel in the decontamination of test ships and barges by Task Group 7.3 personnel" (Reference C.3.2, p. 109).

Nevertheless, radiological training was continued "on a reduced scale" during the test period (Reference C.3.1, Installment 11, p. 11). For example, the last six courses listed in Table 5 took place from May through July. In addition, USS Walton (DE-361) and USS Caliente (AO-53) were given radiological briefings by staff personnel on 6 June and 6 July, respectively, and "all arriving transient units . . . were contacted . . . and briefed on radiological safety matters" (Reference C.3.1, Installment 9, pp. 14-15). Specifically, "a boarding folder containing all pertinent radiological safety information and directives was made up and utilized for visits to Navasota, Walton, and other transient units" (Reference C.3.1, Installment 10, p. 15).

Because Marine Helicopter Transport Squadron 363 (HMR-363) was to be engaged in postshot radiological surveys and recovery operations, the unit was particularly careful to promote radiological safety. Preparations included (1) weekly lectures, films, and decontamination drills, (2) field monitoring problems on outlying islands where low-level radiation existed, (3) simulated "hot" helicopter drills in the washdown bathtub on Badoeng Strait, and (4) familiarization with aircraft decontamination procedures of the two portable decontamination trailers on Eneu (Reference C.3.1.4, pp. 13, 68-69).

On 7 May, a conference of all TG 7.3 radsafe officers was held aboard Estes, at which time a directive on radsafe procedures and other radiological matters was discussed.

On 8 July, an 8-hour conference was held on Curtiss attended by all TG 7.3 radsafe officers as well as commanding officers, executive officers, medical officers, repair party officers, and representatives from NRDL, Navy Bureau of Medicine and Surgery (BuMed), and several of the effects programs. Fallout experience, decontamination operations, and procedures for previous and future shots were discussed, and a lecture on meteorological aspects of radiological safety was given. It is not known how many attended this conference, but the historian for TG 7.3 remarked: "It is felt this and other conferences are extremely beneficial and promote a very healthy interchange of ideas and problems" (Reference C.3.1, Installment 11, p. 14).

TASK GROUP 7.4. Time constraints were critical in TG 7.4 planning for radiological monitor training. The objective was to organize a single program to meet the needs for aircraft monitors, weather-island monitors, and monitors for TG 7.4 operational areas. However, insufficient time and funds precluded sending personnel to established service schools (Reference C.4.1, pp 69-71).

During 29 and 30 November 1955, representatives of TG 7.4 and NRDL agreed to establish a joint TG 7.4-TG 7.3 monitor course to be conducted by NRDL and the 4926th Test Squadron (TAU) (Reference C.4.1, p. 26). The course outline is contained in Appendix A. After coordinating with TG 7.1 in efforts to acquire 150 copies of the LASL radsafe manual, TG 7.4 allotted a few spaces in the course for TG 7.1 personnel. Assistance from TG 7.1 to TG 7.4 in providing training aids was also negotiated. TG 7.4 sought assistance from TG 7.1 because TG 7.3 was unable to provide copies of the NRDL manual for TG 7.4 without funding support (Reference C.4.1, pp. 23-24).

In February 1956, the lesson plans had been drafted for most of the 40-hour course of instruction, the first day being for general matters of joint TG 7.3-TG 7.4 interest. The last 2 days were allocated for separate instruction in areas peculiar to TG 7.4 operations (Reference C.4.1, pp. 18-19).

By early March it was recognized that because of immediate operational requirements, weather-island personnel could not wait for the two course sessions beginning on 9 and 16 April. TG 7.4 consulted with TG 7.5 to arrange for training ten TG 7.4 personnel in the TG 7.5 course already underway. This was settled, and the TG 7.5 course was "essentially the same in content and duration as the planned TG 7.4 course" (Reference C.4.1, p. 22).

TASK GROUP 7.5. TG 7.5 monitors completed radsafe training before integration of the radsafe unit into TG 7.1. Radiological safety at PPG during the period between CASTLE and REDWING was supervised by the Test Division, Albuquerque Operations Office (ALOO), and operated by the Atomic Energy Commission (AEC) contractor, H&N. A specialist in radiological safety was assigned from USPHS as staff advisor to the Director, Test Division, ALOO (Reference C.5.2).

On 15 August 1954, the H&N radsafe unit was activated with the Industrial Relations Division (later changed to Administration Division) as a section of the Safety Department. This unit functioned independently, except for policy direction by the AEC Radiological Officer, until 15 April 1956, at which time it was integrated into the TG 7.1 radsafe unit.

The senior radsafe electronics technician, the head of H&N's radsafe unit, was sent to Fort McClellan, Alabama, and then to Los Alamos for a 3-week training period. Upon his return, a course on radsafe measures was given to selected personnel. This on-the-job training, supervised by the AEC Radiological Safety Officer, qualified four other technicians who, in turn, conducted courses in monitoring as well as radiological safety in general. Graduates of these courses formed the H&N monitoring unit.

SAFETY CRITERIA

Radiological Safety Standards

Radsafe standards for REDWING were set by CJTF 7 after consultation with the Surgeons General of the Army and the Air Force, the Chief of BuMed (Navy), and the Director, Division of Biology and Medicine, AEC (Reference B.0.3, Annex K). These standards are reproduced in Appendix A. Eash task group issued safety regulations based on the JTF 7 standards. Changes between the JTF 7 and the task group regulations either referred to task group reporting procedures or to amplifications of the standards particular to the mission of the task group.

CJTF 7 recognized that sometimes the standards might have to be waived. Possible circumstances included, for example, an air-sea rescue in a radioactive area. In these tactical situations, service exposure limits, based on prompt health effects, would apply. When possible, a radsafe monitor would accompany the tactical operation to determine the extent of overexposure so that medical action could be initiated if required. Such a tactical situation did not occur during REDWING. For all other cases of possible overexposure, a case-by-case evaluation was required by CJTF 7 before permission to exceed the limits was given. This evaluation weighed personnel exposure, importance of the tests, and costs of delays related to the existing limits.

REDWING exposure limits were based on continuous occupational exposure standards that assumed that personnel might have been previously exposed to radiation or might be continuously occupationally exposed in the future. The basic exposure limit was a Maximum Permissible Exposure (MPE) of 3.9 R for any 13-week period with no restriction on exposure rate. This limit was based on the then-accepted National Committee on Radiation Protection and Measurements (NCRP) and International Commission on Radiological Protection occupational limits of 0.3 R per week or 15 R per year.* A few special MPEs were also established. An MPE of 20 R (gamma only) was authorized for the aircrews doing the cloud sampling for the weapons laboratories and the cloud penetration for

* Since the operational phase of REDWING was 24 weeks, it would be possible for a participant to accumulate 7.2 R (0.3 R/week x 24 weeks) and not exceed the exposure limits.

Project 2.66* with the stipulation that if an aircrew member accumulated 3.9 R or more on any one mission, no second mission would be authorized before a lapse of 13 weeks had occurred. An exposure rate limit of 0.02 R/hr was established as the maximum for aircraft passengers on flights returning samples to the home labs.

Planning documents warned the task groups that previous exposure records should be checked to assure the MPE was not exceeded for individuals with prior exposure (Reference B.0.3). This warning was probably directed to the scientific projects of TG 7.1, whose personnel may have been exposed in the laboratory since the previous field tests, TEAPOT at the Nevada Test Site and WIGWAM in the Pacific, were completed about a year before REDWING.

In addition to the overall exposure limits, specific Maximum Permissible Limits (MPLs) related to radioactive contamination on parts of the body, clothing and personal effects, food, water, air, vehicles and equipment, and materials. These MPLs specified either the level of decontamination required or the upper limit for restriction of activity. Table 6 lists the REDWING MPLs.

Individuals exposed to ionizing radiation above the established limits were informed that appropriate remarks would be included in their medical records. Military personnel in this category were then advised to avoid exposure to additional radiation until sufficient time had elapsed to lower their average radiation exposures to 0.3 R per week. Limitations on further radiation exposure for civilians would be determined by the agency having appropriate administrative jurisdiction.

Radiation Exposure Waivers

Various assignments called for waivers of the MPE. The rationale was that use of alternative personnel was not feasible because of the technical nature of the work. Lack of properly trained personnel apparently necessitated extension of the radiation exposure limits for specified individuals so that certain projects could be completed.

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* For planning purposes, no crewmember was to receive a total exposure over 12 R. The 20-R limit was authorized to account for device yields larger than expected (Reference C.4.1, April-May, p. 8).

Table 6. REDWING Maximum Permissible Limits for radiation exposure and contamination.

EXPOSURE	
Personnel	
Skin	0.001 R/hr (about 1,000 CPM)[a]
Hands	30 rep (beta) for the operational period
CONTAMINATION	
Clothing	
Outer clothing	0.007 R/hr
Under clothing	0.002 R/hr
Vehicles and Equipment	
Vehicles, interior surfaces	0.007 R/hr (beta plus gamma)
Vehicles, exterior surfaces	0.007 R/hr (gamma only measured at 5 to 6 inches)
Ships and boats, fixed alpha	2,500 DPM/150 cm^2 for enclosed areas
	5,000 DPM/150 cm^2 for open surfaces
Ships and boats, final clearance	0.015 R/day (= 0.0006 R/hr)
Aircraft, cloud tracking	
turnout required	3.0 R/hr
Respirators, interior surfaces	0.002 R/hr
Air[b]	
Particles <5 microns	10^{-6} μCi/cc (24-hour average)
Particles >5 microns	10^{-4} μCi/cc (24-hour average)
Water, potable	5×10^{-3} μCi/cc (beta plus gamma calculated at 3 days after burst)
Lagoon, water contact sports	50,000 DPM per liter

Notes:

[a]The acronyms CPM, rep, and DPM are defined in the Glossary of Terms, Abbreviations, Acronyms, and Units (Appendix C).

[b]Omitted by Joint Task Force 7; MPL cited is from TG 7.4 (Reference B.4.5)

Source: Reference B.0.3, Annex K.

For instance, waivers were requested from TG 7.1 for two Sandia employees. The two men were involved in the recovery, analysis, and shipment of experimental samples and components, and it was expected they would receive a total exposure of about 7 R. CTU 7 informed the Surgeon JTF 7 that one individual had accumulated a total exposure of 5 R and another had accumulated 3.9 R. The project on which these individuals were working required approximately three more recovery missions. The response to the waiver requests was that the individual with the higher exposure could not participate in any more missions. It was estimated, however, that the other would accumulate less than 1.1 R in the remaining missions. Thus approval was granted for a specific Sandia person to exceed the maximum of 3.9 R, but he could not exceed a total of 5 R (Reference C.0.AG903).

Another request for a waiver on radiation exposure came from TG 7.1. An analysis of desired aircraft positions for certain remaining shots indicated that crews of two effects aircraft (Program 5) would be exposed to predicted exposures in excess of the 3.9 R limit. The planned aircraft positions attempted to balance the project's data needs with the radiation commitment of the crews. The request stressed that changes to the positions selected would substantially reduce the value of participation.

The two crews in question were those of the F-101A and the A3D. The single pilot of the F-101A had accumulated 0.715 R to date, and the expected exposure by completion of the planned program was a maximum of 7.1 R. The 4-man crew of the A3D had received 0.06 R to date and expected a maximum of 6 to 7 R. The response to the waiver request was that the authorized exposure for aircrews of Program 5 would be 7 R total (gamma only) for Operation REDWING. This exposure could be acquired without limitation on rate of exposure, and every effort would be made to ensure that no crewmember was knowingly subjected to a total exposure greater than 7 R (Reference C.0.AG903).

A request for waiver concerned the personnel involved in the rollup operations after REDWING. Shot TEWA at Bikini contaminated Enewetak to the extent that the personnel would be exposed to radiation that might be in excess of 3.9 R in 13 weeks. CJTF 7 authorized an exposure of a maximum of 7 R to these personnel.

Radsafe Monitoring and Instrumentation

Film badge dosimeters worn by the personnel in REDWING were the primary radsafe control to assure that MPE safety criteria were met. The film in these badges darkens when exposed to radiation, and darkening is a measure of radiation exposure.

Both permanent and mission badges were issued. Each consisted of two types of film in a light-tight container: DuPont Type 502 with a range of 0.1 to 10 R, and DuPont Type 606 with a range of 10 to 300 R. Lower exposures (less than 0.1 R) could be measured, but accuracy suffered. Density measurements were made on a Los Alamos FD-1 densitometer. Recording of the badge readings is discussed below in the section on "Recording Personnel Exposures."

Self-reading pocket dosimeters and hand-held radiation detection instruments were routinely used to determine the existence and intensity of radiation and to evaluate the need and efficiency of decontamination. Complete details regarding types of instruments used or the calibrations performed have not been found. Furthermore, information on measurement procedures and distances from radioactive surfaces (e.g., at 1 inch [2.5 cm] or 3 feet [1 meter]) is often incomplete. The data found, however, suggest that the instruments and calibration methodology represented state of the art for radiation detection and measurement in the mid-1950s.

TU 7 of TG 7.1 issued direct-reading Bendix Model 611 pocket dosimeters (0 to 5 R range) to personnel receiving mission badges to enter radex areas. These dosimeters could be read in the field to determine cumulative exposure, thus precluding inadvertent overexposure. Upon return to the radsafe checkpoint, the dosimeter reading was recorded and the device recharged.

The standard monitoring instrument for TG 7.1 and TG 7.5 was the AN/PDR-39* (Reference D.1). The radiological safety report, WT-1366 (Reference C.1.7.1), states the basic instrument for the aerial surveys "was a special ionization

* The AN/PDR-39 ionization chamber radiation detector is essentially the same as the AN/PDR-T1B, with modifications in the electronics to produce a faster meter response when the scale is changed. The T1B was in use as late as 1958, so presumably some were used in REDWING.

chamber built by Jordan Electronics, Inc., to the desired specifications." In addition, some AN/PDR-39 survey meters converted to read to 500 R/hr from their normal range of 100 R were used. The probe was attached to the landing gear of a helicopter; on monitoring surveys both the radiation reading and the helicopter altitude were recorded (Reference D.1). Project 2.6 also performed early-time helicopter radiometric surveys of some of the atolls (Reference C.1.1319). Their aerial survey instrument was a Jordan AGB-10K-SR metal-shelled ionization chamber; sealed inside was a subminiature tube in 10 atm of argon. A 2,000-foot (610-meter) cable connected the chamber to the electronics, allowing the probe to be lowered from a hovering helicopter. The measurement range was reported to be from 0.01 mR/hr to 10,000 R/hr in three logarithmic scales, with reported accuracy of ±10 percent. The instrument was calibrated against a ^{60}Co source belonging to Project 2.1.

The TG 7.2 final report (Reference C.2.2) indicates that monitor training suffered because of instrument deficiencies resulting from the inexperience of maintenance personnel. As a result, the AN/PDR-T1B ion chamber instrument was abandoned and the AN/PDR-27 Geiger-Mueller (GM) detector substituted. It is unclear if this was only for training or if the AN/PDR-27 was also used operationally, or if the AN/PDR-39 ion chamber was the basic instrument.

TG 7.3 used the AN/PDR-27F (GM) and the AN/PDR-18A ion chamber for monitoring, with the ion chamber instrument reportedly employed in the greater radiation fields (Reference C.3.1). Many TG 7.3 ships did not possess the complete allowance of radiac equipment, so the Navy Bureau of Ships (BuShips) issued additional instruments that were inspected, tested, and calibrated by NRDL before their transport to the PPG. Badoeng Strait maintained a pool of radiac spare parts, tubes, batteries, and tools.

Radiac instrument allowances were established by request to BuShips for HMR-363 and VP-1, and instruments were shipped directly to these units. In view of its remote location at Kwajalein during the operation, VP-1 was advised to be as self-sufficient as possible, and that qualified radiac repair technicians should be trained at the Naval Schools Command, Treasure Island. This recommendation was also made to all large ships.

Special instruments were provided to supplement available Navy standard types. Twenty Berkeley side-window GM counters were borrowed from NRDL for personnel monitoring instruments. Twenty "cutie-pies" (ionization radiation detectors) were ordered for monitoring and evaluating high beta-gamma intensities. These instruments were not received until late in the series and many were inoperative and were little used. DT-60 dosimeters were issued to most personnel of TG 7.3. The initial reading, recording, and issue of these dosimeters presented no problems, and since no exposures in the high range measured by these dosimeters occurred during REDWING, their serviceability was not evaluated further.

Radiation sources for instrument calibration and training were obtained from BuShips, but were received without calibration information or convenient individual containers. Calibration was determined and lead "pigs" fabricated in the forward area. The use of actual sources, under close supervision for monitoring drills, appeared to be very effective. A 7-Ci ^{137}Cs source was also borrowed from NRDL for instrument calibration.

TG 7.4 provided instruments for monitoring inflight aircraft, aircraft decontamination, and determining the existence of radioactivity on the weather-reporting islands. The AN/PDR-39 was used to measure aircraft contamination for Project 2.66b (Reference C.1.7.1).

Multiengine aircraft, except the B-57 sampler and early penetration planes, were equipped as follows (Reference B.4.5, Annex C, Appendix 8):

AN/PDR-39 ionization chambers	(1 per aircraft)
AN/PDR-27C Geiger-Mueller instrument	(1 per aircraft)
Film badges (mission type)	(1 each crewmember)
0-200 mR pocket dosimeters	(2 per aircraft)
0-10 R pocket dosimeters	(2 per aircraft)

Single-engine planes and the B-57 sampler and early penetration aircraft were not equipped with the AN/PDR-39 and AN/PDR-27C instruments. The sampler and early penetration aircraft carried special radiation-measuring instruments mounted on the aircraft instrument panel that were readily visible to the pilot. These instruments measured the existing radiation environment and the total exposure. All crewmembers carried mission film badges and the criteria for both types of dosimeters were one per crewmember, in lieu of two per aircraft.

According to a Standard Operating Procedure covering weather-island radiological safety (Reference B.4.5, Tab B to Appendix 6 to Annex A), weather-island detachments were issued the radiological instruments listed in Table 7. All instruments for these detachments were exhanged routinely on weather island resupply flights.

Table 7. Weather island radiological instruments, REDWING.

Instrument	Kusaie	Kapingamarangi	Tarawa	Rongerik
AN/PDR-2	0	0	0	1
AN/PDR-39	2	2	2	4
AN/PDR-27	2	2	2	4
GM counter	0	0	0	2

PRE-EVENT SAFETY MEASURES

Danger Area

Part of the REDWING planning phase was spent defining an area in which local fallout could occur without encountering inhabited islands or normal shipping and aircraft lanes. Shots would be detonated only if predicted winds would deposit local fallout within this specified area.

The danger area recommended by JTF 7, Figure 19, encompassed roughly 1.29 million square kilometers. Other governmental agencies consulted in planning this area were:

- AEC, Division of Biology and Medicine, on the adequacy of the zone
- Department of Commerce and its various Transportation Control Agencies, on the effect of the zone on established air and sea routes
- Department of State, on international implications of the zonal boundaries.

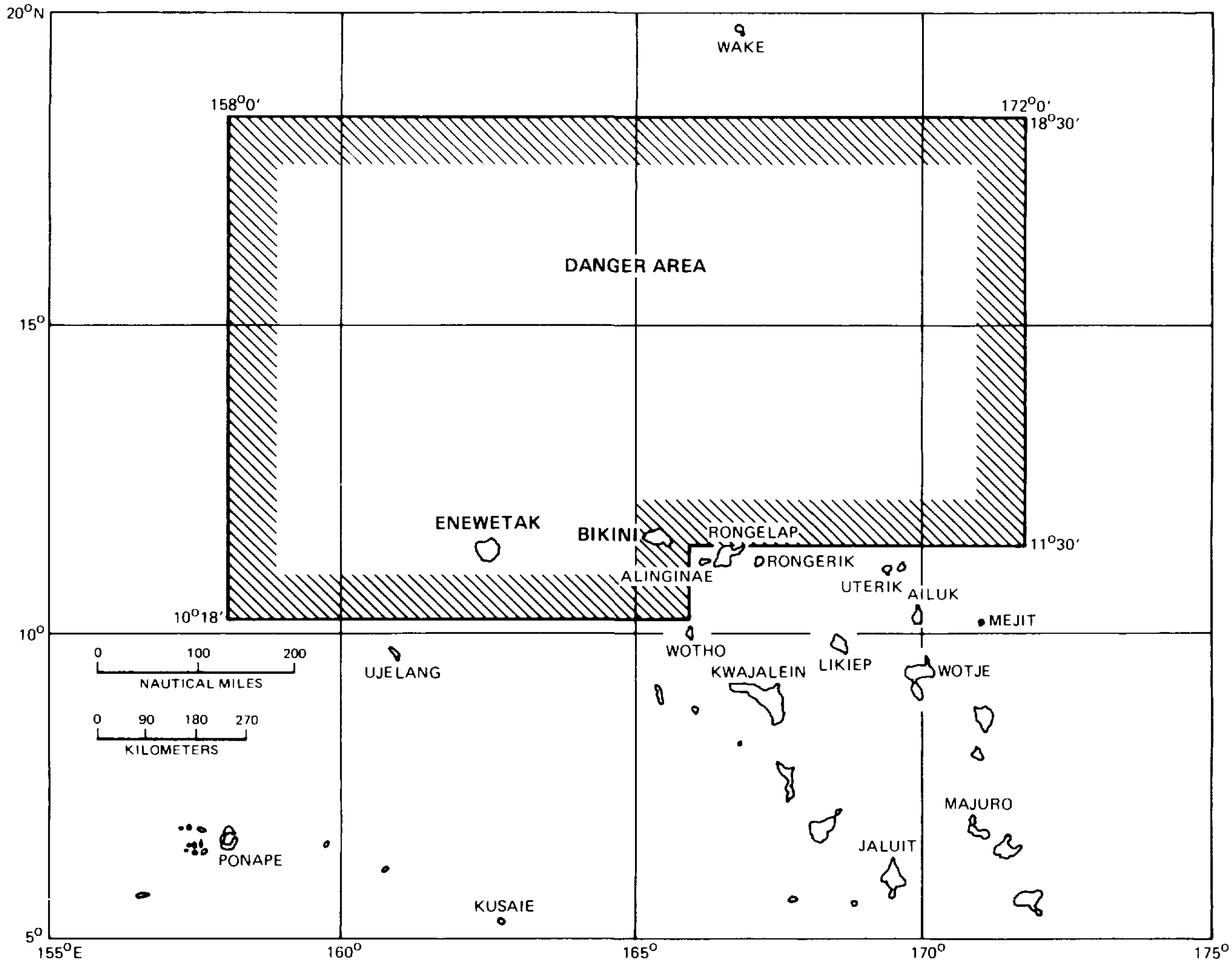

Figure 19. Danger area established for REDWING operations.

After approval by all agencies involved, the AEC publicly announced the limits of the zone. The Navy Hydrographic Office published warning notices to mariners and airmen of the danger area, effective 20 April 1955 through the duration of testing.

To assure that vessels did not venture into this region, the squadron of TG 7.3 P2V aircraft based at Kwajalein frequently patrolled the danger area. Immediately before each shot, these planes intensively searched the area of expected fallout so that unauthorized vessels could be warned and requested to clear. If the vessel could not depart before the scheduled detonation, CJTF 7 was to postpone the shot. If radioactive cloud trajectories seemed to be headed outside the danger area, CJTF 7 was to inform Commander in Chief, Pacific (CINCPAC) and the Civil Aeronautics Administration so that water and air traffic could be diverted (Reference C.0.1).

Fallout Prediction

The Fallout Prediction Unit (FOPU) was responsible for preparing radsafe forecast information for each shot. Accurate prediction was important for two reasons. First, it was needed to guard against local fallout descending upon inhabited atolls or upon project personnel. Secondly, the agencies studying fallout as part of the experimental program did not want fallout from a second shot to add more than 1 percent to the fallout of a preceding shot, as this would interfere with the study of decay rates. If an accurate fallout prediction was not available, a 7-day waiting period between shots would be required to achieve this condition (Reference B.1.3.1).

The unit was manned by personnel from the U.S. Weather Bureau (USWB), the Air Weather Service, Sandia Corporation, and the two weapon development laboratories, UCRL and LASL. It was divided into two groups, each capable of providing the necessary pre- and postshot forecasts. One group operated at Parry and was responsible for Enewetak forecasts. The second group, aboard Estes, performed the forecasts for Bikini.

The FOPU predictions were designed to show contours of equal radiation exposure. Basic to these predictions were weather data indicating how masses of air at various altitudes were moving in both time and space and yield-dependent empirical fallout models resulting from previous tests.

Table 8 shows typical FOPU activities for a single detonation. In practice, two to four forecasts per day were made as shot day approached. This procedure continued if the winds near shot time became unfavorable. At the PPG, winds are not from a constant direction, and significant changes are observed in periods as short as 3 hours. The proper detonation conditions, which required winds that would deposit fallout in the uninhabited danger area north of the shot islands, occurred only during situations of rather short duration (Reference D.2). This required almost continuous prediction (and weather data) as shot time approached.

Table 8. Typical fallout prediction unit activities, REDWING.

Day	Time	Event
D-1	0800-0830	Sector and gross pattern forecast made
	0830-0900	Outlook briefing
	0900-1100	Detailed forecast made
	1100-1200	Main planning briefing
	1300-1400	New forecast issued
	1900-2000	New forecast issued
	2200-2400	Detailed forecast issued
D-Day	2400-0030	Main briefing
	0330-0430	Pattern made for 0200 winds
	0430-0500	Final briefing
		Shot
	0800-0930	Shot pattern constructed from shot time winds

Four different hand calculations were available to FOPU: the Gaussian, for off-atoll prediction; and the Feld, USWB, and Sherman for both on- and off-atoll predictions. Planning documents indicate that the actual technique(s) to be used operationally was to be determined by the speed and accuracy of each method measured at the beginning of the series. The final predictive method(s) adopted has not been determined.

Fallout cloud dimensions and the total amount of radioactivity appearing as local (as opposed to worldwide) fallout were predicted according to analysis based on previous shots. Each of the calculational techniques apportioned the total radioactivity in the cloud into a maximum of 20 levels of discs. Each disc was allowed to fall through the various winds until the ground was reached. Summation of the ground intensities resulting from each disc defined the predicted pattern. The various hand methods differed in the way the radioactivity was apportioned among the discs, the way the radioactivity was apportioned among different fallout particle sizes, and the calculational techniques used to transport the fallout by the winds.

Correlating weather and radiation data by hand is tedious. So, because the value of radsafe information is directly related to its promptness, computers were used to reduce the time interval of calculation. The AEC made three types of analog computers available to the FOPU. An electronic analog developed by the National Bureau of Standards (NBS) in conjunction with the USWB took weather information and estimates of the diameter, height, and distribution of the expected atomic cloud, and within 1/20 second presented the prediction fallout pattern on a cathode ray tube similar to a television screen. The varying brilliance of the marking coincided with the radiation intensity at any point up to 250 nmi (463 km), and sometimes farther, from ground zero. Two such instruments were available to JTF 7 during REDWING. The initial unit was on Estes, and in May a second unit was installed on Parry. An optical analog built by LASL projected the fallout pattern on a film to provide a permanent record. A mechanical computer based on the Gaussian hand method was developed by Sandia Corporation. This computer could predict the radiation level found in traverses across the pattern at different distances.

At the main briefing for CJTF 7, a pattern representing a best-estimate compromise of the various methods was presented by a member of the FOPU. Variations of this pattern, which could be caused by possible wind fluctuations, were indicated by the NBS computer. It was planned that two scales of patterns be given at the briefing: an on-atoll (or close-in) pattern, and a distant (or off-atoll) pattern. The FOPU predictions along with measurements of the actual fallout patterns are presented in Chapters 4 and 5.

Two other groups also prepared fallout predictions, with data being exchanged. Program 2 of TG 7.1 required positioning information so ships could be located properly within the fallout field. This group made predictions of the axis of the "hot" line and the lateral extent of fallout. The expected levels of gamma activity were not quantified, nor were radiation contour lines developed.

The Hq USAF element on Parry prepared trajectories of particle fall from different altitudes and transmitted the data to JTF 7 at 0800 and 2000 daily. For the Bikini shots, this information was transmitted to Estes through Weather Central communications circuit. (Reference C.0.1)

Weather prediction was crucial to FOPU. Weather data collection was a joint responsibility of TG 7.3 and TG 7.4. Experience during CASTLE had shown that over a wide area, prediction of fallout movement for higher-yield tests required estimating weather phenomena that might affect the test site during the 24 to 48 hours before and after each shot. The required data included wind currents from the Earth's surface to altitudes above 100,000 feet (30.5 km). Since the technology available and information on the area's climatology were inadequate to meet this requirement, "JTF-7 devoted much effort to climatological research, technological improvement of weather collecting equipment, and expansion of weather facilities" (Reference C.0.2).

After CASTLE, JTF 7 detailed several staff weather officers to study tropical meteorology at the University of California, Institute of Geophysics. During their research, they investigated the climatology of the Marshall Islands and established a methodology for daily computation of vertical air movements and graphic presentation of the computed results.

Technology available at the time of CASTLE permitted upper air observations to about 30,000 feet (about 9 km) by aircraft and to about 55,000 feet (about 17 km) by weather balloons carrying radiosondes (devices that measure weather phenomena and transmit the information to ground stations). At about 55,000 feet (about 17 km), the latex weather balloons in use became brittle and shattered because of the extreme cold. In preparation for REDWING, the Army, the Air Force, and commercial balloon manufacturers developed a plasticized balloon that permitted observations to altitudes above 100,000 feet (about 31 km). Supplementing balloon soundings for spot observations, the destroyer weather ships employed 5-inch (12.75-cm) gun "window" projectiles. Developed during World War II for radar jamming, these projectiles burst at a preset range, releasing a cloud of metal foil strips ("window") that could then be tracked by radar to determine wind direction and velocity at various altitudes as the strips fell. Window projectiles were helpful for altitudes up to about 35,000 feet (about 11 km).

In addition, the Window Aerological Sounding Projectile (WASP) attached to a Loki rocket motor was developed for REDWING. The WASP/Loki combination, fired from a simple tube installed on ships, was used like the window projectile but reached altitudes of about 100,000 feet (about 31 km).

Owing to the lack of weather facilities in the Central Pacific, it was necessary to expand in extent and density the coverage of the area relevant to Operation REDWING. Accordingly, in the summer of 1955, representatives of JTF 7, the Navy, the Air Weather Service, the Airways and Air Communications Service, and H&N surveyed existing facilities and certain islands with a view to expanding the weather-predicting capability. Based upon the survey (Reference C.0.1, p. 29),

> JTF-7 financed improvements of upper air observing facilities at Koror, Yap, Truk and Ponape, and the reopening of a station at Majuro; a station formerly operated at Rongerik was renovated, and new stations were built on Kusaie, Kapingamarangi, and Tarawa . . . . By the spring of 1955, military-staffed stations at Enewetak and Kwajalein, JTF-7-staffed stations at Rongerik, Tarawa, Kusaie, and Kapingamarangi, and Weather Bureau stations at Truk, Ponape, Majuro, and Wake Islands were ready to function in support of the operation.

In addition, all available routine weather reports were collected from throughout the Pacific. To collect, analyze, and correlate reports and to forecast weather, JTF 7 established a Weather Central at Parry staffed by civilian, Navy, and Air Force personnel. Weather Central was controlled by JTF 7 and supported by an extensive communications network. It provided charts and forecasts by facsimile and teletype circuits to JTF 7 staff and weather support to participating ships and units. More than 500 men under the immediate control of JTF 7 directly supported JTF 7 weather activities (Reference C.0.1, p. 32). Table 9 provides a list of the weather resources available to JTF 7.

To supplement local coverage and to investigate unusual conditions, such as storms, ten Air Force weather reconnaissance planes flew sorties as needed. These aircraft were available for a minimum of two daily flights covering a 1,200-nmi (2,224-km) radius from Bikini. The modified seaplane tender, Curtiss, provided upper air observations at Bikini, and the two destroyers assigned to the operation employed balloons, window projectiles, and WASP rockets at any of five designated stations northwest and northeast of Bikini or east of Enewetak. In addition, all ships and patrol and search aircraft routinely reported the weather.

The accuracy of FOPU's forecasts and early warning of deviations from forecast fallout patterns were checked by a radiation-plotting program organized

Table 9. Joint Task Force Weather Central resources, REDWING.

Location	Communication Means
Guam, Tokyo, Pearl Harbor, Canberra	Radioteletypewriter intercept
Pearl Harbor, Tokyo	Radiofacsimile intercept
Nando	CW radio intercept
Rongerik, Kusaie, Tarawa, Kapingamarangi	Direct CW radio
Weather Reconnaissance Aircraft (WB-50)	CW radio via the Air Operations Center

around a fallout plotting unit composed of AEC and USPHS personnel. Sources for determining actual postshot fallout patterns included ships and aircraft specifically tasked to monitor radiation. Aircraft (code-named Wilson) tracked the radioactive clouds for 24 to 48 hours after each shot. JTF 7 established 16 ground stations outside the PPG for radiological monitoring. In addition, units collecting scientific data contributed information to the radsafe plotters, and all units in the PPG area submitted routine observations.

Recording Personnel Exposures

Experience during the 1954 CASTLE series indicated the advisability of being able to determine the radiation exposure of all test series participants. Accordingly, a film badge dosimeter program was implemented to provide a radiation exposure record for every person engaged in REDWING operations. The readings from these film badge dosimeters were the basis of the "consolidated list of exposures" called for in paragraph 19 of the JTF 7 Radiological Safety Regulation (see Appendix A). The Consolidated List of Exposures (Reference C.1.7.3) was the medium through which the task groups were to notify their personnel's "unit of permanent assignment" of the exposures accrued in REDWING.

Two types of badges were issued: a "permanent" badge given to all project personnel and a "mission" badge given to those required to enter radioactive areas. Exposure records were kept for both types of badge for each individual. The first permanent badges were issued on 15 April 1956, with exchanges scheduled every 6 weeks. Uniquely identified by embossed, red serial numbers, permanent badges were to be worn at all times; it was strongly recommended that they be attached to dog-tag chains rather than carried in pockets. As the operation progressed, it was found that badges worn longer than 4 weeks became badly watermarked, showed severe light leaks, and were generally quite difficult to read. As a result, the exchange period for TG 7.1 and TG 7.5 was shortened to 3 weeks, and the period for all others was shortened to 4 weeks. Figure 20 shows a typical badge exchange. During the operation, 40,000 permanent badges were issued, processed, and recorded; records were maintained on approximately 14,000 individuals.

Mission badges were issued to JTF 7 personnel entering a radex area (radioactivity over 0.010 R/hr). These badges were worn only in the radex area and

Figure 20. Issuing REDWING film badges; dosimeter being read in background.

were turned in for processing upon the wearers' return. Identified by either green or black serial numbers, mission badges were issued only at a TG 7.1 radsafe checkpoint before an individual's entry into the radex area. Exceptions to this policy applied to certain aircrews of TG 7.3 and TG 7.4, who were issued mission badges before flights that might intersect airborne radioactivity.

The mission badge program was designed to rapidly determine the exposure an individual had received while participating in recovery or construction missions in radex areas. No watermark deficiencies were noted with these badges, as the usual period of wear was approximately 12 hours. About 45,000 mission badges were processed. Bendix Model 611 (0 to 5 R) quartz fiber, self-reading pocket dosimeters were also issued with the mission badges, so an individual's exposure while in a radioactive area could be quickly checked. Inaccuracies were noted in the dosimeter readings, however; consequently, this information became primarily a guide as to how quickly mission badges should be processed. If so indicated by the dosimeter reading, a mission badge would be processed immediately upon badge return.

The radsafe unit of each task group was responsible for issuing badges, usually through a film badge control officer. Each task group requested the necessary number of badges from TU 7 of TG 7.1 by 1 April 1956. TU 7 would then deliver the badges required along with an equal number of dosimeter issue, 3- x 5-inch cards (PS-103 cards) serially numbered to correspond with film badge numbers, plus an equal number of 5- x 8-inch cards (cumulative exposure records).

All film badges were to be returned to TG 7.1 authorities without delay; i.e., within 5 to 10 days after the last shot, or, for more remote units, 15 days. All film badges and PS-103 cards were arranged numerically before return to Parry Radsafe. The date of return was marked on each card, to ensure that all time periods were covered by a film badge. After completion of film badge processing, the cards corresponding to the processed film badges were returned to the task group with the recorded exposures indicated.

All film processing and record posting were done manually. As a result, as many as 40 individuals were assigned to the Dosimetry and Records Section. Manual reading and posting operations were tedious and subject to many errors. The Consolidated List of Exposures for all personnel in JTF 7 was maintained at Enewetak Atoll. At Bikini, a file of only those personnel present on the atoll was maintained. This split filing system necessitated a daily exchange of exposure information, primarily from Bikini to Enewetak to maintain the Consolidated List. Exchange was via the radioteletype circuits.

Individual records of military and civilian personnel were forwarded in accordance with service regulations to units of permanent assignment for inclusion in individual field military files or civilian personnel files. These records provided the exposure date, amount of exposure in milliroentgens, approximate duration of any overexposure in hours and minutes, and a space for remarks such as limitations on assignment because of overexposures.

Individual records of AEC-controlled and -administered civilian personnel were processed in accordance with special instructions prescribed by the laboratory or agency with administrative jurisdiction over the personnel.

Letter reports were submitted to the Surgeon General, U.S. Army; the Chief of Staff, BuMed; the Surgeon General, U.S. Air Force; and the Director, Division of Biology and Medicine, AEC. These reports indicated the action taken on the disposition of individual exposure records, comments on overexposures, if applicable, and other pertinent remarks.

Although the intent to badge all personnel entering PPG is clear, records do not exist for all people. This often reflects badges lost before processing or neglect by departing personnel to turn in badges. There is evidence, however, that personnel of a few units, mostly on ships operating only occasionally in the PPG, were not badged, and evidently some records have been lost. For example, exposure information does not exist for the following transient or attached units that arrived at Enewetak or Bikini during the testing period: USS Agawam (AOG-6), USS Cimarron (AO-22), USS Elkhorn (AOG-7), USNS Sgt Archer T. Gammon (T-AK-243), USS Karin (AF-33), USS Kishwaukee (AOG-9), USNS Pvt Joe E. Mann (T-AK-253), USS Menasket (AOG-10), USS Merapi (AF-38), USS Mispillion

(AO-105), USS Namakagon (AOG-53), USS Natchaug (AOG-59), USS Sussex (AK-213), and USS Walton (DE-361). In addition, the Consolidated List for USS Navasota (AO-106) is incomplete since it contains only 31 names, though the Bureau of Naval Personnel muster roll for the ship during REDWING lists a complement of 242. The unclassified incoming correspondence log for TG 7.3 notes a message of 28 May on the subject of "badges for the USS Karin (AF-33)," but there is no evidence specifying whether this was a request for dosimetry (rather than security) badges or whether such badges were provided. In any event, either personnel on these transient ships were not badged or the information was not recorded on the Consolidated List. The final report of CTG 7.3 states more emphatically that film badges "were also furnished to transient ships where indicated" (Reference C.3.2, p. 117). Elsewhere, it is stated that film badges and other radsafe equipment were provided to transient vessels "as needed" (Reference C.3.1, Installment 9, p. 14), but the available evidence does not define this need.

Off-Atoll Radiological Safety

Radioactive fallout was possible in the area outside the PPG, where 16 off-site locations were assigned radsafe representatives by CJTF 7. The weather stations at Wake, Majuro, Ponape, Johnston, Guam, Truk, Iwo Jima, Kwajalein, and Midway were instrumented to detect radiation. In addition, radiation monitoring stations were established at the TG 7.4 weather stations at Rongerik, Kusaie, Kapingamarangi, and Tarawa. Monitoring was also performed at Ujelang, Wotho, and Utirik by USPHS personnel. They provided hourly radiation intensity reports following all shots. Figure 21 shows a monitoring station on Utirik.

The offsite radsafe monitoring net was equipped with GM types of automatic indicating and recording instruments (Figure 21). These instruments were installed at the eight primary stations by AEC New York Operations Office personnel during April 1956 and operated continuously without a single failure, at least through May 1956 (Reference C.0.1). The other islands were monitored with AN/PDR-39 ion chamber and AN/PDR-27 instruments. In addition, Rongerik was issued an AN/PDR-2160 for beta measurements.

Each offsite representative was responsible for safeguarding the health, safety, and welfare of all JTF 7 personnel at the location in question, in

Figure 21. Off-site radiation detection equipment on Utirik Island, REDWING.

addition to protecting the interests of the local inhabitants in matters associated with JTF 7 operations. Time schedules and off-limits areas were planned to control, if necessary, the movement of island inhabitants during the operational period.

To warn populated areas of possible fallout, aerial and surface monitoring was used to determine the exact location and intensities of fallout. Provisions were made for continuous cloud tracking and constant surveillance of the radioactive fallout resulting from all large-yield detonations from H-hour through D+6. To ensure that no portion of the radioactive cloud would drift undetected toward the populated areas of the Marshall Islands, aircraft searched a 30° sector along the predicted midline to a radius of 500 nmi (927 km) for 24 hours after each detonation of megaton yield (Reference C.0.AG903).

The radsafe monitoring stations were established and operated by trained personnel equipped with radiac instruments and two-way radio communications. In the event of fallout at the populated atolls, radsafe monitoring personnel could advise the local inhabitants, through interpreters, of safety measures. Populated areas not covered by monitoring stations were surveyed by aerial flights (Reference C.0.AG903).

General safety instructions were prepared by the Office of CJTF 7 for the islands populated by the Marshallese. Basic health measures were planned to help reduce medical problems among the islanders resulting from radioactivity, and they were instructed as to what precautions to take in case fallout was suspected or confirmed (Reference C.0.AG903).

Detailed safety instruction plans for the island populations indicate there was concern for the welfare of the island inhabitants. On one occasion, a followup visit was conducted to check the island environment. On 25 May 1956, members of the JTF 7 J-3 Division and the Staff Surgeon visited Rongelap to determine the condition of facilities. Samples of the native food plants were collected for radioactive analysis, and the reports indicated that no unusual problems were encountered (Reference C.0.1).

Shipboard Modifications

Radsafe modifications to certain ships and aircraft were undertaken as indicated below:

- Three ships to be used to steam directly into the path of fallout, YAG-39, YAG-40, and Crook County, were supplemented with special crew shielding
- Water washdown systems were installed on all ships in the formal TG 7.3 organization plus Mount McKinley and MV Horizon (there is no evidence regarding the installation of washdown systems on other attached or transient ships) (Reference C.3.1, pp. 112-113)

- New personnel decontamination stations were established aboard Badoeng Strait, Mount McKinley, Estes, and Curtiss
- All ships were provided with radiation-monitoring devices, monitoring points were marked, and monitoring procedures were established and exercised
- A helicopter decontamination "bathtub" on Badoeng Strait was provided.

POSTEVENT SAFETY MEASURES

General Procedures

Detailed plans and checklists were issued for each shot indicating the time sequence of various actions, the task groups and individuals involved, and the time expected in radioactive areas. Appendix A shows a representative checklist, in this case for the INCA detonation.

For shots at Bikini Atoll, all personnel were evacuated to shipboard except for the firing party on Eneu.* The ships left the lagoon, took assigned positions upwind of the atoll, then returned after the shot. People were advised to take personal belongings on each evacuation. Average evacuation time (from island to ship) was 8 hours. Since Eneu was not contaminated by any REDWING events, evacuation never lasted longer than overnight. Return was not authorized until a radiation survey had been performed, however.

The extent of evacation from Enewetak Atoll depended on the size of the shot. The maximum withdrawal required everyone to move from the northeastern islands to either Japtan, Parry, or Enewetak, with a small party permitted on Ananij.

A system of messages was devised to inform REDWING participants of the schedule and conditions during shot detonations. Messages were sent to command headquarters before and after each detonation.

On D-5, the expected time of detonation and information concerning the closing of Enewetak airstrip to transient traffic were announced. At H-18, the radiological outlook for populated areas and expected radiological impact on air and surface routes (including recommendations relative to closing routes)

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* For the ZUNI event, the firing party was aboard the Curtiss.

were announced. Thirty minutes following the detonation (H+30), the exact time of detonation and reports concerning the safety of task force personnel and the populated islands were announced. Daily at 2000 hours, starting on D-day and continuing until information was no longer significant, the radiological situation was noted, and confirmation or revision of expected radiological impact was recorded (Reference C.0.AG903).

The general safety information summarized below guided TG 7.2 personnel on Enewetak and Japtan islands during the operational period. Similar instructions applied to other task groups, and all personnel were issued general safety instructions for D-day.

One minute before shot time, personnel with high-density goggles were instructed to put them on. Goggles were not to be removed until at least 10 seconds after the initial blast, and then only gradually, to accommodate the light change. Those without goggles were to face away from zero point, shield their eyes, and not view the fireball until at least 10 seconds after the burst. Personnel were instructed not to look at the fireball with binoculars at any time and were warned that sunglasses were not to be used in lieu of high-density goggles, as they would afford no protection against the light of the fireball.

The shock wave would reach Japtan in about 35 to 105 seconds and the observation site at Enewetak Island in approximately 60 to 130 seconds, as timed from the first flash of light. Personnel were advised to keep a firm footing until the shock wave had passed.

Personnel were not to climb buildings or other structures to observe the shot. Gusts of wind were expected, and normal precautions were undertaken to secure light objects. Normal duty uniform was worn.

Safety precautions were developed to safeguard building facilities and equipment during shot conditions. Each area required preventive measures to ensure minimum contamination. Safety plans for the mess hall included preparations to cover food, dry stores, and canned goods that were not in closed buildings before D-day. Upon the first detection of fallout, the mess was to be notified, and the building closed and all food covered. A survey would then be made by the TG 7.2 Surgeon and the Radsafe Officer before serving food after the fallout. If the survey indicated contamination of food, dry stores, canned goods, or utensils, such items would be washed, if possible before preparation or serving. If no fallout was detected, no restrictions on food preparation or serving were enforced.

No restrictions other than buttoning-up were required for the hospital during a fallout period. Activities such as swimming, boating, and fishing were prohibited until appropriate radsafe clearance was received (Reference C.0.AG903).

Surveys and Recovery Planning

It was expected that following each detonation, areas of surface and air radioactivity would appear. These areas were designated as radex areas. Before shot times, the forecast air and surface radex areas were disseminated by CJTF 7 throughout the PPG. These forecast radex areas were in effect from H-hour until dissemination of later surface and air radex areas at about H+6. The later radex areas were based on the master radiological situation map maintained in the Radsafe Office of CJTF 7.

The surface radex area was determined by survey with radiac equipment after shot time. The most rapid method of surface survey in the early stages was aircraft and helicopter flights in and around radioactive areas. From the radiation intensities measured at a known altitude, it was possible to obtain an estimate of exposure rates on the surface of the ground or water. Water samples from the lagoon were also collected. Ground surveys followed these initial surveys to clearly delineate radioactive regions. As feasible, a ground survey of the shot atoll was scheduled for H+24 (Reference B.0.3).

All atoll land and lagoon areas in, near, or downwind from the detonation location were considered contaminated until cleared for operations by the task force commander.

Surveys were normally conducted by helicopter supplied by the Marine Corps (HMR-363) for TG 7.1 and included a preentry survey between H+1 and H+3 followed by a detailed survey at H+6 to H+8. Detailed surveys were also normally made on the mornings of D+1 and D+2 as required. The preentry survey noted the level of radioactivity and condition of test and data-gathering structures so that a sample recovery schedule could be established. Monitoring teams conducted the ground radsafe surveys. Each team consisted of three members: an instrument man, a recorder, and a communications man. Ground radsafe surveys were of two types: a detailed survey adapted to assessing areas of generally low radiation, and a predetermined level survey where the team approached a known area of radioactivity, such as a ground zero, until a prespecified level of radioactivity was recorded. The point reached was marked on a map and (usually) a stake driven to mark the location before the team moved back to a lower radiation area.

Results of these surveys were the establishment of two types of radex areas:

1. Limited radex area -- gamma radiation level between 0.010 and 0.100 R/hr
2. Full radex area -- radiation levels above 0.100 R/hr.

Admission to and exit from any radex area was through a radsafe checkpoint. A mission film badge, pocket dosimeter, and booties were required in all radex areas. In addition, admission to full radex areas required complete protective clothing and accompaniment by a qualified radsafe monitor. Personnel and equipment were monitored at the checkpoint as they left the radex area (as shown in Figure 22) and decontaminated if necessary. The Radsafe Center maintained radiation situation maps that were modified after each radsafe survey. Early-time recovery parties were requested to meet at the Radsafe Center at least one hour before planned entry into a radex area to be apprised of the possible radiation contamination and the allowable time in the area.

Altogether, 1,560 parties, containing from 1 to 50 men per party, were processed through the Enewetak checkpoints from 5 May to 20 July 1956. Approximately 9,500 personnel were processed through Bikini checkpoints during the same period. The personnel decontamination station at Enewetak handled a total of 1,558 individuals, while the facility at Bikini processed 3,350 (Reference C.1.3).

Radsafe monitors were assigned to individuals or groups working in radioactive areas or with contaminated equipment during recovery operations. They

Figure 22. Monitoring a recovery party at a radsafe check station, REDWING.

advised the recovery party leader, informing him of radiation intensities at all times, and the recovery party leader was expected to accept this advice and act accordingly. It was the responsibility of both the leader and the members of the recovery party to adhere to the established radsafe procedures (Reference B.0.3). Figure 23 shows a typical recovery team.

In accordance with directives from AEC, items or souvenirs gathered in the vicinity of Enewetak Island were to be inspected for radioactivity before mailing. Radsafe procedures forbade personnel from eating local fruit, plants, or animals. On a few occasions, waterfowl were picked up by personnel and sent to the Marine Biological Laboratories on Parry for study.

Arrangements were made by Patrol Squadron 22 (VP-22) (located in Hawaii) and Aerial Early Warning Squadron Three (located in Guam) to fly radiological reconnaissance. VP-1 patrolled the danger area and provided aerial radiation and reconnaissance surveys. This squadron arrived at the PPG on 15 April 1956

Figure 23. Scientific personnel wearing radsafe clothing rehearsing an early-time recovery in a radex area, REDWING.

and was based at Kwajalein NAS. VP-1 provided radiation reconnaissance for five shots during May using fixed flight patterns (Yoke and Zebra), which were modified to meet the changing conditions of each shot.

For example, the Zebra I flight, acting as the fleet radiation scout, was directed to make a low-altitude radiation and damage survey at H+1 for the ZUNI shot. P2V aircraft performed an early postshot survey, and reentry time was advanced by 1 hour as a result of information provided by Zebra I.

Postshot surveys of the northern Marshall Islands were conducted using WB-50 aircraft. Three flights, designated Baker, Charlie and Dog, monitored the following atolls:

Baker	Kwajalein, Kusaie, Pingelap, Mokil, Ponape, Ujelang
Charlie	Kwajalein, Namu, Ailinglapalap, Namorik, Ebon, Jailut, Mili, Arno, Majuro, Aur, Maloelap, Urikub, Wotje
Dog	Kwajalein, Makin, Marakei, Ebaiang, Tarawa, Malana, Abamama, Aramika, Nonouti, Tabitenea, Onotoa, Tamana, Arorae, Nukunau, Beru.

The WB-50s were used principally after Bikini shots and the P2Vs were used for most Enewetak shots.

Weather reconnaissance aircraft provided 48 hours of aerial radiation reconnaissance (four flights) and flew flight-plan Able after each shot.

Emergency Evacuation

CJTF 7 prepared an emergency evacuation plan in the event of extreme radioactive fallout that would seriously affect joint task force operations. The plan was adaptable to both partial and full-scale evacuation; it also pertained to danger-alert situations such as typhoons, tidal waves, or other dangerous natural phenomena. The plan assumed that conditions would permit small craft to aid personnel and equipment movement. In an emergency, other activities would cease and all energies would be directed to the emergency evacuation.

The following code names indicate the degrees of radioactive fallout alert conditions (Reference B.0.3, p. N-1-1):

1. Evacuation Condition Dog -- significant radioactive contamination expected; all personnel alerted

2. Evacuation Condition Charlie -- significant radioactive contamination present; preliminary preparation for evacuation

3. Evacuation Condition Baker -- Radioactive contamination increasing; all activities directed to evacuate

4. Evacuation Condition Able -- full-scale evacuation ordered

5. E-hour -- Commencement of emergency evacuation.

CTG 7.2 was responsible for designating evacuation assembly areas for Enewetak and Japtan islands, although exact area locations were not mentioned. (CTG 7.5 was responsible for the other islands of Enewetak or Bikini atolls.) The embarkation phase was coordinated with CTG 7.3 who would provide small-craft transport to ships if evacuation was required (Reference B.0.3, p. N-1-1).

No emergency evacuations of land-based personnel occurred during REDWING. Nevertheless, fallout was detected several times on inhabited base islands. Eneu received 0.012 R/hr for a short period after the TEWA shot and 0.010 R/hr for a short period after the NAVAJO shot. Enewetak Atoll received slight fallout from MOHAWK and significant fallout from TEWA. The islands of Enewetak and Parry both received fallout from TEWA for several hours the afternoon and night of 21 July 1956 and throughout the following day. Maximum intensities recorded were 0.100 and 0.120 R/hr.

TG 7.4 weather stations on the islands of Rongerik, Tarawa, Kusaie, and Kapingamarangi were not evacuated during REDWING as significant fallout was not detected. Rongerik reportedly received fallout from several shots during REDWING, however, amounting to a cumulative exposure of between 2 and 3 R (Reference C.4.3, p. 129-130).

Decontamination

Decontamination of personnel and equipment was stressed throughout REDWING. Shower facilities and laundry vans were used to decontaminate personnel and clothing, and special trucks were employed to clean buildings and equipment. Decontamination of clothing became an additional function of TG 7.2 during the operational period. A specially selected team was trained for radsafe laundry work. Laundry vans were located at the western tip of Enewetak Island, ready for use by October 1955. Two decontamination trucks were also available. (Reference C.2.1).

Local, or spot, contamination on personnel was of concern. Various authorities stressed the importance of spot decontamination to preclude, while taking a shower, distribution of localized contaminants to areas of the body not otherwise affected. A portable decontamination unit, manufactured for shipboard use aboard Badoeng Strait, was made from a 55-gallon (208-liter) oil drum.

Personnel would be required to use the portable decontamination unit at the entrance of each decontamination station before taking a shower. The individual would be monitored, and the contaminated spots would be marked with a grease pencil by circling the area. Directly supervised by the station monitor, the individual would clean each area with decontaminant materials furnished with the portable unit. Upon completing spot decontamiation, the individual was remonitored for those specific areas outlined by the grease pencil. Figures 24 and 25 show the process. When the individual concerned

Figure 24. Decontamination monitor locating and marking spots of radioactivity on personnel returning from a radex area, REDWING.

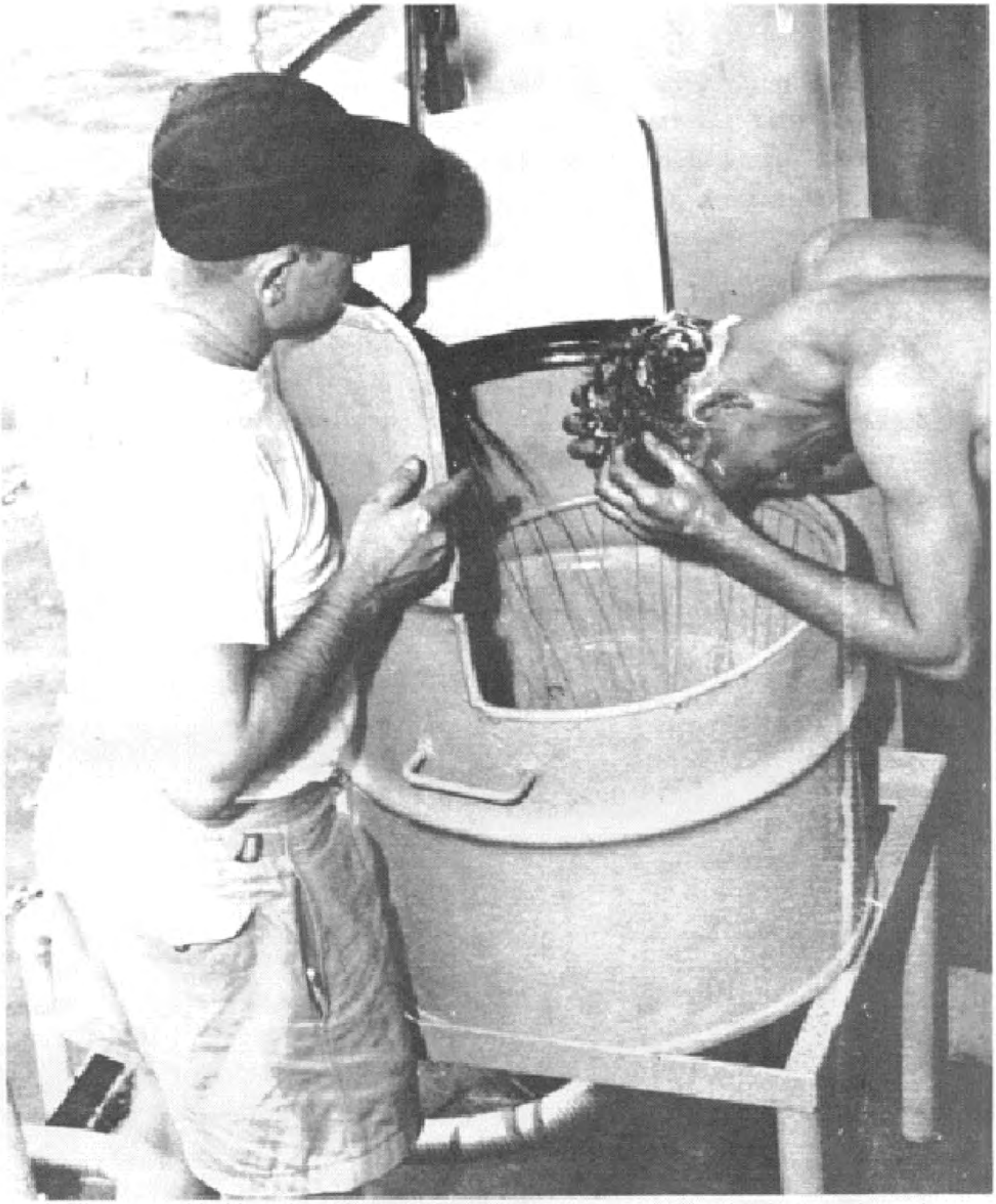


Figure 25. Personnel spot decontamination, REDWING.

had satisfactorily decontaminated local spot areas, he would proceed to the regular decontamination shower. Upon completion of a general shower, the individual would be remonitored by the exit monitor.

By use of hand counters, it was determined that approximately 75 percent of spot contamination on hands was removable with soap and fresh water. Decontamination personnel suggested that the portable unit be routinely used just before showering. The unit was capable of hand decontamination at a rate of about 100 men per hour.

Other than for personnel, general decontamination procedures for TG 7.3 called for spraying the topside of ships with hoses. The spray should hit the surface 15 to 20 feet (4.6 to 6.1 meters) in front of and downwind from personnel handling the hoses. A coverage rate of approximately 4 ft^2/min (0.4 m^2/min) was desired. Contamination on surface craft and aircraft "shall be reduced as much as practicable, and except in unusual cases to a value lower than 7 mr/hr (gamma only)." A surface was considered insufficiently decontaminated if 2 in^2 (13 cm^2) of filter paper rubbed lightly over 12 in^2 (77 cm^2) of contaminated surface read more than 0.0005 R/hr above background when held 2 inches (5 cm) from the open window of an AN/PDR-27 rate meter (Reference B.3.1, p. G-5-4).

The Radiological Safety Plan required that protective clothing be obtained by all units for repair parties and all other personnel who might be involved in decontamination or other duties with a potential exposure to radiological contamination (Reference B.3.1, p. G-3). Figures 26 through 32 show personnel decontaminating equipment.

Ainsworth and USS Catamount served as checkpoints and radsafe centers for afloat operations. The latter served as a checkpoint for boat pool personnel in the contaminated environment at Bikini (Reference C.1.7.2, p. 127). Checkpoints and radsafe centers were also established on Estes, Badoeng Strait, and Curtiss. "These radsafe centers included plotting and briefing areas, clothing and equipment issue points, and personnel decontamintion stations . . . . Control points were established as required" (Reference C.1.7.2, p. 29).

Figure 26. Decontamination a Project 2.62 skiff prior to retrieval, REDWING.

Figure 27. Monitoring the radiation level on a Project 2.62 skiff after retrieval and before removing samples and data, REDWING.

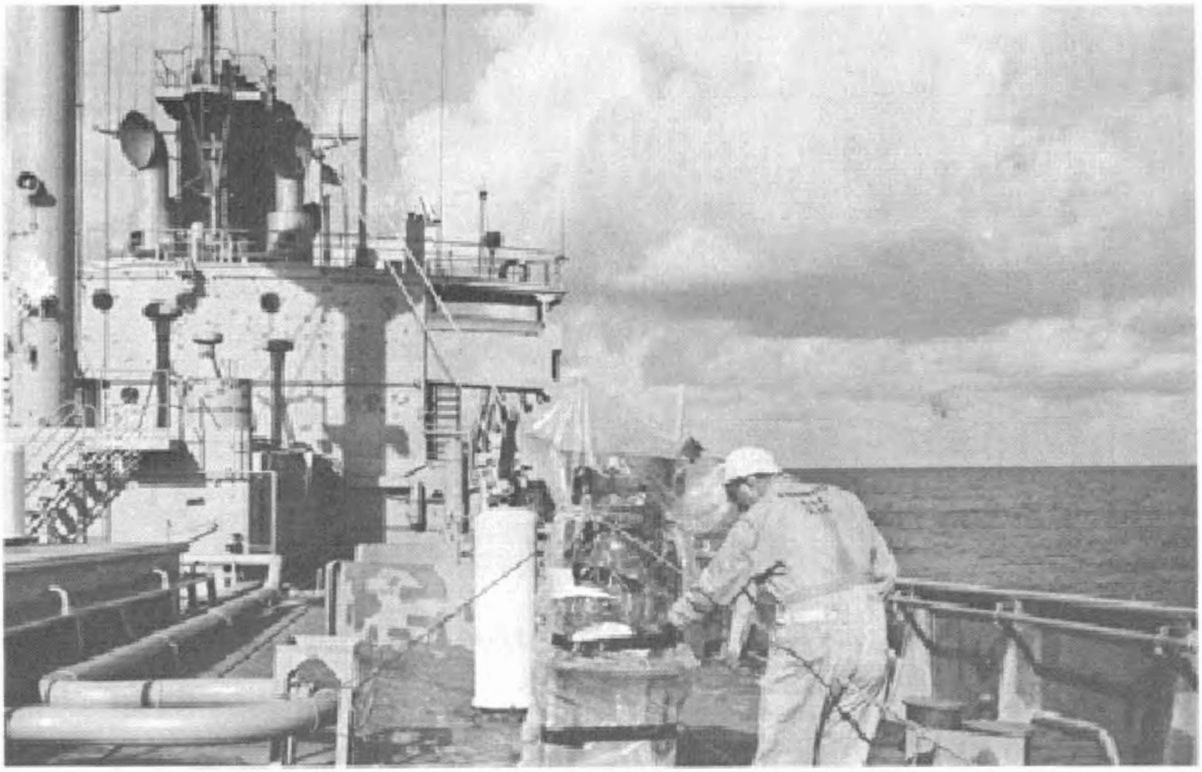


Figure 28. Removing samples from YAG-40 (USS Granville S. Hall); note radsafe clothing.

Figure 29. Scrubbing helicopter to remove contamination, REDWING.

Figure 30. Removing radioactivity from a helicopter, REDWING.

Figure 31. Helicopter in decontamination "bathtub" on USS Badoeng Strait (CVE-116), REDWING.

Figure 32. Decontaminating a B-57 sampler aircraft after flight through a nuclear cloud, REDWING.

TG 7.4 decontamination requirements were primarily oriented toward returned cloud-sampler aircraft and crews. Cloud-sampling aircraft were required to fly through the radioactive clouds formed by the shots, penetrating them at various altitudes and times. These aircraft were equipped with special sample-gathering and radioactivity-measuring devices. The pilot (and crew for multiengine aircraft) wore mission dosimetry badges for every shot.

These aircraft normally became contaminated because fallout particles adhered to surfaces during cloud penetration, requiring decontamination upon return to Enewetak. Figure 32 shows this effort. Aircraft decontamination procedures required both exterior and interior cleaning. Returning aircraft taxied to the end of the runway and were spotted by the decontamination crew. A quick radiological survey of each aircraft was made, and if readings were in excess of 0.020 R/hr, the radiation from the aircraft was allowed to decay to 0.020 R/hr before decontamination.

A detailed survey was made of each aircraft, and results were recorded on forms and sketches. Both beta and gamma intensities were noted. The first washing was made with water and detergent (1 pound to 100 gallons [0.45 kg to 380 liters] of water). The aircraft was then resurveyed. The second washing (if required) consisted of a mixture of one part "gunk" and three parts kerosene followed by another water-detergent rinse. Readings on interior surfaces (occupied areas) had to be reduced to 0.007 R/hr or less. Decontamination personnel were always checked into and out of the wash area. The runoff area was monitored and, if necessary, marked as a contaminated area.

A reply by the Air Force Special Weapons Center (AFSWC) to NRDL concerning the effectiveness of decontamination procedures is quoted in the History of Air Force Atomic Cloud Sampling (Reference A.6):

> Normal decontamination procedures are 95-98% effective on smooth contaminated surfaces of the aircraft. However, the radiation level in the cockpit or next to the engine is only reduced by a factor of about 10% after the initial high-pressure hosing, and about 50% after the first manual scrubbing.
>
> Manpower requirements for the scrubbing process depend on the aircraft type, the degree of decontamination required, and the time available before the aircraft is needed by the operational organization. Normally decontamination requires approximately sixteen manhours on the F-84 and twenty to twenty-two manhours on the B-57. This does not include manhours for support personnel. Area decontamination rates vary from .009 manhours/sq ft. on the F-84 to .006 manhours/sq ft. on the B-57.
>
> I wish to emphasize that although we are sending this information, as requested, this should not be construed to mean that we approve the decontamination of contaminated aircraft as a part of operational activities. The 4950th Test Group (Nuclear) decontaminates their sampler aircraft primarily for the purpose of avoiding cross contamination during sampling operations.

After REDWING concluded, AFSWC continued to question the need for aircraft decontamination and indicated to the AEC that they intended to reduce considerably the manhours for monitoring and decontaminating aircraft. AFSWC indicated that they expected some ground crew personnel might exceed the 0.300 R/week or the 3.9 R total. When apprised of this, the LASL project officer for cloud sampling wrote a note, also reproduced in Reference A.6, to the REDWING Scientific Director as follows:

> I found that [the AFSWC officer replying to NRDL] simply could not understand the philosophy which regards every radiation exposure as injurious but accepts minimum exposures for critical jobs . . . . I find [his] approach to be extremely discouraging. I would like to recommend that he be informed of the following facts of life:
>
> a. That the aircraft are assigned to support our requirements for bomb cloud sampling and would not otherwise be participating in test operations.
>
> b. That there would appear to be no reason why their use in sampling should be required to support some Air Force objective, particularly when it is clear that the two purposes are not compatible.
>
> c. That the AEC Test Manager supports a philosophy of minimal exposure for critical jobs within limits established by competent scientific authority.
>
> d. That all of the precautions have been found to be necessary for the operational management and accurate technical control of the radiation exposures of the people concerned.
>
> e. That our experience indicates that the discard of any of the precautions is a movement back toward our SANDSTONE experience in which people were injured, and that this experience covers eight operations in which the sampling mission was accomplished by the USAF in an outstanding manner with no known injuries.
>
> f. That, specifically, routine decontamination of sampling aircraft is required to permit the instrumentation and sample support technicians to work on and in the aircraft, to prevent the build-up of long-lived activity, and increases in the relative background acquired by the airplane on cloud penetration from an otherwise sticky traffic film.

Another from LASL added the following comments (published in Reference A.6):

> We have always gone on the theory that the only good exposure is zero . . . . I could not disagree more violently [with the AFSWC position]. Perhaps this means that the Air Force is so superior that exposure which might hurt other people do[es] not damage them and the rules necessary for other people [do] not apply to the Air Force personnel. In any event, I feel that this was a most unfortunate statement . . . . I can think of no finer argument to justify the decontamination procedures which have been used in the past. This sentence, in effect, says that we may be able to permit sloppy methods and still squeak by. To this philosophy I take a strong exception. It is my recommendation that the philosophy expressed in this letter should be firmly rejected as it applies to test operations in Nevada and Eniwetok, and most particularly as it applies to sampling planes. What the Air Force wishes to do at their own bases and in their own tactical operation is, of course, no concern of ours.

Transport of Radioactive Material

The arrival and proposed use of radioactive sources at the PPG were reported to the Radsafe Officer, TG 7.1. Transport of radioactive material to and from the forward area was in accordance with AEC regulations, but assignment of couriers and radsafe monitors was subject to separate instructions. No radioactive material could be removed from the test site except as authorized in experimental projects.

All samples of radioactive material transported by aircraft were packaged and loaded to reduce radiation levels to a minimum. Prior to the departure of such aircraft, the Sample Return Director, JTF 7, surveyed the aircraft cargo hold to determine if precautions were adequate. The following criteria were used to determine space and packaging requirements:

- Prior exposure of aircraft crew, courier, and passengers
- Expected future exposures considering length of the trip, compartmental loading requirements, and capability to isolate personnel from radioactive material.

Special Missions

On all flyaway, or sample-return, flights the aircraft was monitored, after loading, by an officer monitor of TU 7 of TG 7.1. The aircrew, couriers, and passengers were briefed by the TG 7.4 Sample Return Coordinator and/or the TG 7.1 monitor about the radioactive samples on board, and the aircraft commander was briefed on the air radex area.

Radsafe monitors on all aircraft were equipped with at least one radiac instrument with sufficient range to accomplish all duties. Each monitor took an orientation course on radiological safety and use of the radiac several days before the flight. Immediately before the flight, the monitor received a situation briefing by the TG 7.4 Nuclear Research Officer or a TG 7.1 radsafe monitor.

On flyaway #1 flights, all passengers and crewmembers were issued film badges, and film badges were provided for issue at crew change stops. Badges intended for issue to new crews were stored in the forward section of the aircraft, outside any measurable radiation field. If any measurable radiation intensity appeared in the cockpit, control badges were included with the crew badges. On flyaway #2 and #3 flights, film badges were issued whenever any individual sample reading was greater than 0.100 R/hr or when the total radiation intensity readings of all the samples was greater than 0.010 R/hr at one meter.

Hq JTF 7 requested 30 officers from TG 7.2 and 20 officers from TG 7.4 to complete a specialized course for sample-return duty. Either task group would designate one officer from the list before each flight, and he would be briefed in detail by the JTF 7 Sample Return Director (Reference C.0.AG903).

CHAPTER 3
DOD EXPERIMENTAL PROGRAM

The REDWING experimental program was focused on the development of weapons, with a secondary interest in their effects. The Department of Defense (DOD) participated in both weapon development and effects experiments but concentrated on the latter. Within Joint Task Force 7 (JTF 7), execution of the experimental program was the function of Task Group 7.1 (TG 7.1). TG 7.1 was divided into task units that corresponded with each of the Atomic Energy Commission (AEC) laboratories or the DOD's experimental program, or that provided a key element of support for the scientific programs such as timing, firing, and radiological safety. Task units were quite unequal in size, varying from nearly 800 men for Task Unit 3 (TU 3), DOD Programs, to a half-dozen for TU 6, Firing.

WEAPON LABORATORIES TASK UNITS

The first two task units were from the weapon laboratories, Los Alamos Scientific Laboratory (LASL) (TU 1) and University of California Radiation Laboratory (UCRL) (TU 2). These task units manned the weapon development experiments conducted by each laboratory in conjunction with the tests of the devices each laboratory provided. Each laboratory had small support groups that actually assembled the weapons (TU 10 for LASL and TU 11 and TU 12 for UCRL) and provided specialized documentary photographic services (TU 8 for LASL and TU 9 for UCRL). Composition of these LASL and UCRL task units was primarily civilian with some military personnel. The civilians were employees of the University of California, which operated the two weapon laboratories for the AEC. Exposure data for the personnel of these task units are not available by unit but are available for the organizations involved, LASL and UCRL. These are presented in Table 51 (Chapter 10).

WEAPON EXPERIMENT SUPPORT TASK UNITS

Two task units performed special activities that were directly connected with the conduct of the tests. The first of these was TU 5, Timing. This unit provided the circuitry that interconnected the nuclear device and the firing center and carried the detonation signal to the device. The firing signal was also used by other activities requiring a detonation-time reference signal or instrument start signals at various preshot times. This unit was staffed by personnel from Edgerton, Germeshausen & Grier (EG&G), an AEC contractor. Exposure data for personnel of this task unit are not available but are available for all EG&G personnel at the Pacific Proving Ground (PPG).

TU 6, Firing, was a small group that activated the firing mechanism through circuits leading from the firing center. For Bikini events, the firing was initiated from a bunker on Eneu. This bunker was occupied by the firing party on all Bikini events except ZUNI, a large, surface burst on Eneman relatively close by. On that test, the firing party was aboard USS Curtiss and a radio signal activated the mechanisms in the bunker on Eneu, which in turn detonated the device. Personnel from the AEC weapon laboratories staffed this task unit.

SANDIA TASK UNIT

Sandia Corporation, a subsidiary of Western Electric Company, operated Sandia Laboratory for the AEC. Sandia's function in nuclear weapon development activities was transformation of the devices designed and developed by the weapons laboratories into weapons usable by DOD. Sandia conducted several experiments appropriate to this activity as TU 4. TU 4 was composed entirely of Sandia Corporation employees. Exposure data for Sandia personnel are presented in Table 51 (Chapter 10).

DOD PROGRAMS TASK UNIT 3

The DOD Effects Program was subdivided into programs focused in areas such as blast, nuclear radiation, thermal, etc. These programs were subdivided into projects, whose composition is provided below.

Program 1 -- Blast Effects

This program was designed to establish basic blast and shock phenomenology of specific shots in various environments by measuring blast-wave parameters in free air and along the surface.

The technique for measuring the static overpressure and the dynamic pressure on the surface involved placement of gauges and recording instruments at appropriate ranges from the burst point. Measurement of blast parameters in free air was attempted in two ways. The first involved dropping blast gauges supported by parachute from an aircraft at the time of the detonation and telemetering their data to a recording station. A second technique involved launching rockets carrying smoke generators just before burst. The smoke trails formed a reference grid against which the burst took place. Visible effects of the shock's passage were photographed, the resulting films analyzed, and pertinent blast information extracted.

Besides measurement of basic blast parameters, other experiments were conducted in the blast effects program. For example, ground shock induced by a nuclear burst was measured by underground gauges on the shot island. Another experiment measured the craters formed by several of the bursts. Techniques used were aerial photomapping and direct plumbing of the crater.

Blast effects personnel were subject to potential radiation exposure during construction, instrument placement, and data recovery. None of these projects, however, required very much preshot construction in possibly contaminated areas; nor did instrumentation placement involve extraordinary exposure potential. Finally, data were either telemetered or in self-recorded formats so that early reentry (with incumbent high exposure potential) was not necessary.

Project 1.1 -- Ground Surface Airblast Pressure versus Distance

Agency: Army Ballistic Research Laboratories (BRL)

Operations: Airblast gauges and pressure transducers were installed to gain information on propagation of blast waves over different surfaces from various yields and heights of burst. Overpressure and dynamic pressure were measured in support of other projects.

Shots: LACROSSE, YUMA, INCA (Enewetak); CHEROKEE, ZUNI (Bikini).

Staffing: Ten persons, all BRL personnel, were associated with this project: three enlisted men and seven civilians. Exposure data for personnel are shown in Table 10.

Project Report: WT-1301 (Reference C.1.3.1301).

Table 10. REDWING personnel exposures identifiable by Department of Defense scientific projects.

Element	No. of Persons Badged	Exposure Ranges (roentgens) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	Over 5	Over 3.9[a]	High (R)
Project 1.1	10		2	4	1	2	1						2.1
Project 1.2	1						1						2.3
Project 1.3	8	2	5	1									0.6
Project 1.4	20	2	17	1									0.9
Project 1.5	20	1	9	4	3	1	2						2.4
Project 1.6	9	1	7	1									0.6
Project 1.8	4				2	1			1				1.1
Project 1.9a	4		1				1	1		1			4.7
Project 1.9b	1	1											0
Project 1.10	1						1						2.3
Program 1 Total	78	7	40	11	7	4	6	1	1	1		1	4.7
Project 2.1	6		1			1		1		2	1	3	5.7
Project 2.2	3									1	2	3	5.7
Project 2.4	2								2				3.2
Project 2.51	4				1			1	1	1		1	4.7
Project 2.52	1		1										0.1
Project 2.61	5		2	1		1			1				3.2
Project 2.62	11		3	1	3	2	1		1				3.3
Project 2.63													
Project Management	6				1	1	1	2	1				3.8
Program 2 Control Center	3		1				1	1					2.9
Enewetak Operations	8			3				1	1	1	2	3	5.9
Bikini Operations	27				6	6	4	5	3	3		3	4.9
Laboratory Operations	14	1	2	2	3	4	2						2.4
Ship Operations	15		1		1	3		4	4	2		2	4.7
Radsafe Operations	14			2	2	3	2	4	1				3.6
Total Project 2.63	87	1	4	7	13	17	10	17	10	6	2	8	5.9
Project 2.64	9	1	4	1	1			1	1				3.0
Project 2.65	30		3	2			1	4	8	9	3	14	6.8
Project 2.66a	12	1		3		2			3	1	2	4	15.8
Project 2.66b	2					1			1				3.7
Project 2.71	2							2					2.9
Project 2.72	5		2	1		1		1					2.5
Project 2.8	5			3	2								1.2
Project 2.9	2								1		1	1	5.4
Project 2.10	3						1	1	1				3.1
Program 2 Total	189	3	20	19	20	25	13	28	30	20	11	34	15.8
Project 3.1	4		3	1									0.5
Project 4.1	14	1	3	5	4	1							1.9
Project 5.1	3		2				1						2.2
Project 5.2	37	1	6	1	4	13	8	3		1		1	4.5
Project 5.3	1							1					2.7
Project 5.4	25	3	4	2	3	6	4			3		3	4.9
Project 5.5	7	1	4			2							1.7
Project 5.6	23		18	2		1				2		2	4.5
Project 5.7	7	1	2	1		1		2					2.7
Project 5.8	1						1						2.3
Project 5.9	7	1	1	1	1		1	2					2.7
Program 5 Total	111	7	37	7	8	23	15	8		6		6	4.9
Project 6.1a-b	Offsite non-PPG experiments												
Project 6.3	5		1	1		1			1	1		1	4.1
Project 6.4	4	1	1			1	1						2.4
Project 6.5	5	3				1		1					3.0
Project 6.6	3		3										0.4
Program 6 Total	17	1	8	1		2	2		2	1		1	4.1
Project 8.1a	17		12	4					1				3.2
Project 8.1b	4		3	1									0.6
Project 8.1c	5		5										0.2
Project 8.2	4		3	1									0.5
Project 8.3	4		2	1				1					2.7
Project 8.4	3	1	2										0.2
Project 8.5	1		1										0.4
Program 8 Total	38	1	25	7				1	1				3.2

Note:

[a]Basic Maximum Permissible Exposure (MPE) was 3.9 R (gamma) per 13-week period; a special MPE of 20 R (gamma) per 13-week period was established for cloud samplers.

Source: Reference C.1.7.3.

Project 1.2 -- Blast Measurements on a Medium-Yield Surface Burst

Agency: Sandia Corporation (SC)

Operations: Static overpressure and dynamic pressure gauges were installed on Runit. Readings on the closest gauge were recorded by wireless telemetry on Parry. Naval Ordnance Laboratory also took blast measurements in conjunction with the project.

Shot: LACROSSE (Enewetak).

Staffing: The only identified person involved was the project officer. He received 2.270 R.

Project Report: WT-1302 (Reference C.1.3.1302).

Project 1.3 -- Blast Measurements by Shock Photography

Agency: Naval Ordnance Laboratory (NOL)

Operations: Rocket launchers were placed on Bokbata to obtain blast measurements vertically above the burst point and at horizontal ranges via photography and smoke rockets. Photography was by EG&G, Project 9.1a.

Shots: LACROSSE, SEMINOLE, INCA, MOHAWK (Enewetak); CHEROKEE, ZUNI (Bikini).

Staffing: Eight persons were associated with this project, all from NOL (five civilians, three servicemen). Exposure data are shown in Table 10.

Project Report: WT-1303.

Project 1.4 -- Free-Air Pressure Measurements at Altitude

Agency: Air Force Cambridge Research Center (AFCRC)

Operations: Drop aircraft deployed a vertical array of 12 parachute-borne, telemetering, blast-pressure canisters to measure free-air peak overpressure and overpressure versus time vertically above an airburst. The results were telemetered to USS Catamount.

Shot: CHEROKEE (Bikini).

Staffing: Twenty persons participated, although a discrepancy exists between the Consolidated List and the project report regarding the affiliation of certain of them. Eight civilians were involved who may have been either Bendix Corporation (Reference C.1.3.1304) or AFCRC (Consolidated List) personnel. Of the other twelve, one was a civilian and eleven were military, including four identified as aircraft crewmen. Exposure data are shown in Table 10.

Project Report: WT-1304 (Reference C.1.3.1304).

Project 1.5 -- Transient Drag Loading of Actual and Idealized Shapes

Agency: Army Ballistic Research Laboratories (BRL)

Operations: Structural components, jeeps, and recording and structure instrumentation were emplaced to investigate aerodynamic-drag characteristics, drag coefficients, response of drag-type targets, and airblast diffraction and drag-loading. Full-scale beams, spherical shapes, military vehicles, and a concrete cubicle were used in the experiment.

Shots: LACROSSE, YUMA (Enewetak); CHEROKEE, ZUNI (Bikini).

Staffing: Twenty participated (ten civilians, ten military), including one serviceman from Sandia Base. Exposure data are shown in Table 10.

Project Report: WT-1305 (Reference C.1.3.1305).

Project 1.6 -- Drag Loading on Model Targets

Agency: Naval Ordnance Laboratory (NOL)

Operations: Model targets (cubes, spheres, cylinders, parallelepipeds) were emplaced and equipped with pressure gauges to measure drag forces as function of time. Dynamic pressure gauges were also installed, with recording at a more distant station via land lines.

Shot: LACROSSE (Enewetak).

Staffing: Nine persons worked on this project, all from NOL, including two servicemen and seven civilians. Exposure data are shown in Table 10.

Project Report: WT-1306 (Reference C.1.3.1306).

Project 1.8 -- Crater Measurements

Agency: Army Engineer Research and Development Laboratories (ERDL)

Operations: Physical characteristics of craters produced by detonations were measured to promote crater-prediction phenomenology. Crater radius, depth, and approximate profile were determined by aerial photography, helicopter soundings, and lead-line measurements from LCMs. Holmes & Narver survey crews performed lead-line soundings, and the Raydist system was used to position LCM. Preshot activities required a survey of ground zero; as ZUNI ground zero was the KOON crater from the 1954 CASTLE series, this preshot activity could have entailed some radiation exposure for participating personnel.

Shots: LACROSSE, SEMINOLE, MOHAWK (Enewetak); ZUNI, TEWA (Bikini).

Staffing: Discrepancies exist between the Consolidated List and the project report regarding the affiliation of project personnel. Nevertheless, four persons can be associated with Project 1.8: three military (one probably from ERDL and two from the Armed Forces Special Weapons Project) and one civilian (probably from Raydist Corporation). Exposure data are shown in Table 10.

Project Report: WT-1307 (Reference C.1.3.1307).

Project 1.9a -- Direct Water-Wave Measurements

Agency: Scripps Institution of Oceanography (SIO)

Operations: Water-wave data from Bikini and Enewetak lagoons were analyzed. Principal observations were made by bottom-pressure-versus-time recorders adapted to different locations and by technical photography. Instrumentation sites were on shore, floating, and submerged. Divers placed and recovered subsurface instrumentation. Inundation surveys were conducted by aerial photography and placement and retrieval of empty cans at selected points. The camera station on Eneu was manned by EG&G employees.

Shots: YUMA, ERIE, SEMINOLE, OSAGE, INCA, MOHAWK, APACHE, HURON (Enewetak); all Bikini shots.

Staffing: Four badged personnel can be associated with this project, all SIO civilians. Exposure data are shown in Table 10.

Project Report: WT-1369 (Reference C.1.3.1369).

Project 1.9b -- Indirect Water Waves from Large-Yield Bursts

Agency: Scripps Institution of Oceanography (SIO)

Operations: Long-period, water-wave recording systems were installed at Ailinginae, Wake, Johnston, and Enewetak to measure waves from Bikini shots in order to determine the capability to predict the nature and characteristics of long-period waves produced by tests at ranges well beyond the zone of significant blast damage. There is no indication that project personnel were closer than the Enewetak installation to the Bikini test site.

Shots: All Bikini shots.

Staffing: One SIO civilian can be definitely associated with this project. His badge had zero exposure.

Project Report: WT-1308 (Reference C.1.3.1308).

Project 1.10 -- Blast over Vegetated and Cleared Areas

Agency: Sandia Corporation (SC)

Operations: Gauges to measure blast overpressure and dynamic pressure were installed on Lujor to determine differences in blast effects over vegetated and sandy surfaces.

Shots: INCA (Enewetak).

Staffing: The only identified person involved is the project officer, whose exposure was 2.270 R.

Project Report: WT-1309 (Reference C.1.3.1309).

Program 2 -- Nuclear Radiation

The program was planned to obtain complete fallout data to assist in constructing a fallout model that would permit extrapolation to different devices, burst heights, and surface conditions. In addition, several projects involved decontamination and nuclear-radiation countermeasures. Finally, projects to study initial gamma and neutron radiations were scheduled to secure data in areas where existing knowledge was considered unreliable or incomplete.

This program was oriented primarily to Bikini operations, and a more detailed discussion of this program is contained in Chapter 4. Projects conducted for this program are summarized below.

Project 2.1 -- Gamma Exposure versus Distance

<u>Agencies</u>: Army Signal Engineering Laboratories (SEL)
Army Evans Signal Laboratory (ESL)
Air Force Special Weapons Center (AFSWC)

<u>Operations</u>: Dosimeters were installed at various stations throughout Bikini Atoll and exposed to initial and residual gamma radiation to determine gamma exposures versus distance from the point of detonation. The dosimeters were collected after each shot (usually within a week) and new dosimeters set up before the next shot.

<u>Shots</u>: All Bikini shots.

<u>Staffing</u>: Four persons from either SEL or ESL were associated with this project (three civilians and one military). In addition, two military from AFSWC were involved. Exposure data are shown in Table 10.

<u>Project Report</u>: WT-1310 (Reference C.1.3.1310).

Project 2.2 -- Gamma Exposure Rate versus Time

<u>Agencies</u>: Army Signal Engineering Laboratories (SEL)
Army Evans Signal Laboratory (ESL)

<u>Operations</u>: Initial and residual gamma exposure rates as a function of time were obtained at various distances from the detonations. Initial and residual gamma instrumentation was installed at sites on Bikini Atoll at the latest practical time before each shot and recovered postshot as soon as radsafe conditions permitted. A Marine helicopter was used in an attempt to determine crater-lip exposure by dropping a detector and then orbiting at safe distance to receive measurements.

<u>Shots</u>: All Bikini shots except DAKOTA.

<u>Staffing</u>: Three persons from SEL were definitely associated with this project. Exposure data are shown in Table 10.

<u>Project Report</u>: WT-1311 (Reference C.1.3.1311).

Project 2.4 -- Decontamination and Protection

Agency: Army Chemical Research Labs/Chemical Warfare Labs (CRL)

Operations: To investigate decontamination techniques for construction materials, panels of various construction materials were mounted on YAG-39 (USS George Eastman) and YAG-40 (USS Granville S. Hall), which operated through regions of fallout. The panels were removed at Parry for decontamination tests.

Shots: CHEROKEE, ZUNI, FLATHEAD, NAVAJO, TEWA (Bikini).

Staffing: Two civilians can be identified with this project, both from CRL. Exposure data are shown in Table 10.

Project Report: WT-1312 (Reference C.1.3.1312).

Project 2.51 -- Neutron-Flux Measurements

Agencies: Army Chemical Research Labs/Chemical Warfare Labs (CRL)
Air Force School of Aviation Medicine (AFSAM)

Operations: Neutron detectors were placed in predetermined locations at distances of about 200 to 1,000 yards (183 to 915 meters) from the device to measure the neutron flux and spectrum.

Shots: YUMA, ERIE, BLACKFOOT, KICKAPOO, OSAGE (Enewetak); CHEROKEE (Bikini).

Staffing: Four persons were affiliated with this project: three from CRL (two civilians, one military) and one military from AFSAM. Exposure data are shown in Table 10.

Project Report: WT-1313 (Reference C.1.3.1313).

Project 2.52 -- Neutron-Induced Soil Radioactivity

Agency: Sandia Corporation (SC)

Operations: Soil samples were exposed to neutron radiation to help establish the importance of neutron-induced residual gamma radiation. The soil samples were encased in containers and attached by cable to a concrete deadman. Recovery was accomplished by helicopter shortly after detonation.

Shots: YUMA (Enewetak); CHEROKEE (Bikini).

Staffing: The project officer is the only identified person. He received 0.090 R.

Project Report: WT-1314 (Reference C.1.3.1314).

Project 2.61 -- Rocket Determination of Activity Distribution Within the Stabilized Cloud

Agencies: Naval Radiological Defense Laboratory (NRDL)
Horning-Cooper (also noted as Cooper Development Corp.)

Operations: Forty rockets were fired from Eneu through the radioactive clouds and the results telemetered to Eneu and USS Knudson.

Shots: CHEROKEE, ZUNI, NAVAJO, TEWA (Bikini).

Staffing: Five persons were asociated with this project: four from NRDL (three civilians, one uniformed) and one from Horning-Cooper. Exposure data are shown in Table 10.

Project Report: WT-1315 (Reference C.1.3.1315).

Project 2.62 -- Fallout Studies by Oceanographic Methods

Agency: Scripps Institution of Oceanography (SIO)

Operations: USS McGinty, USS Silverstein, and MV Horizon surveyed fallout area, making various radiometric and oceanographic measurements in contaminated water and collecting water samples. Ship movements were coordinated by the Control Center on USS Estes. Horizon met YAG-39 to conduct certain measurements. LCU-1136 performed a radiological survey of lagoon, and USS Sioux picked up deep-moored skiffs. Pretest surveys of the nearby ocean waters were also made.

Shots: All Bikini shots.

Staffing: Eleven civilians from SIO can definitely be associated with the project. Exposure data are shown in Table 10.

Project Reports: WT-1316 (Reference C.1.3.1316); WT-1349 (C.1.3.1349).

Project 2.63 -- Characterization of Fallout

Participating Agencies	Identified Personnel		
	Civilian	Military	Total
Naval Radiological Defense Laboratory	51	18	69
Bureau of Ships	2	2	4
Bureau of Medicine and Surgery	-	1	1
New York Naval Shipyard	1	-	1
Armed Forces Special Weapons Project	3	1	4
Hanford Atomic Power Operations (GE)	6	-	6
Oak Ridge National Laboratory	2	-	2
Total	65	22	87

Operations: Fallout samples were collected from all the Bikini tests except DAKOTA. Radiological surveys were made of the ocean waters in the fallout zones for these shots. Collection stations were land based on Bikini, Nam, Jelete, and Aomen islands at Bikini Atoll; on unmanned rafts, skiffs, and barges YFNB-13 and YFNB-39 moored in Bikini Lagoon and in the open sea northwest to northeast of Bikini; and from the manned and radiologically shielded ships YAG-39, YAG-40, and USS Crook County. Activities included:

Control Center -- aboard USS Estes doing fallout prediction, data interpretation, and manned ship control.

Bikini Operations -- placement, arming, and data recovery from collectors on land and moored stations. Subdivided into Barge Team, Raft Team, and Skiff Team.

Ship Operations -- operations of ship-borne instrumentation, water sampling, and sample preparation. Subdivided into YAG-30 Team, YAG-40 Team, and Crook County Team.

Laboratory Operations -- laboratory analysis was done on YAG-40 while underway and at Parry Island at Enewetak.

Enewetak Operations -- preparation and forwarding of samples to NRDL for further analysis and also routine administrative functions.

Radsafe Operation -- individual monitors accompanied the teams in their work. All persons cited as being from the New York Naval Shipyard, Oak Ridge National Laboratory, and Hanford Atomic Power Operation were part of this operation.

Project 2.64 -- Fallout Location and Delineation by Aerial Surveys

<u>Agency</u>: Atomic Energy Commission, New York Operations Office (AEC-NYKOPO)

<u>Operations</u>: Radiation detectors were mounted in P2V-5 aircraft that surveyed ocean areas of expected fallout. Four planes, stationed at Enewetak Island, were available but only one or two were used on a single day. Helicopters and P2V-5 aircraft were used for air-absorption measurements.

<u>Shots</u>: SEMINOLE, MOHAWK (Enewetak); CHEROKEE, ZUNI, FLATHEAD, NAVAJO, TEWA (Bikini).

<u>Staffing</u>: Nine AEC (civilian) personnel were associated with this project. Exposure data are shown in Table 10.

<u>Project Report</u>: WT-1318 (Reference C.1.3.1318).

Project 2.65 -- Land Fallout Studies

<u>Agencies</u>: Army Chemical Research Labs/Chemical Warfare Labs (CRL)
Army 9710th Test Unit, ACC Detachment, Edgewood Arsenal

<u>Operations</u>: Fallout samples were collected on Bikini and Enewetak atolls, a barge, and three ships to make radiochemical and radiophysical measurements and exposure-rate contours, and assess the role of base surge in radioactive transport. A probe was lowered from a helicopter to within 3 feet (1 meter) of the ground to record radiation readings.

<u>Shots</u>: LACROSSE (Enewetak); CHEROKEE, ZUNI, FLATHEAD, NAVAJO, TEWA (Bikini).

<u>Staffing</u>: Thirty persons were associated with Project 2.65: twenty-five affiliated with CRL (thirteen military and twelve civilians), and five affiliated with the 9710th. The group's overall exposure data are shown in Table 10.

<u>Project Report</u>: WT-1319 (Reference C.1.3.1319).

Project 2.66a -- Early Cloud Penetrations

<u>Agencies</u>: Air Force Special Weapons Center (AFSWC)
Kaiser Electric

Operations: To measure radiation exposure and exposure rate received when flying through a radioactive cloud, 27 penetrations of six nuclear clouds at times from 20 to 78 minutes after detonation and at altitudes from 20,000 to 50,000 feet (6.2 to 15.3 km). Maximum radiation rates as high as 800 R/hr were observed and several flights yielded total individual exposures of 15 R to the crew. Kaiser Electric advised on the electronic instrumentation. The TG 7.4 Early Penetration Element contributed aircrews and aircraft. Aircrews were later monitored for possible internal dose.

Shots: APACHE (Enewetak); CHEROKEE, ZUNI, FLATHEAD, DAKOTA, NAVAJO (Bikini).

Staffing: Eleven from AFSWC were identified with the project (all military), in addition to one civilian from Kaiser Electric. Exposure data for the 12 men identified with the project are shown in Table 10. (Exposure data for the Early Penetration Element is covered in Chapter 8.)

Project Report: WT-1320 (Reference C.1.3.1320).

Project 2.66b -- Contact Radiation Hazard Associated with Aircraft Contaminated by Early Cloud Penetrations

Agency: Air Force Special Weapons Center (AFSWC)

Operations: F-84 and/or B-57 aircraft (Project 2.66a see above) penetrated the cloud at times from 24 to 40 minutes, returning to Enewetak within 1 hour. Measurements were taken over the next 21 hours to establish the radiation levels on various sections of planes and assess the protection to the aircrew afforded by wearing different types of gloves. Crews from TG 7.4 Early Penetration Element assisted.

Shots: ERIE, INCA, APACHE (Enewetak); ZUNI, FLATHEAD, DAKOTA (Bikini).

Staffing: Exposure data for the TG 7.4 Early Penetration Element is covered in Chapter 8. Two men from AFSWC were identified with the project and exposure data for these personnel are shown in Table 10. These men were also participants in Project 2.66a.

Project Report: WT-1368 (Reference C.1.3.1368).

Project 2.71 -- Ship-Shielding Studies

Agency: Naval Radiological Defense Laboratory (NRDL)

Operations: To determine the relative gamma radiation fields on ships and environments and the interaction of gamma radiation with steel, detectors were installed at various locations on YAG-39 and YAG-40, which maneuvered in vicinity of fallout. The data were returned to Parry for evaluation.

Shots: CHEROKEE, ZUNI, FLATHEAD, NAVAJO, TEWA (Bikini).

Staffing: Two civilians from NRDL can be identified with the project. Exposure data are shown in Table 10.

Project Report: WT-1321.

Project 2.72 -- Evaluation of Two Standard Navy Dosimeters in Residual Radiation Fields Aboard Ships

Agencies: Navy Bureau of Ships (BuShips)
Navy Bureau Medicine and Surgery (BuMed)
Naval Research Laboratory (NRL)
Naval Radiological Defense Laboratory (NRDL)

Operations: Many dosimeters were mounted on Masonite phantoms (a representation of a human form) and exposed to fallout on YAG-39 and YAG-40, which maneuvered through fallout fields. The YAGs departed Bikini on the day preceding each shot and returned to Enewetak postshot, where slides and dosimeters were removed. A week elapsed between loading and reading dosimeters.

Shots: FLATHEAD, TEWA (Bikini).

Staffing: Five persons can be identified with this project: four civilians (two from NRL, one from NRDL, one from Buships) and one military from BuMed. Exposure data for identified personnel are shown in Table 10.

Project Report: WT-1350 (Reference C.1.3.1350).

Project 2.8 -- Shipboard Radiological-Countermeasure Methods

Agency: Naval Radiological Defense Laboratory (NRDL)

Operations: Various test surfaces and specimens were exposed to fallout on YAG-39, YAG-40, *Crook County*, and YFNB-29. Contaminability-decontaminability studies were performed when ships returned to Enewetak Lagoon.

Shots: ZUNI, FLATHEAD, NAVAJO, TEWA (Bikini).

Staffing: Five civilians from NRDL were associated with this project. (The decontamination work itself was performed by a crew from *USS Estes* brought over from Bikini.) Exposure data for the NRDL personnel identified are shown in Table 10.

Project Report: WT-1322 (Reference C.1.3.1322).

Project 2.9 -- Standard Recovery Procedure for Tactical Decontamination of Ships

Agencies: Navy Bureau of Ships (BuShips)
Naval Radiological Defense Laboratory (NRDL)

Operations: YAG-39, YAG-40, and *Crook County* were contaminated by fallout and then subjected to decontamination procedures such as firehosing, hand-scrubbing, and hot-liquid-jet cleaning. Some sections of the ships were washed down previously, others not.

Shots: ZUNI, FLATHEAD, NAVAJO, TEWA (Bikini).

Staffing: Two civilians, one from BuShips and one from NRDL, can be identified with this project. (Actual decontamination was performed by a crew from *Estes* brought to Enewetak.) Exposure data for identified personnel are shown in Table 10.

Project Report: WT-1323 (Reference C.1.3.1323).

Project 2.10 -- Verification of Shipboard Washdown Countermeasures

Agencies: Navy Bureau of Ships (BuShips)
Naval Radiological Defense Laboratory (NRDL)

Operations: YAG-39 and YAG-40 were equipped with washdown systems that sprayed the aft portion of the ship, but not the forward. The YAGs maneuvered throughout fallout operating their washdown systems, delivered samples to Bikini, and returned to Enewetak for decontamination.

Shots: CHEROKEE, ZUNI, FLATHEAD, NAVAJO, TEWA (Bikini).

Staffing: Three were assigned to this project: one civilian from BuShips, one civilian from NRDL, and one military from NRDL. (Actual decontamination was performed by a crew from Estes brought to Enewetak.) Exposure data for the identified personnel are shown in Table 10.

Project Report: WT-1324 (Reference C.3.1.1324).

Program 3 -- Effects on Structures

This program was chiefly concerned with checking the effect of blast from multimegaton devices on structures and consisted of one basic experiment: exposure of several steel-framed, industrial-type buildings to airblast loading from CHEROKEE.

Project 3.1 -- Effect of Length of Positive Phase of Blast on Drag-Type and Semidrag-Type Industrial Buildings

Agencies: Blast Effects Group, Air Force Wright Air Development Center (WADC)

University of Illinois

Army Ballistic Research Laboratories (BRL)

Operations: Six steel-frame, industrial-type buildings constructed on Iroij and three manmade islands were instrumented and exposed to the CHEROKEE blast. To set the structures at the proper ranges from burst point, three manmade islands were constructed along the reef between Nam and Iroij at Bikini from material dredged from the lagoon bottom and retained by bulkheads. The buildings constructed on these were instrumented for reaction to the blast (see Figure 8). Films also recorded the response of the buildings. Both self-recording gauges and electronic recording was used. Instrumentation installation and recording was done by BRL.

Shot: CHEROKEE (Bikini)

Staffing: Four persons were associated with this project: two civilians, one from BRL and one from University of Illinois, and two military, from (WADC). Exposure data for the identified personnel are shown in Table 10.

Project Report: WT-1325 (Reference C.1.3.1325).

Program 4 -- Biological Effects

This program consisted of one project, which exposed animals in order to study the induction of chorioretinal burns as the result of viewing the fireball. Rabbits and monkeys were exposed in holding devices so their eyes looked at the burst point. Data recovery was by medical examination of test animals.

Project 4.1 -- Chorioretinal Burns

Agencies: Air Force School of Aviation Medicine (AFSAM)
Air Force Wright Air Development Center (WADC)

Operations: The eyes of rabbits and monkey were exposed to thermal radiation from six shots. The animals were placed at various exposure sites and then recovered and returned to Japtan. Placement of the test animals and their postshot recovery required careful timing and prompt reentry to protect the general health of the test subjects. Exposure stations on Eneu and Bikini islands for the Bikini shots and Japtan and Runit for the Enewetak shots were not particularly close-in, however.

Shots: LACROSSE, ERIE, MOHAWK (Enewetak); CHEROKEE, ZUNI, NAVAJO (Bikini).

Staffing: Fourteen were associated with this project: twelve from AFSAM (ten military and two civilians) and two military from WADC. Exposure data are shown in Table 10.

Project Report: WT-1326 (Reference C.1.3.1326).

Program 5 -- Effects on Aircraft Structures

Program 5 was implemented primarily to ensure that current weapon-delivery criteria were reliable and that the maximum delivery capability of the aircraft was correctly defined. A secondary objective was the collection of basic data for use in the theoretical analyses of the delivery capability of other aircraft types.

Most experiments in this program required direct inflight exposure of Air Force and Navy aircraft. The aircraft were specially instrumented to record response to the thermal pulse and airblast wave. A ground-based project exposed missile materials on towers very close to the burst points of several shots, with sample recovery requirements.

Project 5.1 -- Thermal and Blast Load Effects on a B-47E Aircraft in Flight

Agencies: Air Force Wright Air Development Center (WADC)
Cook Research Laboratories
Hastings Instrument Company

Operations: B-47E aircraft instrumented to measure thermal, overpressure, gust, and aircraft response were exposed inflight for nine shots: side-on for MOHAWK and HURON, and heading away from ground zero for all others.

Shots: MOHAWK, APACHE, HURON (Enewetak); all Bikini shots.

Staffing: Three persons were definitely associated with this project: two from WADC (one military, one civilian), and one from Cook Research Laboratories. Their exposures are shown in Table 10.

Project Report: WT-1327 (Reference C.1.3.1327).

Project 5.2 -- In-Flight Participation of a B-52

Agencies: Air Force Wright Air Development Center (WADC)
Boeing Aircraft Company

Operations: A B-52 was extensively instrumented to obtain measured-energy input and aircraft response data. The major instrumentation for aircraft response positioning was done by a Bombing Navigation System (BNS). Participation was scheduled for nine shots, but on one shot the aircraft aborted just before detonation because of BNS difficulties.

Shots: MOHAWK, APACHE, HURON (Enewetak); CHEROKEE, ZUNI, DAKOTA, NAVAJO, TEWA (Bikini).

Staffing: At least 37 persons were associated with this project: 29 civilians (including 3 from Boeing and 26 from WADC) and 8 military personnel from WADC. Exposure data are shown in Table 10.

Project Report: WT-1328 (Reference C.1.3.1328).

Project 5.3 -- In-Flight Participation of B-66 Aircraft

Agencies: Air Force Wright Air Development Center (WADC)
Douglas Aircraft Company

Operations: A B-66B was exposed inflight to shock wave and thermal pulse, primarily to define delivery capabilities of aircraft.

Shots: LACROSSE, ERIE, INCA, MOHAWK, APACHE, HURON (Enewetak); all Bikini shots.

Staffing: One civilian from WADC is definitely associated with this project; he received 2.735 R. Exposure data are shown in Table 10.

Project Report: WT-1329 (Reference C.1.3.1329).

Project 5.4 -- In-Flight Participation of a B-57B

Agencies: Air Force Wright Air Development Center (WADC)
Martin Company

Operations: A B-57B was instrumented to measure overpressure, gust, and thermal inputs, plus response of components during flight.

Shots: LACROSSE, ERIE, INCA, APACHE, HURON (Enewetak); ZUNI, FLATHEAD, DAKOTA (Bikini).

Staffing: Twenty-five were associated with this project: five military and twenty civilians (nineteen from WADC and one from Martin). Exposure data are shown in Table 10.

Project Report: WT-1330 (Reference C.1.3.1330).

Project 5.5 -- In-Flight Participation of F-84F Aircraft

Agencies: Air Force Wright Air Development Center (WADC)
Cook Research Laboratories

Operations: Two F-84F aircraft were exposed inflight to nuclear blast and thermal loads. One aircraft was designated for "capabilities" and the other for "research." Both were instrumented with numerous sensors and were positioned by the Raydist system for Bikini operations and radar at Enewetak.

Shots: LACROSSE, ERIE, MOHAWK, APACHE, HURON (Enewetak); CHEROKEE, ZUNI, FLATHEAD, DAKOTA, NAVAJO (Bikini).

Staffing: Seven were associated with this project: six military from WADC and one civilian from Cook Research Laboratories. Exposure data for these are in Table 10.

Project Report: WT-1331 (Reference C.1.3.1331).

Project 5.6 -- In-Flight Participation of F-101A Aircraft

Agencies: Air Force Wright Air Development Center (WADC)
McDonnell Aircraft Company

Operations: An F-101A aircraft was instrumented to measure inflight gust, blast, and thermal inputs and responses to these on components of airframe and engine. The aircraft was positioned at predetermined points in the vicinity of detonations.

Shots: LACROSSE, ERIE, MOWHAK, APACHE, HURON (Enewetak); FLATHEAD, DAKOTA, NAVAJO (Bikini).

Staffing: Twenty-three persons were associated with this project: six military from WADC and seventeen civilians (three from McDonnell and fourteen from WADC). Exposure data are given in Table 10.

Project Report: WT-1332 (Reference C.1.3.1332).

Project 5.7 -- Albedo and Thermal-Flux Measurements from Aircraft

Agencies: Air Force Cambridge Research Center (AFCRC)
Technical Operations, Inc. (TechOps)
Allied Research Associates (ARA)

Operations: Calorimeters, radiometers, spectrographs, and cameras were placed in each of four aircraft provided by WADC Aircraft Effects Program (Projects 5.1 through 5.4). WADC also checked instrumentation. NRDL furnished thermal sensors.

Shots: LACROSSE, ERIE, INCA, MOHAWK, APACHE, HURON (Enewetak); CHEROKEE, ZUNI, FLATHEAD, DAKOTA, NAVAJO, TEWA (Bikini).

Staffing: Seven persons were definitely associated with Project 5.7, two military and four civilians from AFCRC. Another civilian was from either AFCRC or ARA. Exposure data for personnel are shown in Table 10.

Project Report: WT-1333 (Reference C.1.3.1333).

Project 5.8 -- Evaluation of the A3D-1 Aircraft for Special Weapons Delivery Capability

Agencies: Navy Bureau of Aeronautics (BuAer)
Naval Air Special Weapons Facility (NASWF)
Douglas Aircraft Company

Operations: An A3D-1 aircraft was instrumented to record thermal radiation and blast and gamma data and exposed to seven shots. The aircraft was heading away from all shots at time of burst.

Shots: APACHE, HURON (Enewetak); CHEROKEE, ZUNI, FLATHEAD, NAVAJO, TEWA (Bikini).

Staffing: One person (military) from NASWF was associated with this project. He received 2.315 R (see Table 10). Other project personnel cannot be identified.

Project Report: WT-1334 (Reference C.1.3.1334).

Project 5.9 -- Weapon Effects on Missile Structures and Materials

Agencies: Air Force Wright Air Development Center (WADC)
University of Dayton
University of California Radiation Laboratory (UCRL)
Allied Research Associates (ARA)
General Electric Company

Operations: A total of 103 specimens (covering 30 different designs) was exposed to fireballs of two shots. Samples were located at varying distances from ground zero, some on lightweight towers. Eighty-eight specimens were recovered at varying times, up to 1 November 1956.

Shots: ERIE, MOHAWK (Enewetak).

Staffing: Seven persons were definitely associated with this project: one from WADC, three from University of Dayton, two from UCRL, and one from ARA. All were civilians except the person from WADC. Exposure data are shown in Table 10.

Project Report: WT-1335 (Reference C.1.3.1335).

Program 6 -- Studies of Electromagnetic Effects

Program 6 emphasized long-range detection of nuclear explosions, utilizing the electromagnetic signal generated by the explosion. An additional aim was the study of effects of nuclear explosions on the ionosphere and the attenuation of radio waves in highly ionized regions. Experimental close-in telemetry links were tested to determine if the propagation path was affected by the burst.

Program 6 activities did not present an opportunity for radiation exposure of project personnel. The only project having close-in instrumentation telemetered data back to the base islands, and early reentry was not required.

Project 6.1a -- Short-Baseline Narol Measurements

Agency: Air Force Cambridge Research Center (AFCRC)

Operations: Stations located in Hawaiian Islands and California used time-to-arrival bomb detector nets to study the feasibility of using the electromagnetic pulse from a nuclear detonation to determine ground-zero position and yield.

Shots: All.

Staffing: Since stations were not at Pacific Proving Ground, no radiation exposure potential existed for the personnel involved in this project.

Project Report: WT-1336 (Reference C.1.3.1336).

Project 6.1b -- Field-Strength Measurement for Accurate Location of Electromagnetic Pulse Sources

Agencies: Air Force Cambridge Research Center (AFCRC)
Sperry Gyroscope Company

Operations: To determine the accuracy with which sources of electromagnetic radiation resulting from atomic explosions could be located at remote ranges, stations were established in the Central Pacific and continental United States. Sperry Gyroscope Company operated two networks.

Shots: All.

Staffing: The closest station was 1,450 nmi (2,685 km) from the test site, so no exposure potential existed for the personnel of this project. One civilian from AFCRC is listed in the Consolidated List; he has a recorded exposure of zero, but apparently he did not return all of his film badges.

Project Report: WT-1350 (Reference C.1.3.1350).

Project 6.3 -- Ionospheric Effects of Nuclear Detonations

Agencies: Army Signal Engineering Laboratories (SEL)
Army Evans Signal Laboratories (ESL)
Air Force Cambridge Research Center (AFCRC)

Operations: Ionospheric disturbances were recorded by instrumentation located at Rongerik and Kusaie, and on aircraft within 400 km of ground zero.

Shots: MOHAWK, APACHE, HURON (Enewetak); all (Bikini).

Staffing: Since stations were not at the Pacific Proving Ground, personnel involved were not exposed for this project. However, five men were badged and are shown on Table 10. The exposures shown on Table 10 would have not resulted from project activities.

Project Report: WT-1337 (Reference C.1.3.1337).

Project 6.4 -- Airborne Antennas and Phototubes for Determination of Nuclear-Weapon Yield

Agencies: Air Force Wright Air Development Center (WADC)
Advance Industries, Inc.
Convair-General Dynamics Company

Operations: Measurements were taken on 14 shots (10 from aircraft and 4 from ground) of electromagnetic radiation and thermal radiation. For in-flight measurements the aircraft was exposed with its right side broadside to burst and generally at 18,000 feet (5.5 km) altitude.

Shots: LACROSSE, YUMA, BLACKFOOT, KICKAPOO, OSAGE, INCA, MOHAWK, APACHE, HURON (Enewetak); CHEROKEE, ZUNI, DAKOTA, NAVAJO, TEWA (Bikini).

Staffing: Four persons, all civilians with Advance Industries, are associated with this project and are shown on Table 10.

Project Report: WT-1352 (Reference C.1.3.1352).

Project 6.5 -- Measurement of Radiofrequency Electromagnetic Radiation from Nuclear Detonations

Agencies: Army Signal Engineering Laboratories (SEL)
9677th Test Unit, Ft. Monmouth

Operations: Detection and recording instrumentation was installed at Enewetak (Parry) and Kwajalein to obtain oscillographic waveforms of electromagnetic pulses generated by the detonations.

Shots: All except LACROSSE.

Staffing: Five persons are definitely associated with the project: three civilians from SEL, one military from SEL, and one military from 9677th Test Unit. Exposure data for identified personnel are shown in Table 10.

Project Report: WT-1353 (Reference C.1.3.1353).

Project 6.6 -- Attenuation of Telemetry Frequencies by Nuclear Detonations

Agency: Naval Research Laboratory (NRL)

Operations: Electromagnetic propagation anomalies were measured at an early time after detonation with telemetry links, receivers, and transmitters. Three shots were involved, but data were acquired from only two.

Shots: BLACKFOOT, OSAGE, INCA (Enewetak).

Staffing: Three NRL civilians identified with the project are shown on Table 10.

Program 8 -- Thermal Radiation and Effects

Program 8 primarily documented the thermal output of the CHEROKEE airburst. A secondary objective was to collect data on thermal phenomenology and thermal effects on materials.

Basic thermal radiation measurements were made from ground and aircraft stations. These experiments placed some instrumentation in the aircraft of Program 5. Thermal effects on materials were also measured from ground stations.

Instrument placement and data recovery for the thermal projects did not expose personnel to radiation.

Project 8.1a -- Basic Thermal Radiation Measurements from Ground Stations

Agency: Naval Radiological Defense Laboratory (NRDL)

Operations: Stations were set up on Runit and Billae for LACROSSE; Iroij, Aomen, and Bikini for CHEROKEE; and Aerokoj, Jelete, and Eneu for ZUNI.

Shots: LACROSSE (Enewetak); CHEROKEE, ZUNI (Bikini).

Staffing: Seventeen from NRDL were affiliated with this project, all but one were civilians. Exposure data for personnel are shown in Table 10.

Project Report: WT-1338 (Reference C.1.3.1338).

Project 8.1b -- Measurement of Irradiance at High Time Resolution

Agency: Naval Radiological Defense Laboratory (NRDL)

Operations: Trailer instrument stations were set up on Aomen and Bikini for CHEROKEE and Eneu for ZUNI to study the distribution of thermal radiant power as a function of time.

Shots: CHEROKEE and ZUNI (Bikini).

Staffing: Four persons from NRDL were associated with this project, three civilians and one military. Exposure data for personnel are shown in Table 10.

Project Report: WT-1347 (Reference C.1.3.1347).

Project 8.1c -- Spectral Distribution of Irradiance with High Time Resolution

Agencies: Naval Radiological Defense Laboratory (NRDL)
Naval Air Special Weapons Facility (NASWF)

Operations: Two remotely operated spectrometers were placed on Aomen and Bikini for CHEROKEE and on Eneu for ZUNI at same station as Project 8.1b.

Shots: CHEROKEE, ZUNI (Bikini).

Staffing: Five were associated with this project: four from NRDL (three civilians, one military) and one from NASWF (military). Exposure data are shown in Table 10.

Project Report: WT-1348 (Reference C.1.3.1348).

Project 8.2 -- Thermal Effects on Cellulosic Materials

Agencies California Forest and Range Experiment Station (CFRES)
U.S. Forest Service -- Forest Products (USFS)
Naval Radiological Defense Laboratory (NRDL)

Operations: Specimens of cellulosic materials were set up at sites on Aomen and Iroij for exposure to thermal radiation from CHEROKEE and were retrieved after the shot.

Shots: CHEROKEE (Bikini).

Staffing: Four civilians were associated with this project: two from NRDL, one from USFS, and one from CFRES. The exposure data for these are shown in Table 10.

Project Report: WT-1347 (Reference C.1.3.1347).

Project 8.3 -- Evaluation of Self-Recording Thermal Radiation Instruments

Agencies: Army Chemical Research Labs/Chemical Warfare Labs (CRL)
Los Alamos Scientific Laboratory (LASL)

Operations: Thermal radiation detection instruments were installed at Iroij, Aomen, and Bikini for CHEROKEE.

Shots: CHEROKEE (Bikini).

Staffing: Four persons were associated with this project: three from CRL (one civilian, two military) and one from LASL (civilian). Exposure data are shown in Table 10.

Project Report: WT-1340 (Reference C.1.3.1340).

Project 8.4 -- Thermal Effects on Strength of Aircraft Structural Sandwich-Type Panels

Agencies: Navy Bureau of Aeronautics (BuAer)
Cook Research Laboratories

Operations: Test panels of varied materials and facing thicknesses were subjected to transient heat pulses in unloaded and prestressed conditions. Forty unloaded panels and two FJ-4 elevators were exposed. Recorders were located in an underground shelter and recovered by helicopter.

Shots: CHEROKEE, ZUNI, NAVAJO, TEWA (Bikini); APACHE (Enewetak).

Staffing: Three men were associated with this project: two from BuAer (one civilian, one military), and one civilian from Cook Research Laboratories. The exposure data for these are shown in Table 10.

Project Report: WT-1341 (Reference C.1.3.1341).

Project 8.5 -- Airborne High-Resolution Spectral Analysis

Agencies: Navy Bureau of Aeronautics (BuAer)
Naval Air Special Weapons Facility (NASWF)

Operations: Comparison was made of the thermal radiation spectral region from five detonations by P2V-2 aircraft. On all shots, the aircraft courses were outbound during shock-loading period.

Shots: LACROSSE, ERIE, (Enewetak); CHEROKEE, ZUNI, FLATHEAD (Bikini).

Staffing: One person, a civilian from BuAer is definitely associated with this project. He received 0.4 R. The exposure for this individual is shown in Table 10.

Project Report: WT-1342.

Program 9 -- Supporting Photography

This program had the missions of photographing the history of the radioactive cloud and supplying technical and documentary photographic coverage to essentially every project in the military effects programs. Several photographic stations were set up from which motion pictures were taken, but their locations were generally such that radiation exposure potential was minimal.

Project 9.1a -- Cloud Photography

Agencies: Edgerton, Germeshausen & Grier (EG&G)
Air Force 6007th Reconnaissance Group

Operations: Three RB-50 aircraft (Nos. 7120, 7131, and 7135) at altitudes from 18,000 to 30,000 feet (5.5 to 9.2 km) and ranges of 40 to 120 nmi (75 to 222 km) from ground zero photographed the clouds at times to 17 minutes postshot.

Shots: LACROSSE, MOHAWK, APACHE (Enewetak); CHEROKEE, ZUNI, FLATHEAD, DAKOTA, NAVAJO, TEWA (Bikini).

Staffing: Only the project officer was identifiable. He was an Armed Forces Special Weapons Project military officer and also acted as the Project 9.1b Project Officer; it is not clear that his exposure reflects Project 9.1a operations.

Project Report: ITR-1343 (Reference C.1.3.1343).

Project 9.1b -- Documentary Photography

Agency: Armed Forces Special Weapons Project (AFSWP)

Operations: Planning and coordination

RADIOLOGICAL SAFETY (TASK UNIT 7)

TU 7 was the basic radsafe unit for the entire task force. TU 7 did not provide monitors for all activities in radiological exclusion (radex) areas as these were provided usually by the project or activity itself. TU 7 did provide monitors in radiological survey activities. The other activities of TU 7 are covered in Chapter 2.

Personnel for TU 7 were provided by an Army unit, the 1st Radiological Safety Support Unit (RSSU), supplemented by a few Air Force and Navy personnel. Civilians from naval shipyards throughout the United States served in this task unit also. Specific exposure data for this task unit as a whole are not available, but are available for the 1st RSSU in Table 45.

CHAPTER 4
BIKINI TEST OPERATIONS

Bikini Atoll was used for the large-yield tests that, had they been conducted at Enewetak, would have required evacuation of personnel and threatened the physical facilities with contamination or damage. During REDWING, six devices were tested at Bikini, four detonated on barges, one airdropped, and one detonated at the surface. (See Table 1 for a list of REDWING detonations.)

In early May, the task force at Bikini numbered about 1,000 on Eneu and in the various advance camps and about 4,200 aboard the naval units stationed there. These 4,200 constituted almost the entire naval component of Joint Task Force 7 (JTF 7).

Operations at Bikini depended on support from Enewetak for certain key elements of testing. For example, test devices were brought from Enewetak ready to be armed and fired, so that technical personnel and special facilities to store and assemble the devices were not needed at Bikini.

The process for device placement at Bikini was as follows. After devices were readied in the assembly area on Parry Island, Enewetak Atoll, by personnel of the Atomic Energy Commission (AEC) laboratories, the devices were moved to Bikini Atoll. For barge tests this meant that the devices were placed in final position in cabs aboard the barges at a special slip within the assembly area. This slip was equipped with a gantry to handle the transfer of heavy equipment to the barges. Cabs were merely shelters to protect devices and personnel working on them from weather and unauthorized viewers. A view of a device installed in a cab aboard a barge is shown in Figure 33.

Device-bearing barges were then towed to USS Catamount. Catamount would have come over from Bikini the prior day after boarding a special detail of Marine Corps guards from USS Curtiss. The barge would then be moved into the well of Catamount with the aid of the TG 7.5 Boat Pool, and the Catamount would leave for Bikini. Surface escort was provided by a destroyer escort vessel, and a P2V from Patrol Squadron One (VP-1) provided continuous air cover.

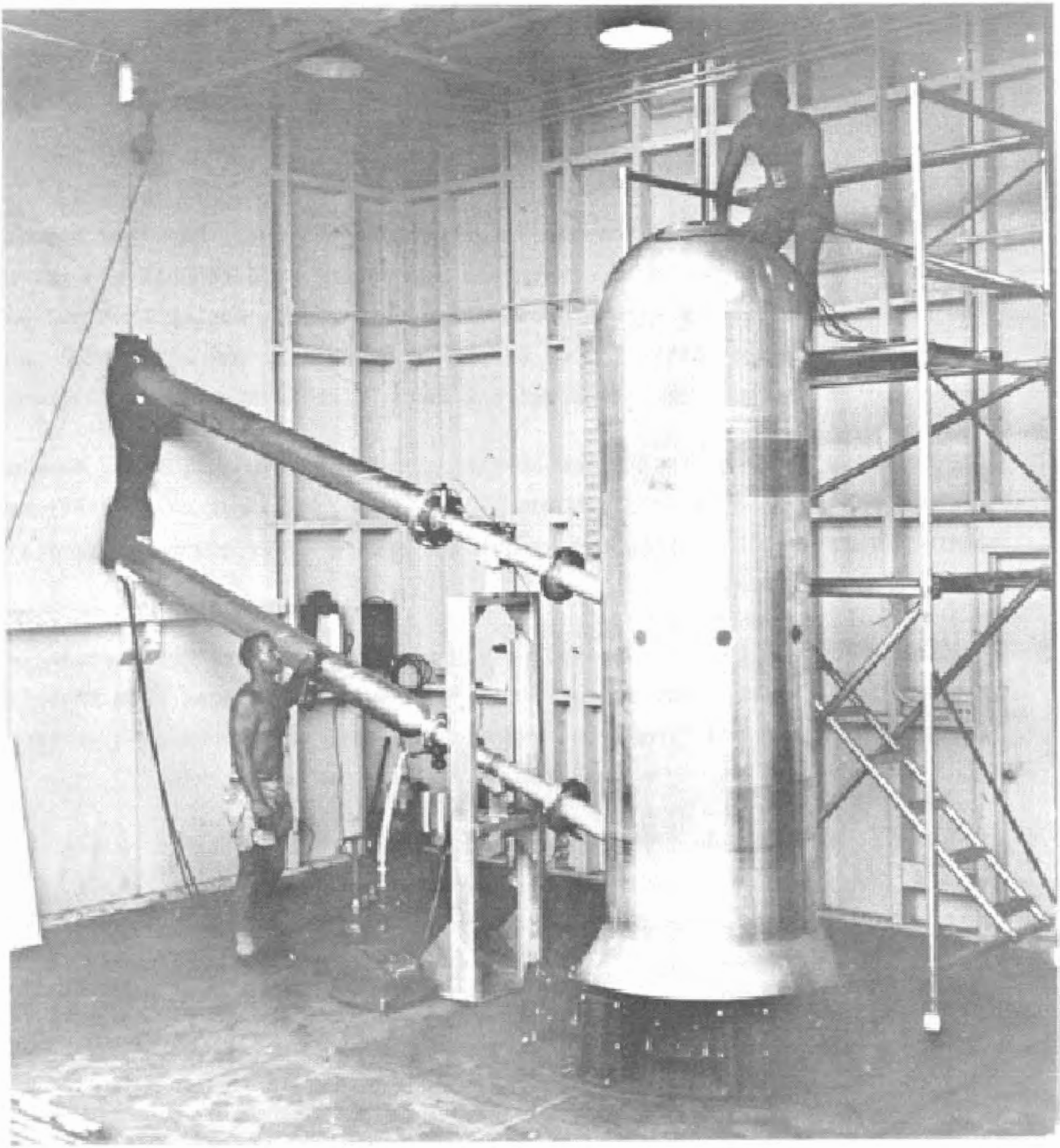


Figure 33. Test device installed in a cab on a barge, REDWING.

At Bikini the barge would be moved out of Catamount's well with the aid of the TG 7.5 Boat Pool Bikini. Figure 34 shows the FLATHEAD barge being moved from Catamount. The shot barge was then towed and moored at the shot point (Figure 35).

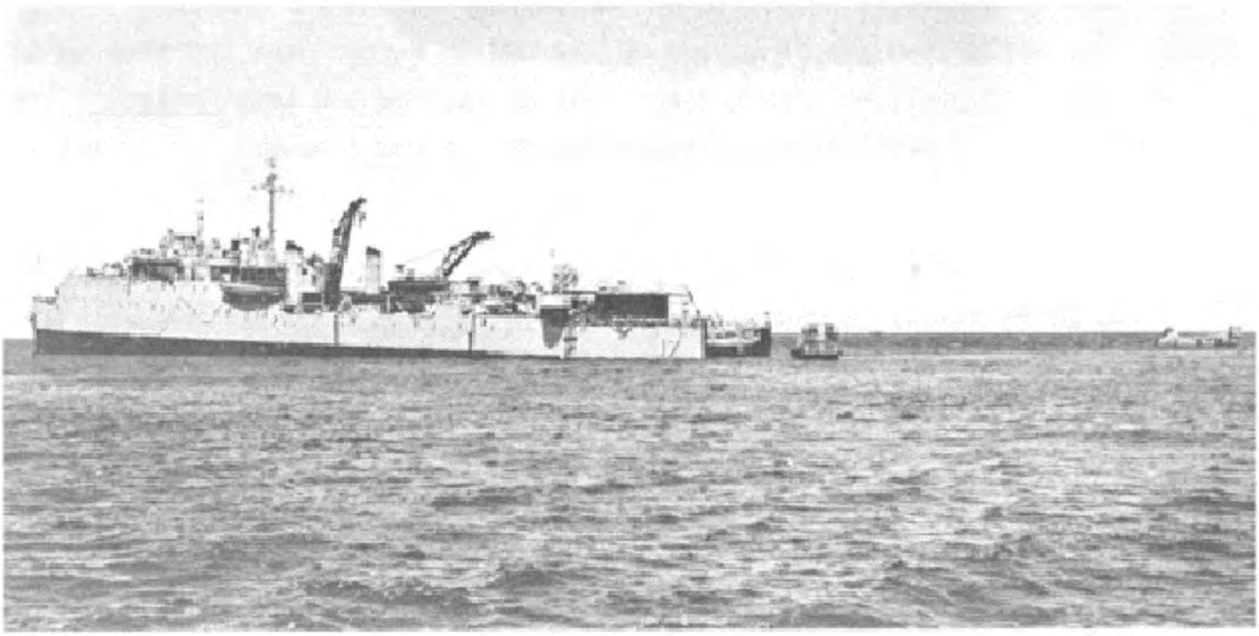


Figure 34. FLATHEAD device barge being removed from the well of USS Catamount (LSD-17), REDWING.

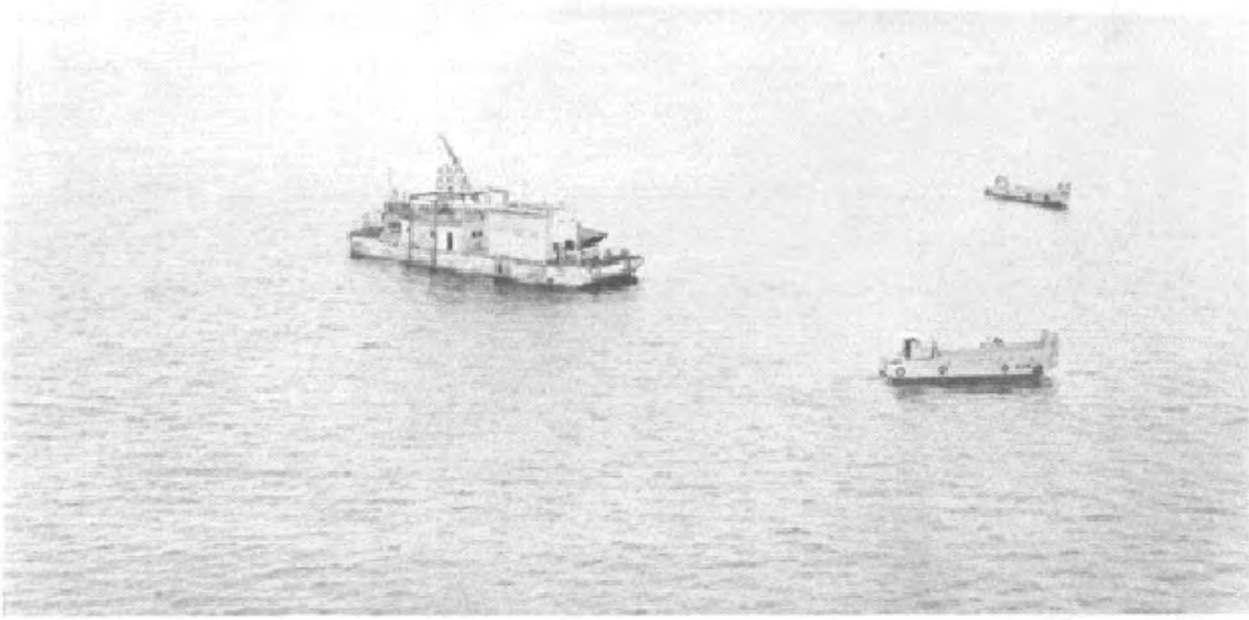


Figure 35. NAVAJO barge moored at detonation site, Bikini Atoll, REDWING.

The ZUNI device, detonated on the surface at Eneman, was loaded on a trailer and driven aboard a Navy TG 7.3 LCU at Parry. The LCU then moved aboard Catamount like a shot barge. At Bikini the LCU left Catamount and proceeded to a ramp on Eneman where the device could be driven off and taken to the zero point.

The core of the scientific programs personnel was housed at Enewetak and traveled to Bikini as required as shot time approached. All operations at Bikini were predicated on the fact that the atoll was to be evacuated at shot time, and the task force was prepared to live aboard the fleet while working ashore should the atoll become contaminated.

In spite of dependence on facilities at, and personnel from, Enewetak Atoll, test operations were conducted at both Bikini and Enewetak. On 28 May and 12 June, detonations were fired at both atolls with simultaneous detonations on the 12 June shots.

Department of Defense (DOD) operations were centered on weapon-effects testing, and tests at Bikini were of particular interest to effects experiments. The effects programs to which DOD assigned the highest priority were the nuclear radiation program, which was almost exclusively a Bikini operation, and the aircraft effects program, which was heavily oriented toward Bikini shots. The structural response program, "an important and costly experiment" (Reference B.1.3.1), depended entirely on one event at Bikini.

The large yields at Bikini were perceived as capable of introducing new effects in fallout development that would require new mathematical models in order to calculate the distribution of radioactive fallout, the aim of the nuclear radiation program.

The large yields also provided higher static overpressures over larger areas and much longer pulses of dynamic pressure than were possible with the lower-yield Nevada Test Site or Enewetak detonations. The longer duration pulse is an effective destructive agent against many targets of military interest, thus explaining the interest of the blast and structural response program in the Bikini shots.

Knowledge of the capability of delivery aircraft to survive delivery of large-yield weapons motivated the aircraft effects program.

These Bikini-oriented, high-priority programs are discussed below.

DOD BIKINI EXPERIMENTS

Program 2 -- Nuclear Radiation Program

The major effort of Program 2 was directed toward gathering data on the nature and distribution of radioactive products from high-yield thermonuclear devices detonated on or near the surface. Such data could eventually be applied to predicting fallout from any specified burst. In particular, this goal involved measurement of radiation fields inside the mushroom cloud, above land surfaces, and above and in seawater, as well as collection of fallout material. Other experiments dealt with initial radiation from nuclear detonations; still others used fallout contamination to perform tests of shielding, decontamination, and instrumentation. Stations used in this program were both land- and sea-based, manned and unmanned.

A control center instructed survey vessels as to which stations to take up for data collection. The control center also received data from these stations and coordinated further movement of the vessels. To position ships properly the control center had to predict the direction of fallout. This fallout-prediction capability was separate from that maintained by the Task Force Commander, Fallout Prediction Unit (FOPU). The program also prepared samples for return to the Naval Radiological Defense Laboratory (NRDL) and maintained laboratory and shipment facilities at Enewetak.

LAND STATIONS. The islands of Bikini Atoll were utilized extensively as bases for fallout-collection and radiation-measuring devices. In general, fallout-collection and residual-radiation measurements were performed throughout the atoll, whereas station locations for gamma and neutron initial-radiation measurements were on islands near surface zero. Fallout collection included both total and time-increment collections; radiation measurements included fallout time of arrival, exposure rate versus time, and total exposure.

MOORED STATIONS. Because available land areas covered only a small portion of the fallout pattern, an array of floating instrument stations was moored within Bikini Lagoon and north of the atoll. Three pontoon rafts, instrumented to measure time of arrival and total exposure and to collect total-fallout samples, were located along an east-west line approximately bisecting the lagoon. Two YFNB barges with complete total and time-incremental samplers and radiation detectors were moored at various locations in the lagoon for the different shots, as determined by expected fallout zones and peak overpressures. Approximately 16 skiffs were moored in the deep ocean north of the atoll by a special technique devised by the Scripps Institution of Oceanography (SIO). These were instrumented to collect total-fallout samples and to measure integrated exposure, time of arrival, and, in some cases, penetration of activity to various ocean depths.

FALLOUT-COLLECTION SHIPS. Three ships (YAG-39 [USS George Eastman], YAG-40 [USS Granville S. Hall], and USS Crook County), which had been modified to permit operation from a shielded control room (Figures 36 and 37), were positioned in the expected fallout zone prior to arrival of fallout. These ships collected fallout on their surfaces and in incremental and total collectors. The Crook County and the aft sections of the YAGs were washed down during fallout. Panels of various building materials, samples of common shipboard items, and Masonite phantoms were exposed on the YAG decks that were not washed down.

Instruments aboard the ships performed the following functions: (1) exposure-rate measurements versus time at locations above and below decks, (2) incremental air filtering, (3) gamma spectroscopy of individual particles and samples, (4) early-time decay studies on particles and samples, (5) exposure-rate measurements versus depth in the water, (6) exposure-rate measurements versus time above water, and (7) incremental and total fallout collection.

SURVEY SHIPS. Two Navy destroyer escorts and the SIO research vessel, MV Horizon, proceeded into the ocean fallout area after radioactive material had been deposited and performed the following functions: (1) exposure-rate measurements just below the ocean surface along the ships' tracks, (2) occasional measurement of exposure rate versus depth, and (3) water sampling.

SURVEY AIRCRAFT. Two P2V-5 aircraft, instrumented to measure exposure rate versus time, were flown at constant altitude over the ocean fallout area.

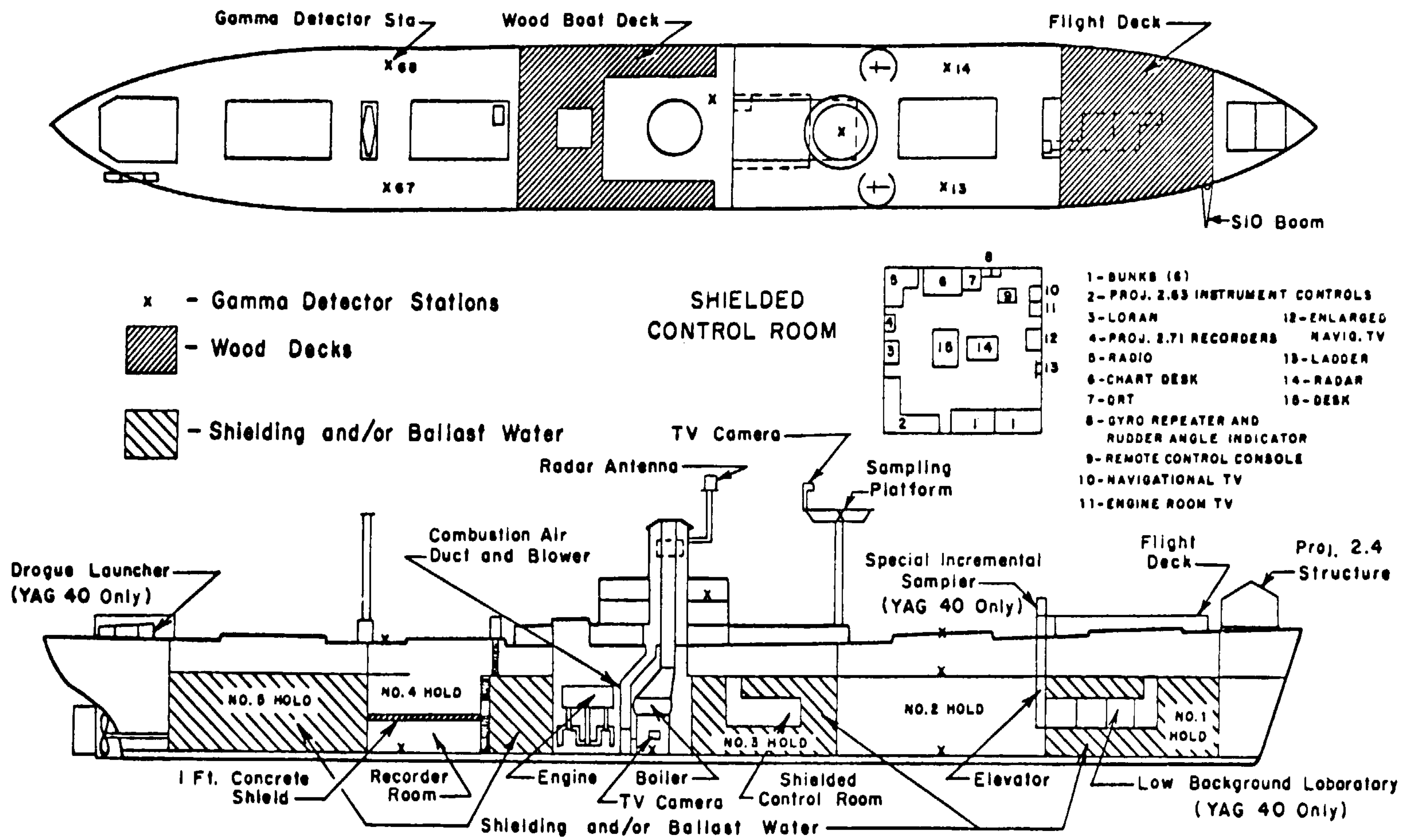


Figure 36. General arrangement of YAG-39 (USS George Eastman) and YAG-40 (USS Granville S. Hall), REDWING.

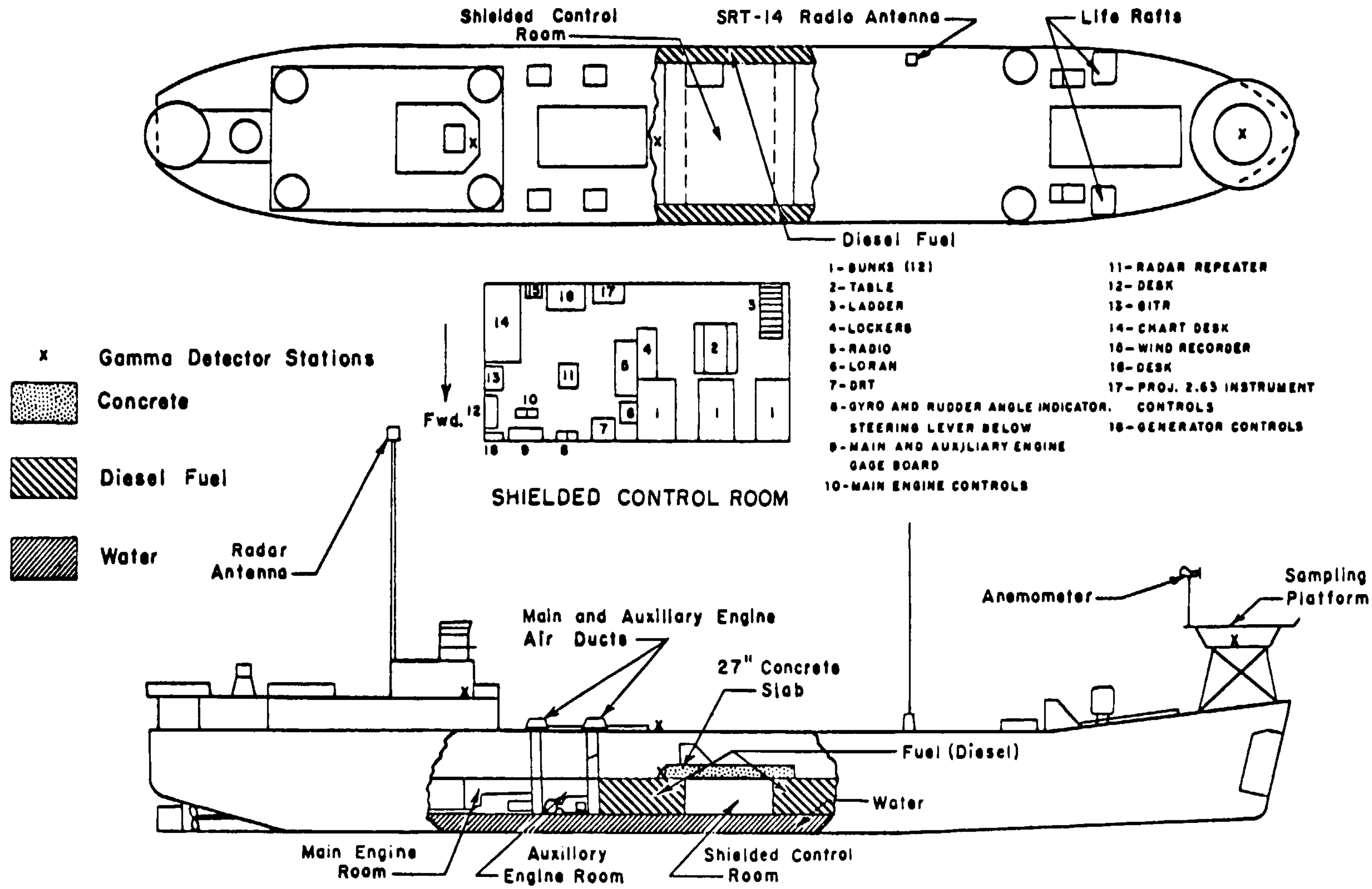


Figure 37. General arrangement of USS Crook County (LST-611), REDWING.

Their records provided the data for constructing contours of equal exposure rate above the ocean surface.

A radiation-sensitive probe, suspended on a long cable below a helicopter, was lowered to a position 3 feet (1 meter) above the surface of radioactive islands. Probe readings were noted inside the helicopter.

CLOUD-PENETRATION ROCKETS. A salvo of six rockets was fired at H+7 and another at H+15 into the mushroom clouds of shots CHEROKEE, ZUNI, and NAVAJO. Four rockets were fired at H+7 into the TEWA cloud. Data from ion-chamber radiation detectors in the rockets were telemetered to receiver-recorder stations at Eneu and aboard USS Knudson.

CLOUD-PENETRATION AIRCRAFT. Several B-57B aircraft, instrumented to measure exposure rate and total exposure, were flown through the radioactive clouds and stems from shots CHEROKEE, ZUNI, FLATHEAD, DAKOTA, APACHE, and NAVAJO as early as 20 minutes and as late as 78 minutes after detonation. Upon return to base at Enewetak, the aircraft were subjected to contamination-decontamination studies.

LABORATORY FACILITIES. Principal laboratory facilities available to the fallout-documentation projects included equipment to perform chemical analysis, particle-size analysis, radioautography, gamma and beta counting, gamma spectroscopy, and photographic development and densitometry. These facilities were located, in part, aboard YAG-40, on Parry, and at NRDL and the Chemical Warfare Laboratories (CWL).

Program 3 -- Structures Effects Program

This program participated only in the CHEROKEE test and is further discussed below with the CHEROKEE shot.

Program 5 -- Aircraft Effects Program

This program required close control and coordination of aircraft in flight in order to achieve a precise burst-time position for the aircraft. To place the aircraft correctly and to obtain a complete record of flight paths at H-hour and at the time of shock arrival, various aircraft and ground electronic positioning systems were utilized.

TEST PREPARATIONS AND EVACUATION

In preparing for tests at Bikini two kinds of activity occurred. The first was the winding down of construction and general support activities in preparation for the evacuation of the atoll and then evacuation itself. The second was an acceleration of installation activities, arming the test device, and final preparation for the scientific program.

Bikini events were detonated with all personnel evacuated except for a small firing party in a heavily shielded bunker on Eneu, although even this bunker was evacuated for one shot. The withdrawal process began 5 days before a shot and culminated when task force ships sailed out of Bikini Lagoon the afternoon before the shot, carrying Bikini-based personnel. The nature and scheduling of these operations are suggested by the accompanying tables (Tables 11 and 12). Overall consideration in these activities was identification of personnel and material resources that would not be needed at Bikini again and could be evacuated to Enewetak, or even withdrawn from the Pacific Proving Ground (PPG). The flow of men and materials was from the advance camps either to the evacuation ships directly or to the main camp at Eneu where transfer to ships took place.

As support personnel left Bikini, special flights were being added to the Enewetak-to-Bikini shuttle flights (Reflectors) to accommodate an influx of personnel assigned to the command structure of the task force or to the scientific program. Among these late arrivals were the teams to prepare or arm the device for detonation and make final adjustments on instrumentation for recording data.

USS Estes became the center of command-and-control activities. It not only was the flagship for Commander JTF 7 (CJTF 7) and the commanders of TG 7.3 and TG 7.4 (afloat), but also housed control facilities for the extensive nuclear radiation program, the center controlling aircraft in the aircraft effects program, the FOPU and the Fallout Prediction Center (FOPC). Command ship activities were fully engaged in the early afternoon before the burst.

In general, other housing afloat at Bikini was assigned as follows:

Table 11. Bikini test preparations, REDWING.

Activity	Day/Time
Ship Movement	
Designate destroyer weather station	D-4
Destroyer on station and commences weather observations	D-3
USS Crook County (LST-611) departs for fallout collection station	D-1/0700
MV Horizon, USS McGinty (DE-365), and USS Silverstein (DE-534) depart for Program 2 activities	D-1/1300
YAG-39 (USS George Eastman) and YAG-40 (USS Granville S. Hall) depart for fallout collection station	D-1/1600
All fleet sortie	D-1/1700
Search and rescue (lifeguard destroyer on station 30 nmi [56 km] east of Enewetak)	D-day/0000
Weather and Fallout Prediction	
Command weather-radsafe briefing at Parry	D-2/0830
Command weather-radsafe briefing at Parry	D-1/0830
Forecast of air and surface radex areas	D-1/1200
Fallout Prediction Unit embarks on USS Estes (AGC-12)	D-1/1300
H-18 advisory on cloud trajectories and fallout	D-1/1415
Command Post Movement	
Special flights to Bikini with Task Group 7.1, Hq Joint Task Force 7 personnel and Commander, Joint Task Force 7	begin D-1/0900
Joint Operations Center, Hq Task Group 7.1, Task Unit 3, program control on Estes	D-1/1300
Aircraft Movement	
Prepare WB-50 cloud-tracker Wilson 1	D-1/2130
Begin aircraft takeoffs from Enewetak	D-day/0300
Patrol Squadron One radiological reconnaissance planes from Kwajalein	D-day/0500
Commander, Task Group 7.4 to flag plot on Estes; all aircraft in position	D-day/(H-4 min)

Table 12. Bikini evacuation schedule, REDWING.

Activity	Day/Time
Security	
P2V aerial surveillance	Begin D-1
Destroyer escort or PAD sweeps	Begin D-1
Commander Task Group 7.3 report Danger Area clear	D-1/2100
Physical Plant Closedown -- Camps	
Dismantle unneeded camps	Begin D-5
Evacuation of unneeded equipment and trailers	Begin D-4
Last P.O., P.X., etc. service at Lomilik	D-3
Last P.O., P.X., etc. service at Enenman, Eneu	D-2
Last hot meals at advance camps	D-1/(AM)
Last hot meals at Eneu	D-1/1200
Barricade Aerokojlol-Aerokoj airstrip	D-1/1500
Barricade Eneu airstrip	D-1/1600
Physical Plant Closedown -- Afloat	
ATF tow YFNB to safe anchorage	D-4
Tow barges and lighters to anchorage	D-2
Land LCM aboard USS Catamount (LSD-17)	D-1/1300
Personnel Evacuation	
Excess personnel to Enewetak aboard regular Reflector and special flights	Begin D-2
All personnel except assembly and arming teams evacuated at least as far as Eneu	D-1/1530
Mustering (accounting) for all personnel	Begin D-1
Reports on evacuation and mustering	D-1/1600 D-1/1800 D-1/2000 D-1/2200
Fleet Sortie	
Task force personnel aboard; sortie begins	D-1/1700
Report all ships clear of lagoon	D-1/1900

USS Curtiss (AV-4) -- TG 7.1 Command Section (less those at the control station on Eneu) and key scientific, staff section, and task unit personnel

USS Badoeng Strait (CVE-116) -- Radiological safety (radsafe) team and persons scheduled for early reentry and recovery by helicopter

USNS Fred C. Ainsworth (T-AP-181) -- Scientific project personnel, CTG 7.5, and Holmes & Narver (H&N) civilians

USS Catamount (LSD-17) -- Early TG. 7.1 boat reentry-recovery parties and a small number of radsafe personnel.

The number of persons evacuated from Bikini for each of the tests is shown in Table 13. As the series progressed, requirements for personnel on Bikini

Table 13. Number of persons evacuated from Bikini during REDWING.

Vessel	CHEROKEE (May 21)	ZUNI (May 28)	FLATHEAD (June 12)	DAKOTA (June 26)	NAVAJO (July 11)	TEWA (July 21)
USS Curtiss (AV-4)	75	96	77	72	80	60
USNS Fred C. Ainsworth (T-AP-181)	225	173	145	134	104	103
USS Badoeng Strait (CVE-116)	73	82	48	30	46	36
USS Estes (AGC-12)	21	19	18	4	16	18
USS McGinty (DE-365)	3	3	3	0	3	3
USS Catamount (LSD-17)	21	5	7	9	5	5
MV Horizon	26	26	26	0	24	24
USS Sioux (ATF-75)	3	6	3	0	3	3
USS Knudson (APD-10)	6	12	0	0	0	6
USS Mount McKinley (AGC-7)	3	0	0	0	0	0
YAG-39 (USS George Eastman)	10	11	11	0	10	10
YAG-40 (USS Granville S. Hall)	15	16	17	0	14	16
USS Crook County (LST-611)	4	6	5	0	5	5
USS Silverstein (DE-534)	3	3	2	0	4	3
Total	488	458	362	249	320	292

declined as advance camps were closed, their functions having been completed. The total evacuated for the last shot was only about 60 percent of the nearly 500 required for the first event. After the personnel had embarked, the fleet withdrew from the lagoon to the open sea some 33 to 50 km southeast.

REENTRY AND RECOVERY

The detonations were always scheduled at either 40 or 20 minutes before sunrise. At this time of day the atmosphere was most free of clouds. The ships' crews and the evacuees were issued protective goggles or cautioned to look away from burst point at the time of detonation. After the initial flash subsided, the rising fireball could be viewed directly. Such a view is presented in Figure 38. The task force would prepare to reenter by moving toward Bikini. When Badoeng Strait had closed to within about 8 km of Eneu (usually at approximately H+1.5), two radiological survey helicopters were launched. These helicopters sought information concerning the radiological situation at Eneu and in the lagoon and, as conditions permitted, general lines and levels of radioactivity throughout the atoll. As soon as definite information was

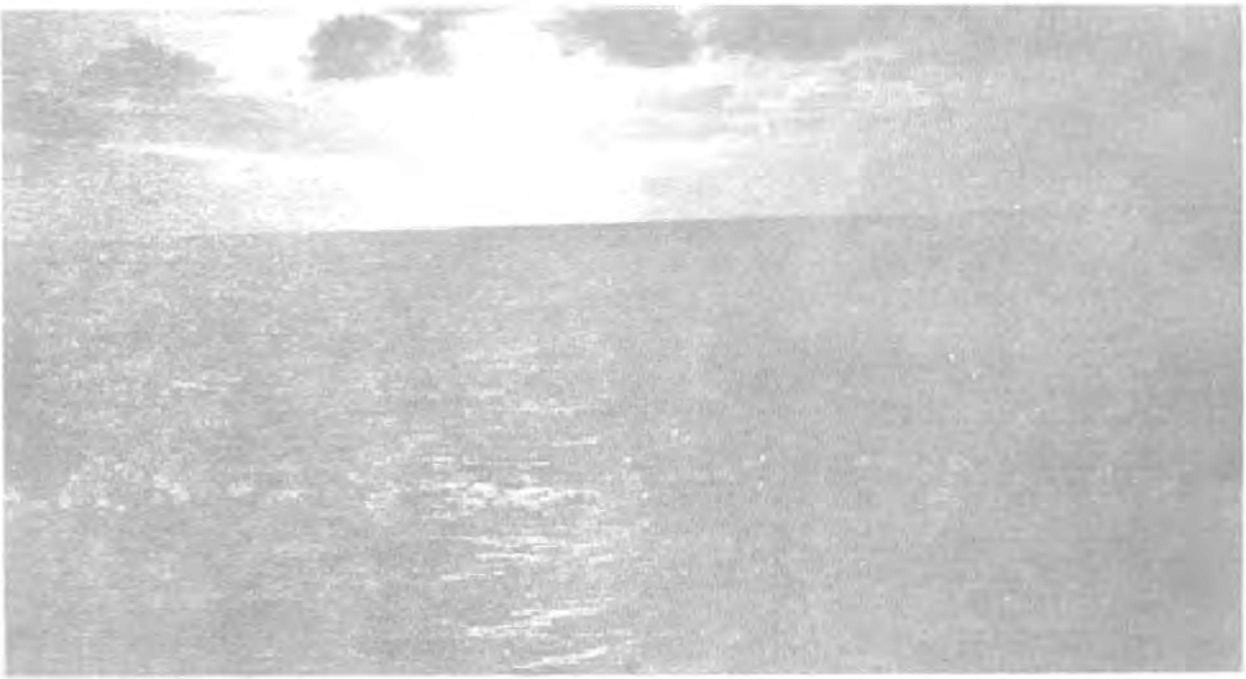


Figure 38. CHEROKEE cloud as viewed from fleet sortie area, REDWING.

received that Eneu and the anchorage were clear, permission was obtained to proceed with early recovery missions and with the initial phase of reentry. Priority for reentry on helicopters was (1) ten TG 7.4 personnel to activate the Eneu airstrip, (2) five TG 7.1 personnel to establish the Operations Section ashore, (3) twenty TG 7.5 personnel to begin essential camp services ashore, and (4) seven TG 7.1 personnel to man radsafe checkpoints. In all cases, this ship-to-shore shuttle was completed before declaration of reentry hour. Recovery operations varied from shot to shot, depending on radiological conditions resulting from the event and the number and location of experimental projects.

Once it had been determined that Eneu radioactivity was not at a level prohibiting 24-hour occupancy, general movement of personnel was initiated. After reentry of Catamount into Eneu anchorage and discharge of the LCMs, scheduled water-taxi service was established, generally by H+7. On a half-hour schedule, LCMs provided a continuous ship-to-shore-to-ship circuit. Radsafe staff and sections were normally fully operational ashore no later than 1200, and a noon meal was served on Eneu to early reentrants. However, to decrease the load on camp facilities, most of the Eneu residents ate lunch aboard ship on shot days. The camp was normally fully operational again by H+8.

RADIOLOGICAL SAFETY SERVICES

Control points for entry into radiological exclusion (radex) areas were established at the boat landing and helicopter pad at Eneu. Records of individual entry and exit into radex areas were evidently made at the control points, but these records have not been located. In addition, control points and radsafe centers were established on Ainsworth, Curtiss, Badoeng Strait, Estes, and Catamount. These radsafe centers included plotting and briefing areas, mission film badging, clothing and equipment issue points, and personnel decontamination stations.

Personnel decontamination facilities, consisting of clean and "hot" change areas and showers, were established on Eneu Island adjacent to the Radsafe Building. Approximately 3,400 persons were processed during REDWING. Laundry services for protective clothing were provided by H&N personnel using laundry facilities installed on radsafe barge. This barge provided complete personnel decontamination facilities as well as laundry facilities and was to be used in the event that Eneu was contaminated and operations had to be conducted entirely from shipboard. Only the laundry facilities on the barge were used (Reference C.1.3.1).

Equipment decontamination (vehicles and Marine Corps helicopters) was accomplished by the Army Chemical Corps decontamination trucks, since no steam generator was available at Bikini.

The Plotting and Briefing Section of TU 7 was responsible for all radiation surveys. These surveys were conducted by helicopters of Marine Helicopter Transport Squadron-363 (HMR-363). A preentry survey was flown at H+2 to H+4, with a detailed one following at approximately H+6. Other detailed surveys of the entire atoll were flown on succeeding days after each shot as required. Data were sent back via the flight-operations radio net when necessary. These surveys delineated radex areas of the atolls.

Atoll evacuation required that the preentry survey originate from afloat. Normally, the helicopter selected for the mission departed from Badoeng Strait and made its first stop at Curtiss to pick up the radsafe personnel. The helicopter then stopped on Eneu to pick up CTG 7.1, who was with the firing party and the mission was carried out. Once the island of Eneu was declared clear by CTG 7.1, personnel returned to the island and all operations were conducted from ashore (Reference C.1.3.1).

Radiation monitors for recovery parties were provided by TU 7 when required. Usually, scientific projects supplied their own monitors and demand for TU 7 monitoring assistance was small.

The radiochemistry trailer, obtained from the Army Signal Corps, was deckloaded on Ainsworth. All radiochemistry work was carried out in this trailer. The Laboratory Section handled approximately 400 water samples, which were taken from the water supplies of the various ships and from the swimming beach on Eneu. No chemical analysis was required; gross beta-gamma activity was determined.

Little interference with preparations for firing the various devices was caused by radioactivity from previous tests. In certain cases, exact placement of the shot barge was delayed for a day or so as radiation levels were excessive in those areas in which surveyors had to work. Generally speaking, however, no delay was encountered as a result of radioactivity (Reference C.1.3.1).

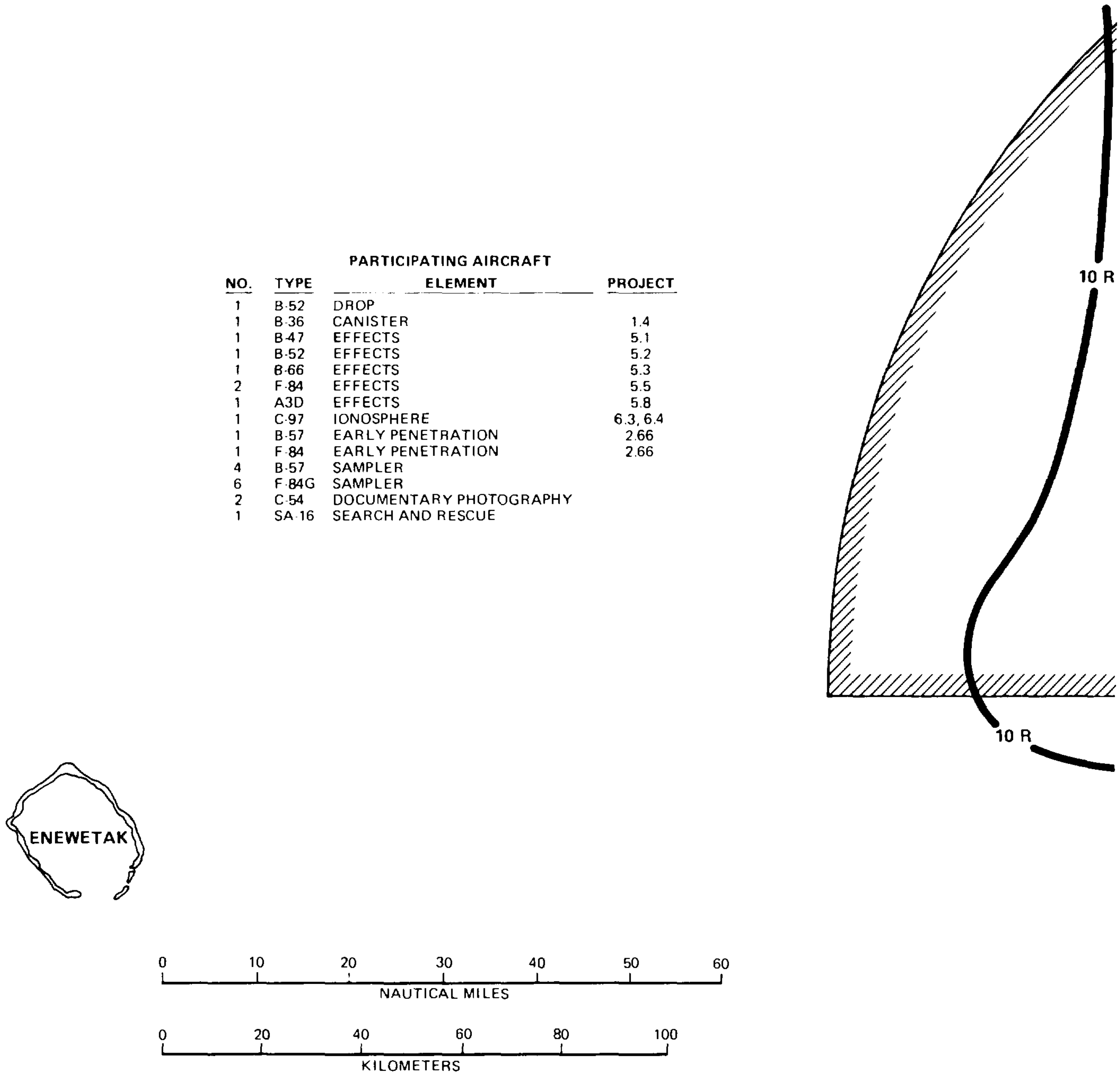
CHEROKEE

CHEROKEE was the first test at Bikini, a test event called for by DOD, and the only shot of the series not expressly for weapon development. The shot was rather a demonstration that the United States could air-deliver multimegaton-yield thermonuclear weapons using B-52 jet bombers. The device, designed and developed by Los Alamos Scientific Laboratory (LASL), was airdropped from a B-52 and exploded at an altitude of 5,000 feet (1.5 km) above Nam on 21 May 1956. Although a demonstration, the shot provided a large-yield burst well above the surface, and it was therefore of considerable interest for airblast effects experiments. However, the explosion was considerably off target, lessening its value.

The DOD scientific experiments for CHEROKEE are listed below.

- Program 1 -- Blast Effects: Projects 1.1, 1.3, 1.4, 1.5, 1.9
- Program 2 -- Nuclear Radiation: Projects 2.1, 2.2, 2.51, 2.52, 2.61, 2.62, 2.63, 2.64, 2.65, 2.66
- Program 3 -- Structures Effects: Project 3.1
- Program 4 -- Biological Effects: Project 4.1
- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.5, 5.7, 5.8
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4, 6.5
- Program 8 -- Thermal Radiation: Projects 8.1, 8.2, 8.3, 8.4, 8.5
- Program 9 -- Photography: Project 9.1.

Full descriptions of the various projects are presented in Chapter 3. The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 39. Two experiments were unique and were not repeated on other tests.



PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-52	DROP	
1	B-36	CANISTER	1.4
1	B-47	EFFECTS	5.1
1	B-52	EFFECTS	5.2
1	B-66	EFFECTS	5.3
2	F-84	EFFECTS	5.5
1	A3D	EFFECTS	5.8
1	C-97	IONOSPHERE	6.3, 6.4
1	B-57	EARLY PENETRATION	2.66
1	F-84	EARLY PENETRATION	2.66
4	B-57	SAMPLER	
6	F-84G	SAMPLER	
2	C-54	DOCUMENTARY PHOTOGRAPHY	
1	SA-16	SEARCH AND RESCUE	

Figure 39. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for CHEROKEE, REDWING. Heavy line defines a predicted fallout area of 10-roentgen infinite gamma exposure. Ship positions are shot time except YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall), and USS Crook County (LST-611), which are positions at times of maximum fallout activity.

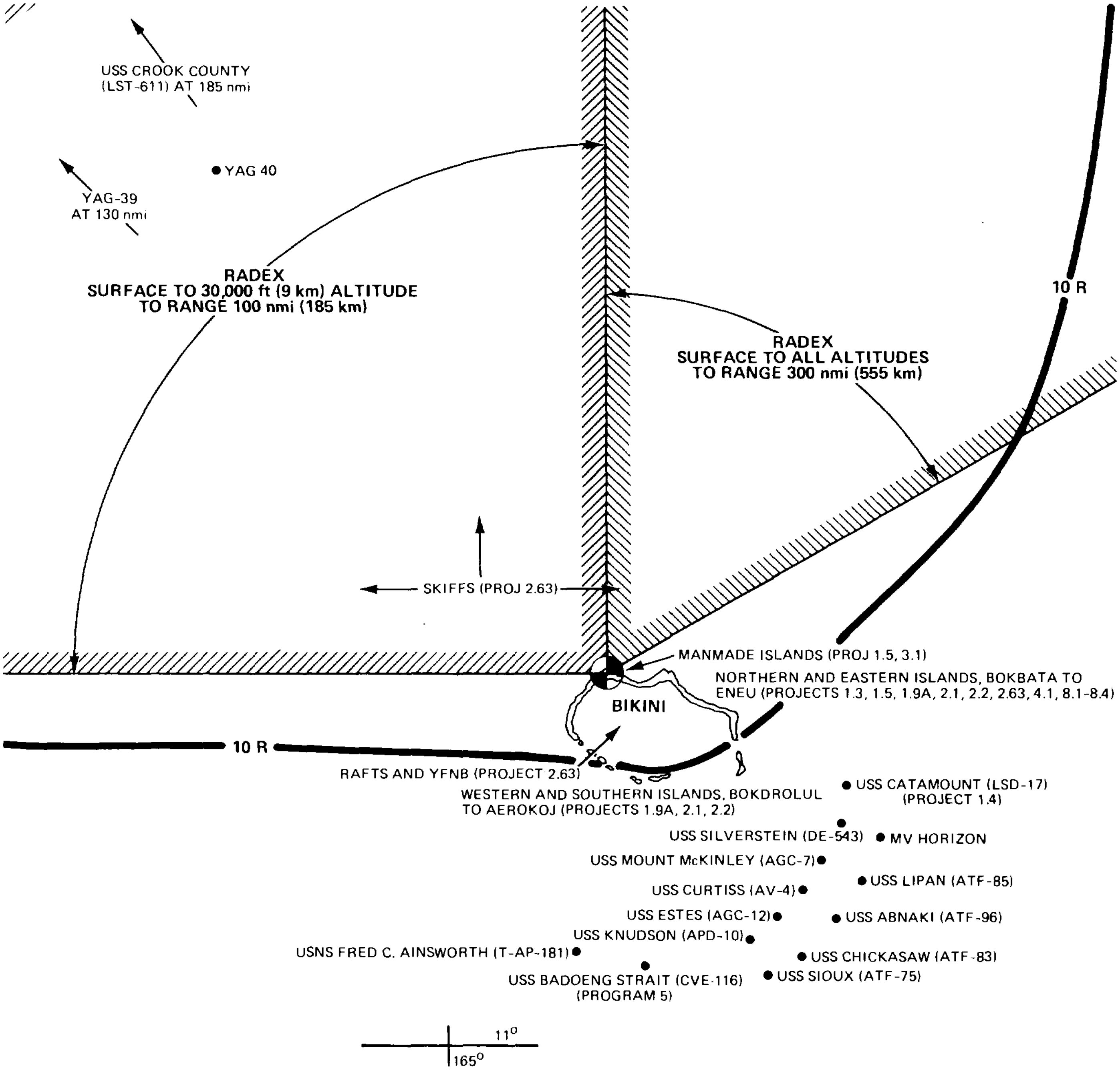


Figure 39. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for CHEROKEE, REDWING. Heavy line defines a predicted fallout area of 10-roentgen infinite gamma exposure. Ship positions are shot time except YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall), and USS Crook County (LST-611), which are positions at times of maximum fallout activity. (continued)

The first was Project 1.4. This experiment measured blast-wave parameters in free air and required an aircraft to precede the drop aircraft over the burst point. The preceding aircraft dropped airblast instrument canisters that were supported by parachute above and to the side of the burst point. Considerable planning and coordination was required to place these canisters properly. Data from these experimental canisters were telemetered to Catamount, which was with the remainder of the fleet southeast of Bikini.

A second DOD experiment unique to CHEROKEE was Project 3.1, in which three sets of steel-framed industrial buildings of the type that were felt to be especially vulnerable to blast-wind damage were built at increasing distances from the proposed burst point so that gradations of damage could be correlated with range. There were no islands at the desired ranges from the intended burst point, however, and it was therefore necessary to construct three islands on which to place the buildings. These islands were built over the reef between Nam and Iroij along the northern perimeter of this atoll. A picture of one of these islands is shown in Figure 8.

The manmade islands and Bokbata, Iroij, Bikini, and Coca islands were also instrumented by other projects in the blast program to measure blast parameters on the ground. Aircraft of Program 5 were instrumented with thermal instrumentation provided by Program 8. Ground-based thermal measurements were made at Iroij, Aomen, and Bikini islands. Animals from the biomedical program's retinal burns project were exposed at Eneu. Ionospheric effects experiments, conducted from aircraft stations and from remote locations, also participated.

A total of 38 mission aircraft took part in the test. The Raydist system, positioned on Badoeng Strait, controlled the maneuvers and positioning of aircraft for the shot. Effects aircraft were one A3D-1, one B-47, one B-52, one B-66, and one F-84F. A B-36 was used for the canister drop. Three B-57s and six F-84s accomplished the sampling effort. A fourth B-57 was used as sampler control aircraft. Table 14 shows locations at detonation time for the effects air- craft for which information is available.

USS Mount McKinley (AGC-7) was used as an observer platform for this event. This Special Observer Group was made up of 16 members of the press and news media, 17 civilian state and federal civil defense administrators, and 20 members

Table 14. H-hour positions of effects aircraft, CHEROKEE, REDWING.

	A3D	B-52	B-47E	B-66	F-84F
Direction from burst (^{o})	--	--	007	184	194
Slant range (km)	19.6	14.3	19.3	18	41.8
Altitude (km)	10.4	9.5	10.1	10.4	8.5
Heading (^{o})	--	--	257	223	050

of the Joint Office of Test Information. This latter group had ten AEC personnel, seven DOD (four military, three civilian) representatives, two Federal Civil Defense Administration employees, and one State Department representative. Mount McKinley was positioned with the bulk of the fleet off Bikini.

Surface and air radex area predictions were based on the fallout expected if the device failed to detonate in the air and produced a ground burst instead. The radex areas for H-hour to H+6 were:

Surface to 30,000 feet (9 km) altitude:	Bearing 270^{o} to 360^{o}T, 100-nmi (185-km) range
Surface to all altitudes:	Bearing 0^{o} to 60^{o}T, 300-nmi (555-km) range.

The radex notices were withdrawn by H+12.

The B-52 released the device too soon on its bomb run, which was from the northeast toward Nam. In consequence the detonation was about 20,000 feet (6.1 km) northeast of the intended burst point.

The detonation cloud reached an estimated height of 80,000 feet (24 km) with the lower portion moving to the northwest and upper and main portion moving generally east-northeast at approximately 10 knots (18.5 km/hr) (Reference C.1.7.2).

The initial radsafe helicopter preentry survey at H+2 showed the atoll to be free of radiation except for readings of about 0.010 R/hr at Nam. Reentry was scheduled for 1000, about H+4. Fallout activity on both YAG-39 and YAG-40 was much less than 0.001 R/hr (Reference C.1.3.1312).

The early-penetration B-57 made three flights through the cloud at 59 to 75 minutes after burst and averaged readings of about 3.6 R/hr with a peak rate of 8.4 R/hr.

The Wilson 1 WB-50 cloud-tracking aircraft conducted a survey beginning at H+6 in a 30° sector bearing 60° to 90° extending about 260 nmi (480 km) from Rongerik. Only two contacts with the cloud were made, both less than 0.01 R/hr. The second aerial monitoring flight (Wilson 2) at H+18 to H+26 covered a triangular pattern from Bikini to Utirik to Wake to Enewetak and return without encountering radiation in excess of background. Off-atoll monitoring stations reported no exposures higher than background through D+3.

Because of heavy participation in CHEROKEE, a very tight recovery schedule was predicted, with the full commitment of available helicopters. The total absence of detectable radioactivity, however, alleviated the demand for helicopters in several ways. First, the need for early recovery trips to pick up instrumentation before it became contaminated was obviated. Second, 60 percent of the missions devoted to recovering fallout samples were cancelled because there was nothing to recover. One carefully rehearsed mission to the intended surface zero area to recover neutron threshold samples was greatly simplified, inasmuch as only one recovery team was required rather than the two that had been planned. Two teams had been anticipated as necessary to keep the individual radiation exposures low. Several D+1 missions were accomplished on D-day as a result of availability of helicopters.

ZUNI

ZUNI was detonated at 0556 on 28 May at the surface of the western end of Eneman Island. Ground zero was near the KOON crater from Operation CASTLE. The yield of the University of California Radiation Laboratory (UCRL) device was 3.5 MT. The bunker of Eneu was evacuated for this shot, the firing sequence being initiated by a radio signal from Curtiss.

The DOD scientific experiments for ZUNI are listed below:.

- Program 1 -- Blast Effects: Projects 1.1, 1.3, 1.5, 1.8, 1.9
- Program 2 -- Nuclear Radiation: Projects 2.1, 2.2, 2.4, 2.61, 2.62, 2.63, 2.64, 2.65, 2.66, 2.71, 2.8, 2.9, 2.10

- Program 4 -- Biological Effects: Project 4.1
- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.4, 5.5, 5.7
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4
- Program 8 -- Thermal Radiation: Projects 8.1, 8.5
- Program 9 -- Photography: Project 9.1.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 40. Table 15 indicates positions at detonation for effects aircraft for which information is available.

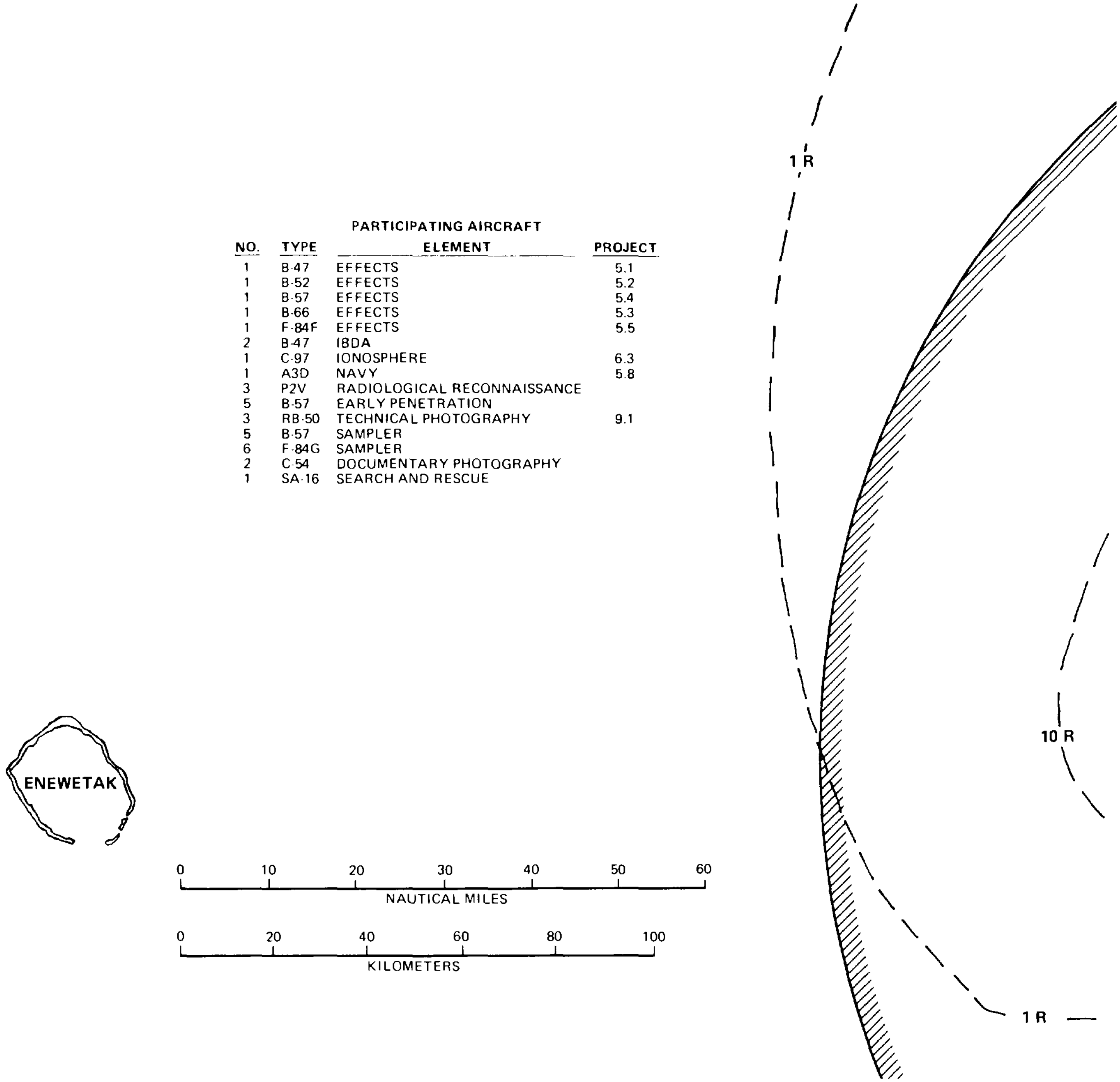
L-20s and H-19s from TG 7.4 supported TG 7.1 from D-3 through D+1. These aircraft were used for H+1 radsafe surveys, damage assessment, and recovery of high-priority experiments.

Surface and air radex areas in force from H-hour to H+6 were:

Surface to 30,000 feet (9 km) altitude:	Bearing 240° to 360°T; 100-nmi (185-km) range
Surface to all altitudes:	Bearing 0° to 80°T; 300-nmi (555-km) range.

The ZUNI cloud topped at 85,000 feet (26 km). The cloud base was at about 30,000 feet (9 km). Its diameter at time of maximum height was about 75,000 feet (23 km). General cloud movement was to the north at 15 knots (28 km/hr); however, the lower portion of the stem moved to the west at about the same speed. The 30,000-foot (9-km) winds turned to the southeast sometime late on shot day causing light fallout on atolls southeast of Bikini.

ZUNI, with its high yield (3.5 MT) and surface placement, formed a large crater. The western end of Eneman Island was destroyed and its constituent materials pulled up into the cloud. Among the materials in the cloud was part of the residue from the KOON device, which apparently detonated inefficiently at the same site in 1954. This crater was flooded by the lagoon waters and the truncated western tip of the island measured 0.450 R/hr 4 days after the burst (Reference C.1.3.1332).



PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-47	EFFECTS	5.1
1	B-52	EFFECTS	5.2
1	B-57	EFFECTS	5.4
1	B-66	EFFECTS	5.3
1	F-84F	EFFECTS	5.5
2	B-47	IBDA	
1	C-97	IONOSPHERE	6.3
1	A3D	NAVY	5.8
3	P2V	RADIOLOGICAL RECONNAISSANCE	
5	B-57	EARLY PENETRATION	
3	RB-50	TECHNICAL PHOTOGRAPHY	9.1
5	B-57	SAMPLER	
6	F-84G	SAMPLER	
2	C-54	DOCUMENTARY PHOTOGRAPHY	
1	SA-16	SEARCH AND RESCUE	

Figure 40. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for ZUNI, REDWING. Dashed lines define predicted fallout areas (infinite gamma exposure, roentgens). Ship positions are shot time except YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall), and USS Crook County (LST-611), which are positions at times of maximum fallout activity.

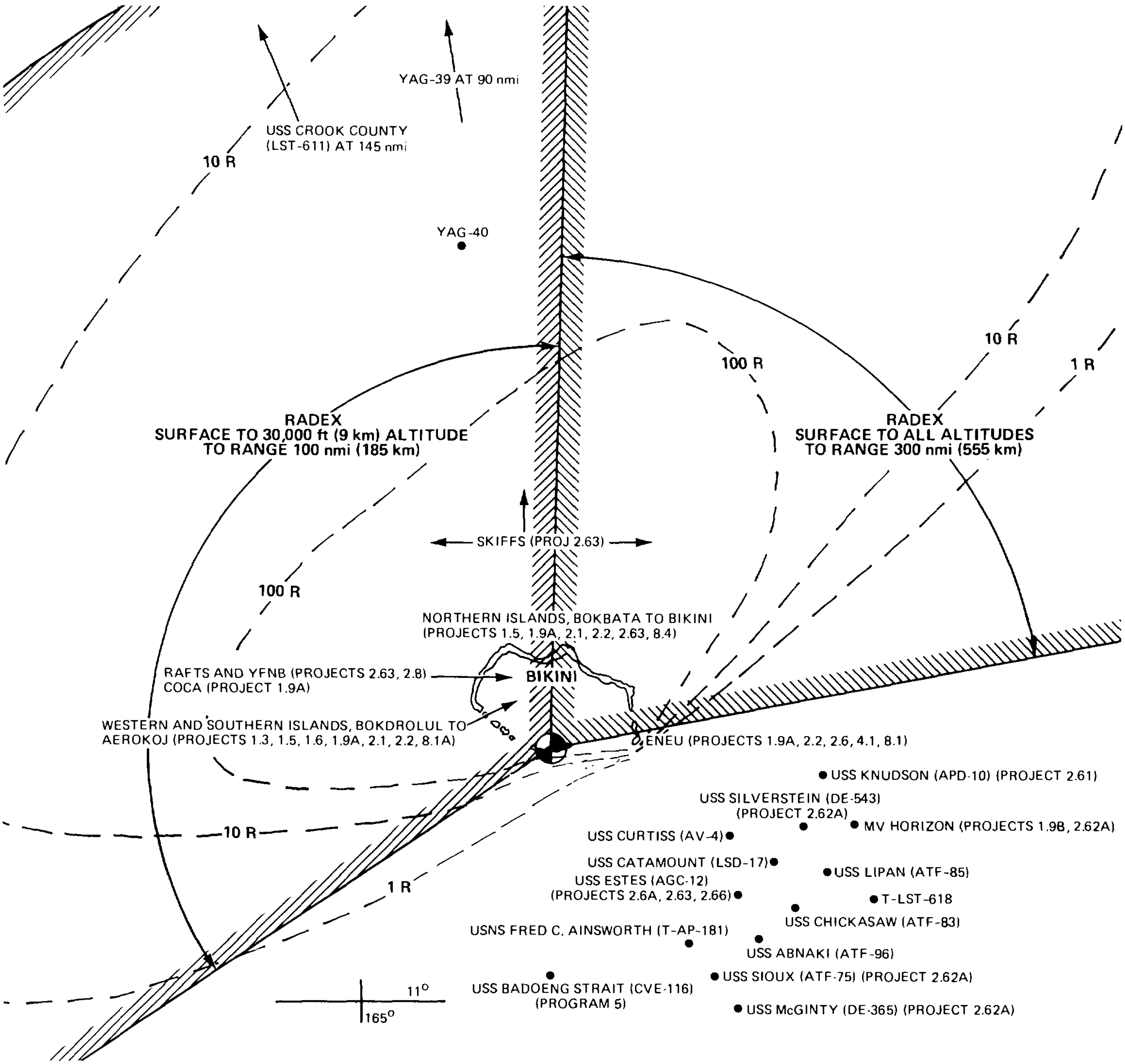


Figure 40. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for ZUNI, REDWING. Dashed lines define predicted fallout areas (infinite gamma exposure, roentgens). Ship positions are shot time except YAG-39 (<u>USS George Eastman</u>), YAG-40 (<u>USS Granville S. Hall</u>), and <u>USS Crook County</u> (LST-611), which are positions at times of maximum fallout activity. (continued)

Table 15. H-hour positions of effects aircraft, ZUNI, REDWING.

	A3D	F-84F	B-47E	B-66	B-57B[a]	B-52
Direction from burst (°)	---	322	000	070	---	---
Slant range (km)	13	80.8	13.5	9.3	11.6	12
Altitude (km)	8.6	10	9.5	4	5.2	9.8
Heading (°)	---	130	250	070	081	---

[a]B-57B pilot and engineer received no gamma radiation exposure.

Heavy radioactivity was measured throughout most of Bikini. At H+4, an exposure rate of 75 R/hr was determined for Bokbata, and exposure rates of 50 R/hr at H+4 extended along the northern rim of the atoll from Nam to Odrik. Fortunately, Eneu was only lightly touched by fallout; an H+4 value of 0.003 R/hr was reported (Reference C.1.3.1). Initial radiological surveys for the Bikini Atoll islands are summarized in Table 16.

The Zebra I aircraft, positioned south of Eneu between surface zero and the fleet, reported no radiation levels greater than background at H+1. Zebra I was instructed to make a low-altitude survey of Eneu and the lagoon anchorage. At H+1.5 both areas were reported "clean."

Initial helicopter radsafe surveys began at H+1.5 and confirmed the Zebra I readings. Reentry was then scheduled to begin at 0900, about H+2, and was complete at about 1400.

At H+3, the P2V reconnaissance aircraft intercepted a segment of the cloud about 60 nmi (111 km) west of Bikini at 12,000 feet (3.7 km) (Reference C.1.7.2). Low-level activity was recorded at Enewetak at H+9.5 (0.00015 to 0.0003 R/hr). Peak exposure rate was at about H+11, when values of 0.001 R/hr were reported at "places where dust and dirt congregate" (Reference C.2.2, p. 97).

Early-penetration B-57 aircraft (Project 2.66) made three flights through the ZUNI cloud at H+52 to H+78 minutes. Average exposure rates in the cloud were about 25 R/hr with a peak of 60 R/hr. The pilots on these penetration flights received 1.2 to 2.1 R.

Table 16. Summary of Bikini radiological surveys after ZUNI, REDWING.

Island	Survey Reading (R/hr) (on ground except as noted) H+3[a]	H+6[a]	H+8[a]	D+2[b]	Unshielded Exposure (R) H+76[c]
Bokbata	---	45	---	0.9	605
Nam	---	28	50-60	1.3	420
Iroij	---	28	50-60	0.9	485
Lomilik	---	30	50-60	1.5	620
Bikini	1[d]	0.8-3	---	0.06-0.26	52
Eneu	0	0.002	0	---[e]	0.3
Aerokoj	---	10	---	0.28	---
Lele	---	60	20	0.48	135
Eneman	---	---	---	18.6[f]	---
Enidrik	---	50	20	0.2-0.3	---
Jelete	2[g]	8	---	0.4	245
Oroken	0.5[h]	3.5	---	0.26	145

Sources and Notes:

[a]Reference C.1.7.2.

[b]Reference C.1.7.1.

[c]Reference C.1.3.1317.

[d]At 200 feet (about 60 meters) altitude south of Bikini.

[e]Eneu had fallout from H+28 to H+40, peak 0.12 R/hr.

[f]On shore, west tip next to crater. 0.45 R/hr at D+4 (Reference C.1.3.1307).

[g]At 20 feet (6 meters) altitude.

[h]At 1,000 feet (about 300 meters) altitude.

Wilson 1 conducted a survey beginning at H+6 in a 20° sector bearing 75° to 90° with an apex at Rongerik and extending 480 km to the east. No radiation in excess of background was encountered. Wilson 2 flew the triangular Utirik-Wake-Enewetak survey at 3 km altitude at H+10 and H+18 and found no radiation in excess of background (Reference C.1.7.2). The maximum radiation levels were 0.32 R/hr at H+25 on YAG-39 and 7.2 R/hr at H+7 on YAG-40 (Reference C.1.3.1312).

Aerial monitoring flight Able (described in Chapter 2) flew at 60 meters altitude on D+1. Exposure rates above background, but less than 0.010 R/hr, were recorded at Kwajalein, Alinginae, Rongelap, Rongerik, Utirik, Bikar, and Tongi. Maximum fallout levels at some offsite monitoring stations are given in Table 17. Eneu experienced light fallout on D+1 with "average intensities" of about 0.005 R/hr (Reference C.1.7.2). Fallout began at about H+28 and continued until about H+40. The peak intensity was reported to be 0.012 R/hr. The swimming beach was closed for an unknown time because of lagoon contamination (Reference C.1.7.1). Enewetak is also reported to have received "very light fallout" on D+1, but the exposure rates were not given (Reference C.1.7.2).

Table 17. ZUNI contamination (R/hr) at offsite islands, REDWING.

		Location			
Date	Time	Rongerik	Utirik	Wotho	Ujelang
29 May	0800	0.003	---	---	---
	1200	0.006	0.00003	---	0.00001
	1800	0.013	---	0.0003	0.00010
	2200	0.012	0.00003	0.0012	0.00012
30 May	0400	---	---	0.006	---
	0600	0.010	0.00003	0.0045	---
	0800	---	---	0.0045	0.00025
	1200	0.009	0.00003	0.0045	0.00024
	1800	---	0.00003	0.0045	---
	2400	0.008	0.00003	0.004	---

FLATHEAD

The FLATHEAD shot, a device developed by LASL, was detonated on a barge located about 0.4 km south of Iroij Island in the vicinity of the UNION crater at 0626, 12 June 1956.

The DOD scientific experiments for FLATHEAD are listed below.

- Program 1 -- Blast Effects: Project 1.9

- Program 2 -- Nuclear Radiation: Projects 2.1, 2.2, 2.4, 2.62, 2.63, 2.64, 2.65, 2.66, 2.71, 2.8, 2.9, 2.10
- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4, 6.5
- Program 8 -- Thermal Radiation: Project 8.5
- Program 9 -- Photography: Project 9.1.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and ships of the task force are shown in Figure 41.

There were 32 aircraft participating. Seven effects aircraft and four B-57 sampler (Reference C.1.1F) aircraft participated. Table 18 gives the locations at shot time for the effects aircraft listed. One of the F-84Fs and the F-101A were directly over surface zero at detonation time.

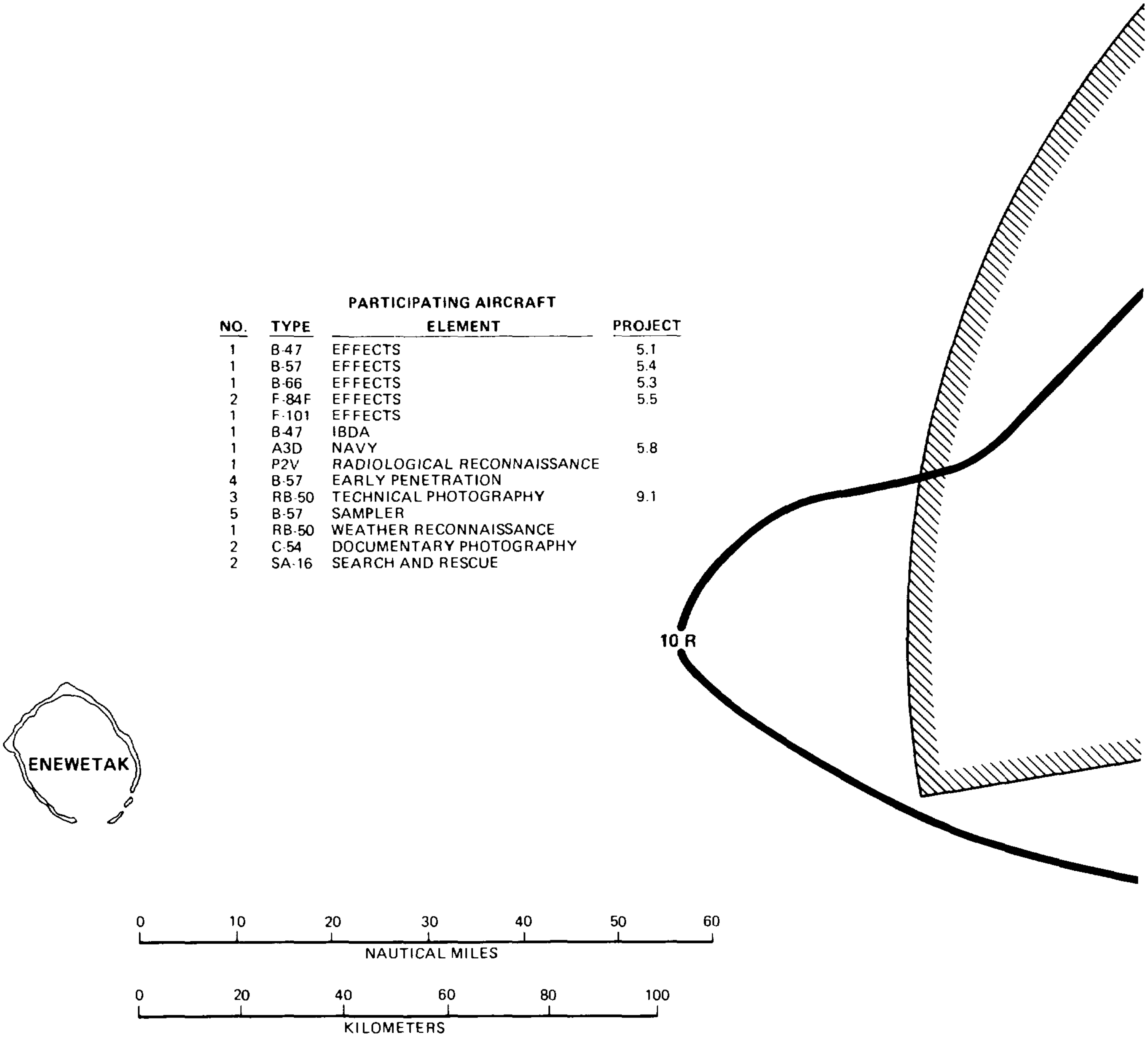
Surface and air radex areas were:

Surface to all altitudes: (H-hour to H+1)	Within 10 nmi (18.5 km) of Bikini
Surface to all altitudes: (H-hour to H+6)	Bearing 260° to 20°T; 100-nmi (185-km) range.

The estimated cloud height was 60,000 feet (18 km). The middle and upper portions of the cloud moved to the northeast; the lower cloud and the stem moved to the west at 15 knots (28 km/hr). An early-penetration B-57 (Project 2.66) made one flight through the cloud at H+49 minutes. The average exposure rate was about 120 R/hr with a maximum of 240 R/hr.

FLATHEAD heavily contaminated the northern islands of Bikini. The exposure rate at H+4 was from 20 to 40 R/hr between Bokbata and Lomilik. No radiation was reported from Eneu, and neither recovery operations nor preparations for the next shot were delayed by the fallout (Reference C.1.7.1).

Reentry hour was 0830, 12 June, based on aerial monitoring by the P2V aircraft. The initial radsafe survey began at H+3 and reported that fallout was still occurring over the reef and lagoon in the vicinity of Iroij. A complete helicopter survey was made at H+7 to H+8. Results of these surveys and later Bikini surveys are shown in Table 19.



PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-47	EFFECTS	5.1
1	B-57	EFFECTS	5.4
1	B-66	EFFECTS	5.3
2	F-84F	EFFECTS	5.5
1	F-101	EFFECTS	
1	B-47	IBDA	
1	A3D	NAVY	5.8
1	P2V	*RADIOLOGICAL RECONNAISSANCE*	
4	B-57	EARLY PENETRATION	
3	RB-50	TECHNICAL PHOTOGRAPHY	9.1
5	B-57	SAMPLER	
1	RB-50	WEATHER RECONNAISSANCE	
2	C-54	DOCUMENTARY PHOTOGRAPHY	
2	SA-16	SEARCH AND RESCUE	

Figure 41. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for FLATHEAD, REDWING. Heavy line defines a predicted fallout area of 10-roentgen infinite gamma exposure. Ship positions are shot time except YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall), and USS Crook County (LST-611), which are positions at times of maximum fallout activity.

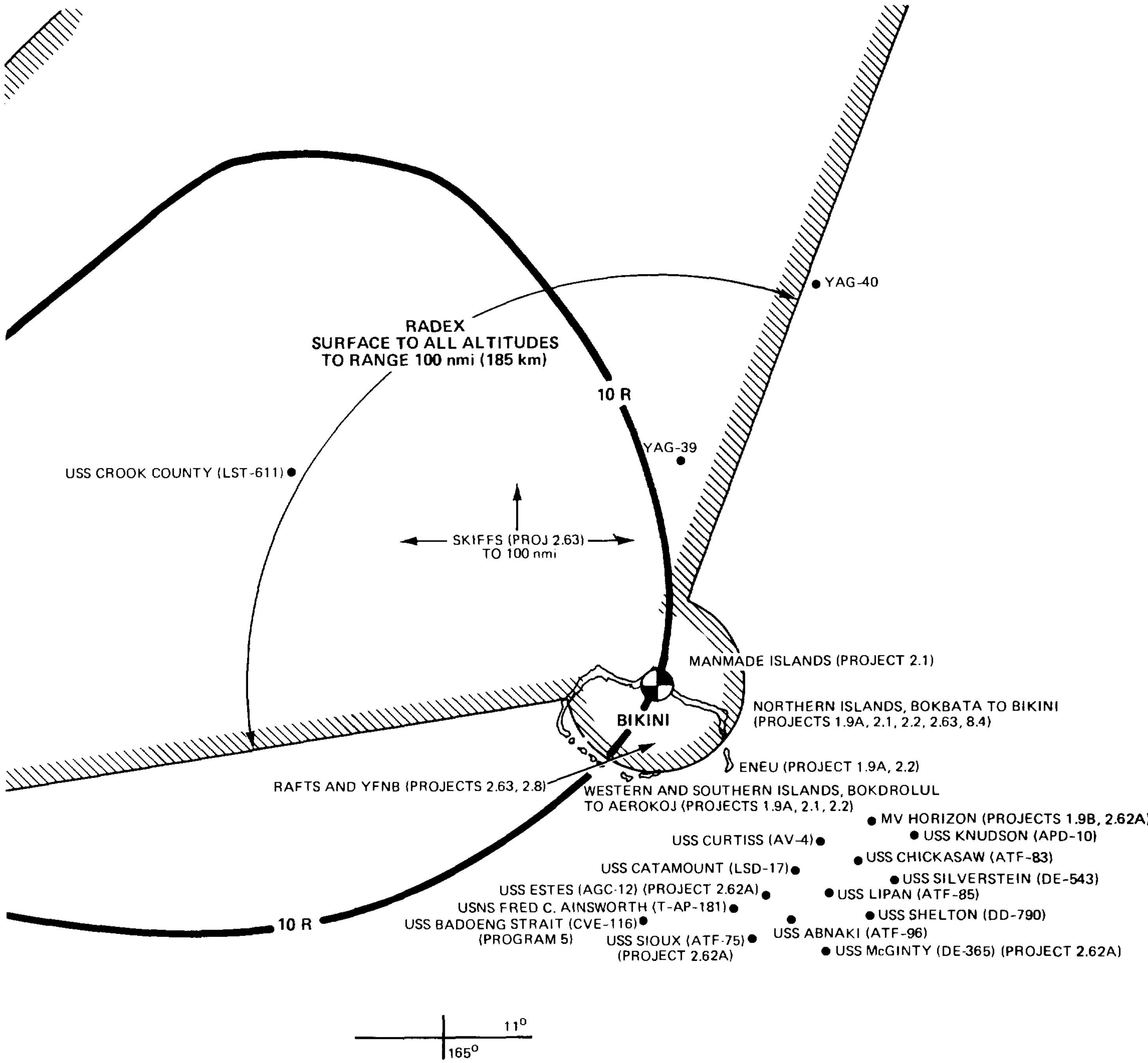


Figure 41. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for FLATHEAD, REDWING. Heavy line defines a predicted fallout area of 10-roentgen infinite gamma exposure. Ship positions are shot time except YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall), and USS Crook County (LST-611), which are positions at times of maximum fallout activity. (continued)

Table 18. H-hour positions of effects aircraft, FLATHEAD, REDWING.

	A3D	F-84F	F-84F	B-47E	B-66	B-57B[a]	F-101A[b]
Direction from burst (°)	---	000	220	000	118	---	304
Slant range (km)	3.9	6.4	13.5	11.6	7.7	8.8	8.2
Altitude (km)	4.3	6.4	5.5	11.6	5.5	7.9	8.2
Heading (°)	---	122	097	303	118	119	124

Notes:

[a]B-57B pilot and engineer received no radiation exposure.

[b]F-101A pilot received no gamma radiation.

Table 19. Summary of Bikini radiological surveys after FLATHEAD, REDWING.

	Survey Reading (R/hr) (on ground except as noted)				Unshielded Exposure (R)
Island	H+3[a]	H+7-8[a,b]	D+1[c]	D+3[c]	H+76[d]
Bokbata	---	4.5	1.05	0.465	528
Nam	---	5.0	1.925	0.785	665
Iroij	30	7.0	1.815	0.875	1,180
Lomilik	---	5.5	1.225	0.530	1,100
Aomen	10	2.5	0.665	0.320	375
Bikini	10	0.006	0.010	0.010	---
Eneu	---	---	---	---	---
Aerokoj	---	0.025	0.018	0.014	---
Lele	---	---	0.045	0.040	---
Eneman	---	0.500	0.900	0.600	---
Jelete	---	0.018	0.020	0.020	---
Oroken	---	0.020	0.010	0.010	---

Sources and Notes:

[a]Reference C.1.7.2.

[b]At 25 feet (8 meters) altitude.

[c]Reference C.1.7.1.

[d]Reference C.1.3.1317.

The Wilson 1 cloud-track aircraft flew a sector bearing 30° through 60° with an apex on Bikini. The flight began at H+6 and returned via Utirik and Rongerik. Wilson 1 also encountered exposure rates of 0.01 to 0.05 R/hr to the north and west of Bikini. The Wilson 2 flight between Enewetak, Utirik, and Wake at H+10 to H+18 reported exposure rates above background but less than 0.01 R/hr throughout the flight, indicating a general smearing of the debris by variable winds at various levels. Radiation above background was reported by Wilson 2 south of Bikini, at Rongelap, Rongerik, Utirik, southeast of Wake and northwest and west of Wake (Reference C.1.7.2). The maximum exposure rate reported on the YAGs was 0.15 R/hr at H+11 for YAG-39 and 0.25 R/hr at H+17 for YAG-40 (Reference C.1.3.1312).

No increase in background radiation was reported by the off-atoll monitoring stations (Reference C.1.7.2).

The lagoon waters of Bikini were contaminated by FLATHEAD. Most of the lagoon showed elevated readings on the shot day, with surface waters in the vicinity of the shot being between 0.150 and 3 R/hr. After 7 days, readings of 0.002 R/hr on the surface and at a depth of 30 meters were obtained in the northern portion of the lagoon. Areas still read 0.002 R/hr in the northwest quadrant of the lagoon after 11 days. The swimming beach on Eneu was closed because of this contamination.

DAKOTA

DAKOTA, provided by LASL, was detonated at 0606, 26 June 1956, on a barge 0.4 km south of Iroij Island in the UNION crater.

The DOD scientific experiments are listed below.

- Program 1 -- Blast Effects: Project 1.9
- Program 2 -- Nuclear Radiation: Project 2.66
- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4, 6.5
- Program 9 -- Photography: Project 9.1.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 42.

PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-47	EFFECTS	5.1
1	B-52	EFFECTS	5.2
1	B-57	EFFECTS	5.4
1	B-66	EFFECTS	5.3
2	F-84F	EFFECTS	5.5
1	F-101	EFFECTS	
1	A3D	NAVY	5.8
3	P2V	RADIOLOGICAL RECONNAISSANCE	
5	B-57	SAMPLER	
6	F-84G	SAMPLER	
1	SA-16	SEARCH AND RESCUE	

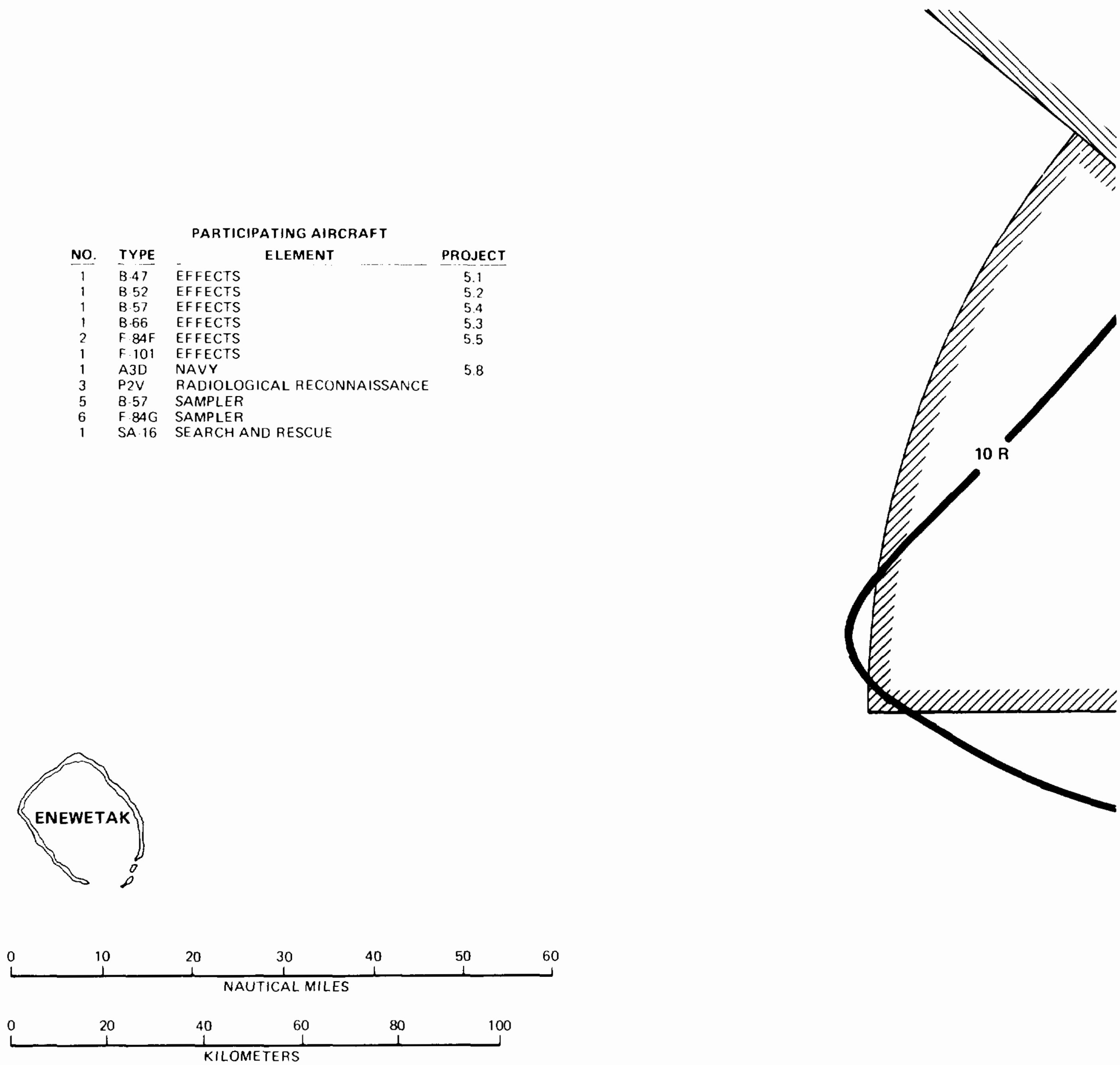


Figure 42. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for DAKOTA , REDWING. Heavy line defines a predicted fallout area of 10-roentgen infinite gamma exposure. Ship positions are shot time except YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall), and USS Crook County (LST-611), which are positions at times of maximum fallout activity.

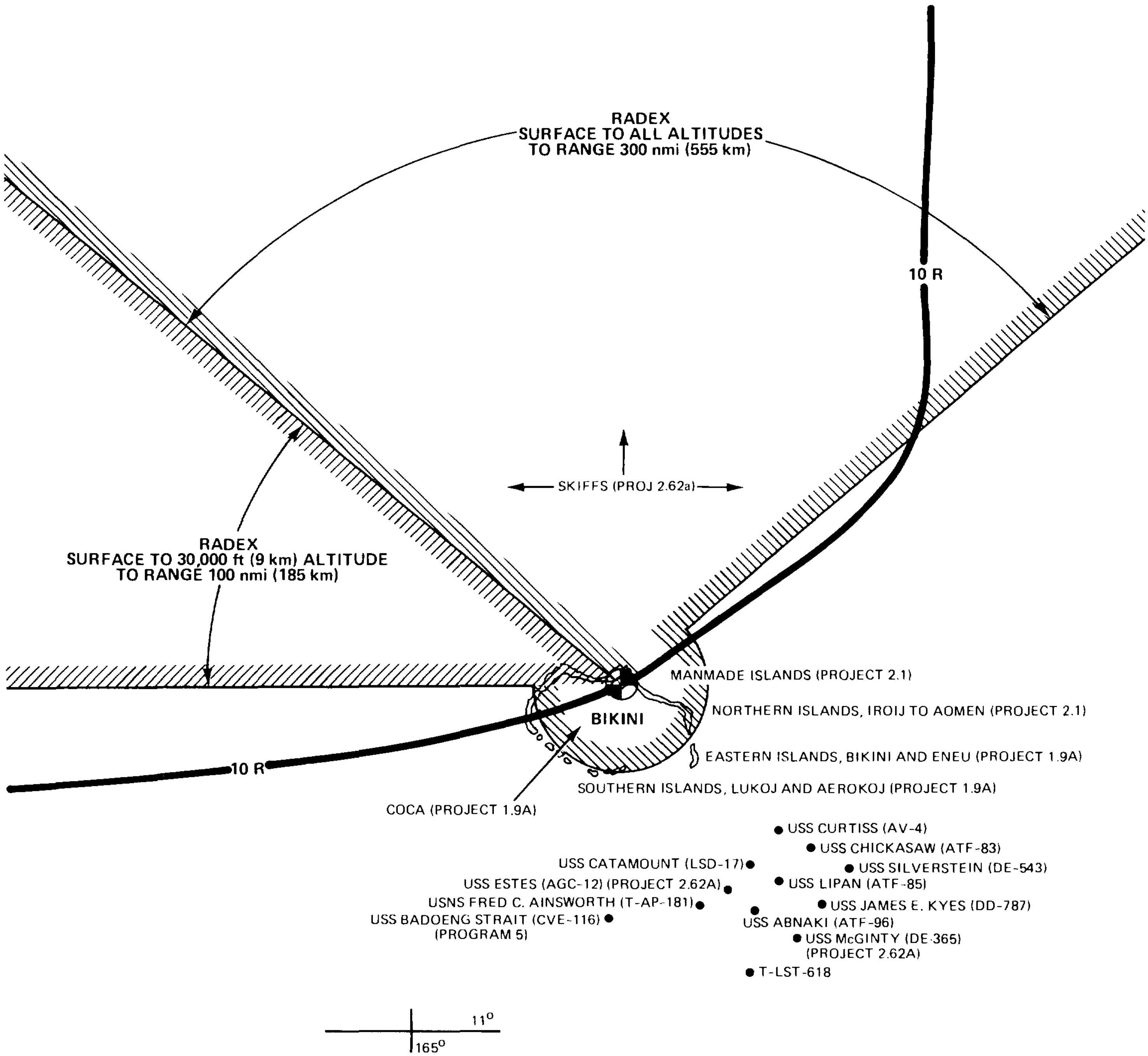


Figure 42. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for DAKOTA, REDWING. Heavy line defines a predicted fallout area of 10-roentgen infinite gamma exposure. Ship positions are shot time except YAG-39 (<u>USS George Eastman</u>), YAG-40 (<u>USS Granville S. Hall</u>), and <u>USS Crook County</u> (LST-611), which are positions at times of maximum fallout activity. (continued)

A total of 33 aircraft participated in this shot (Reference C.4.2). Seven effects aircraft and eight sampling aircraft were aloft. One B-57 controller guided the samplers (Reference C.4.3). Table 20 lists the effects aircraft positions.

The B-52 was diverted to Hickam after the shot because of possible blast damage to flaps, brakes, or brake chute that would make its landing at Enewetak impossible.

Table 20. H-hour positions of effects aircraft, DAKOTA, REDWING.

	F-84F	F-84F	B-47E	B-66	B-57B	F-101A	B-52
Direction from burst (^{o})	289	225	000	127	---	299	---
Slant range (km)	6.2	14	7.9	4.9	7.5	7.9	7.5
Altitude (km)	6.2	7.1	7.3	3.1	5.4	7.9	6.7
Heading (^{o})	120	095	270	127	119	119	---

Sources: F-84 aircraft (Reference C.1.3.1331)
B-47E aircraft (Reference C.1.3.1327)
B-66 aircraft (Reference C.1.3.1329)
B-57B aircraft (Reference C.1.3.1330)
F-101A aircraft (Reference C.1.3.1332)
B-52 aircraft (Reference C.1.3.1328)

Surface and air radex areas, based on prediction, in force from H-hour to H+6 were:

Surface to 30,000 feet (9 km) altitude	Bearing 270^{o} to 310^{o}T; 100-nmi (185-km) range
Surface to all altitudes:	Bearing 310^{o} to 50^{o}T; 200-nmi (370-km) range.

Height to the top of DAKOTA's cloud was 81,000 feet (24.7 km). Diameter at stabilization was 93,000 feet (28.3 km). The upper portion of the cloud moved west-northwest, the middle cloud east-northeast, and the bottom cloud and stem northwest. The upper umbrella of the cloud extended almost from Bikini to Enewetak, and sampling aircraft returning to Enewetak at higher altitudes encountered patches of radioactive material. Bikini radiological surveys are summarized for DAKOTA in Table 21.

Table 21. Summary of Bikini radiological surveys after DAKOTA, REDWING.

	Survey Reading on Ground (R/hr)				
Island	H+1.5[a]	H+3[b]	H+8[b]	D+1[c]	D+2[c]
Bokbata	---	---	0.900	0.270	0.165
Nam	---	---	1.200	0.660	0.195
Iroij	---	3.000	1.400[d]	0.565	0.170
Lomilik	---	---	0.048[d]	0.325	0.060
Aomen	---	0.100	---	---	0.038
Bikini	0.002	0.010	0.003	0.004	0.004
Eneu	0.0002	---	---	---	---
Aerokoj	0.003	---	0.025	0.025	0.015
Lele	---	---	---	0.030	0.015
Eneman	0.050	---	0.700	0.700	0.260
Jelete	---	---	0.010	0.010	0.010
Oroken	---	---	0.016	0.015	0.015

Sources:

[a]From Zebra P2V at 200 feet (61 meters) (Reference C.1.7.2).

[b]From helicopter at 30 feet (9 meters) (Reference C.1.7.2).

[c]Reference C.1.7.1.

[d]Reading at 10 feet (3 meters).

The highest exposure rate encountered by a sampling aircraft was about 150 R/hr. That plane penetrated the cloud at 50,000 feet (15.3 km), and the pilot received 7.5 R in the cloud and about 1.3 R on the return flight. Planes penetrating at lower altitudes encountered considerably lower levels of radiation.

The Marine helicopter squadron (HMR-363) providing airlift for data recovery and survey operations noted that in "the immediate area surrounding ground zero . . . a very low intensity fine dust and atomized water . . . of about 20 mR/hr. . . . The pilots and personnel embarked in the aircraft were found to be reading 30-40 mR/hr." (Reference C.3.1.4, p. 72).

Wilson 1 WB-50 cloud-tracking aircraft working in a sector defined by Enewetak in the west, Taongi in the northeast, and Utirik due east recorded readings in the 0.002 to 0.020 R/hr range 6 to 8 hours after the shot at an altitude of about 10,000 feet (3 km). Over Bikini the reading was only background at H+6 but at H+11 on its return to Enewetak, Wilson 1 recorded a reading of 0.110 R/hr about one-third of the way between Bikini and Enewetak at an altitude of 9,600 feet (2.9 km).

The Wilson 2 WB-50 cloud tracker covering the same area except going as far north as Wake, outbound from Enewetak in the west, starting at about H+10 had readings less than 0.0005 R/hr over Bikini, Rongelap, Utirik, and Bikar. On the northernmost portion of the flight over Wake, 0.0002 R/hr was recorded at about H+12. On the return flight over the same path readings similar to those outbound values were noted. The flight was at about 10,000 feet (3 km).

Flight Able, the WB-50 tracker flying the D+1 AEC New York Operations Office Marshall Island survey made the following readings at lower altitudes: Taongi, 0.015 to 0.020 R/hr at an altitude of 1,000 feet (305 meters); Utirik, 0.025 R/hr at an altitude of 500 feet (153 meters). Jemo had no radiation at 400 feet (122 meters), nor did Kwajalein at 100 feet (31 meters).

Ground level readings at Parry Island at Enewetak were less than 0.00025 R/hr during shot day with two periods of higher readings of 0.003 to 0.004 R/hr during late afternoon and early evening hours.

NAVAJO

The LASL NAVAJO experimental device was exploded on a barge 0.4 km south of Iroij Island in the vicinity of the UNION crater at 0556 on 11 July 1956.

The DOD scientific experiments for NAVAJO are given below.

- Program 1 -- Blast Effects: Project 1.9
- Program 2 -- Nuclear Radiation: Projects 2.1, 2.2, 2.61, 2.62, 2.63, 2.64, 2.65, 2.66, 2.71, 2.8, 2.9, 2.10
- Program 4 -- Biological Effects: Project 4.1
- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.5, 5.6, 5.7, 5.8

- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4, 6.5
- Program 9 -- Photography: Project 9.1.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are given in Figure 43.

Thirty-five aircraft participated in the shot. Two of the fifteen effects aircraft scheduled to participate (the B-66 and B-57) aborted the mission. Known positions of the effects aircraft at burst time are given in Table 22.

Nonmission TG 7.4 aircraft (H-19s and L-20s) supported TG 7.1 personnel. TG 7.4 aircraft ferried 38 persons on D-day, 20 on D+1, and 25 on D+2. At H+3, two H-19s were used to retrieve animals exposed to the detonation (Reference C.1.1N). Also, an H-19 was used to check the rocket launching station at H+3.

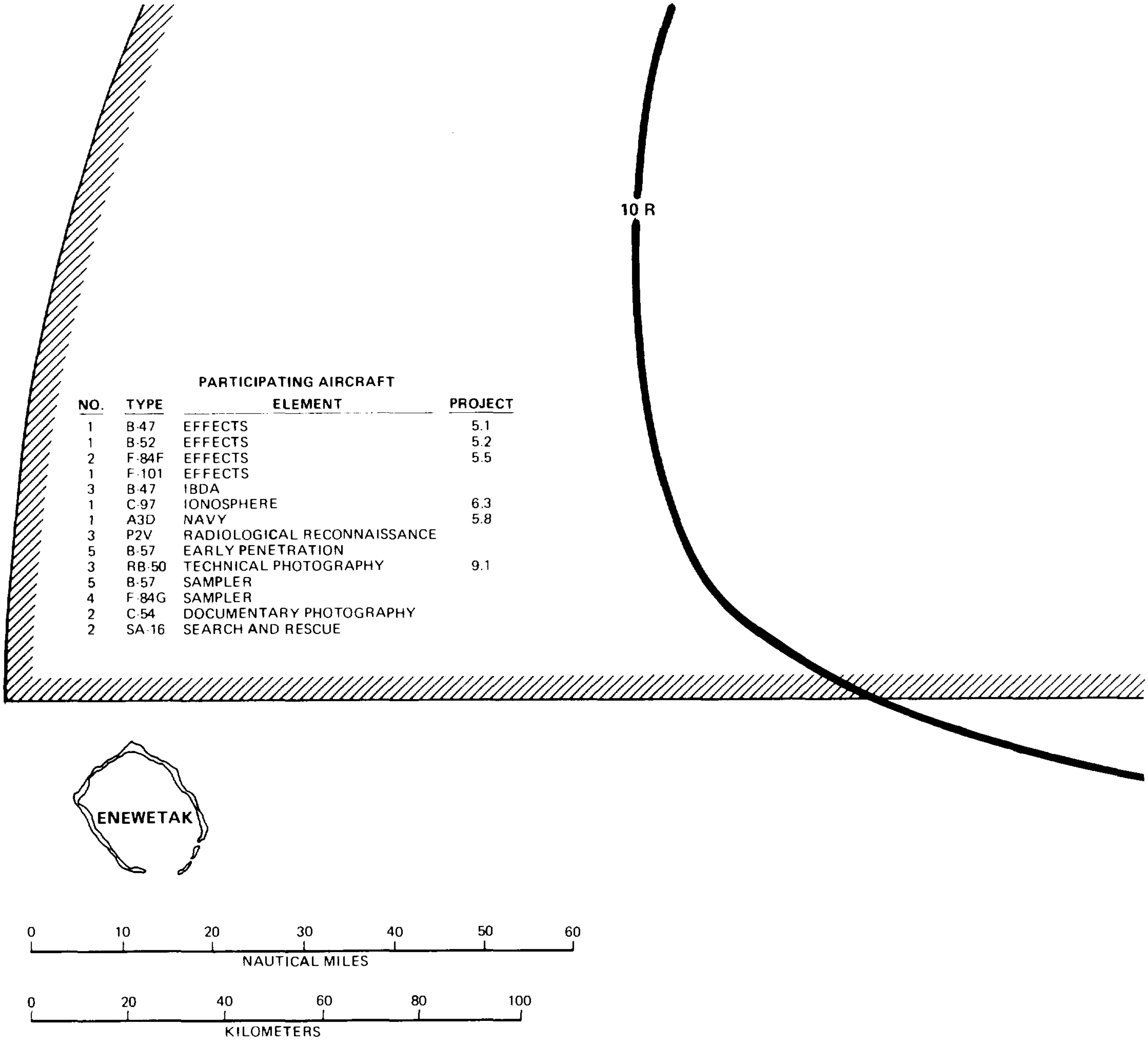
Surface and air radex areas, established on the basis of FOPU predictions, were:

Surface to all altitudes: (H-hour to H+1)	Within 10 nmi (18.5 km) of Bikini
Surface to all altitudes: (H-hour to H+6)	Bearing 260° to 360°T; 200-nmi (370-km) range.

The NAVAJO cloud stabilized at an altitude of 103,000 feet (31 km) with a diameter of 140,000 feet (43 km). The lower and upper portion moved to the west while the middle cloud moved east-northeast.

The initial radsafe survey began at H+3 and a second survey at H+5. No contamination was noted at Eneu or the fleet anchorage. The northern portion of the atoll experienced contamination levels of 5 to 8 R/hr at H+5 (Reference C.1.7.2). Bikini radiological surveys are shown in Table 23. Measured radiation levels did not present an obstacle to recovery operations.

Six early cloud penetrations were made by Project 2.66 B-57s at H+22 to H+38. In-cloud exposure rates to about 60 R/hr were noted. YAG-39 recorded a maximum contamination level of 1.3 R/hr at H+5, and YAG-40 experienced 0.110 R/hr at H+13 (Reference C.1.3.1312).



PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-47	EFFECTS	5.1
1	B-52	EFFECTS	5.2
2	F-84F	EFFECTS	5.5
1	F-101	EFFECTS	
3	B-47	IBDA	
1	C-97	IONOSPHERE	6.3
1	A3D	NAVY	5.8
3	P2V	RADIOLOGICAL RECONNAISSANCE	
5	B-57	EARLY PENETRATION	
3	RB-50	TECHNICAL PHOTOGRAPHY	9.1
5	B-57	SAMPLER	
4	F-84G	SAMPLER	
2	C-54	DOCUMENTARY PHOTOGRAPHY	
2	SA-16	SEARCH AND RESCUE	

Figure 43. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for NAVAJO, REDWING. Heavy line defines a predicted fallout area of 10-roentgen infinite gamma exposure. Ship positions are shot time except YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall), and USS Crook County (LST-611), which are positions at times of maximum fallout activity.

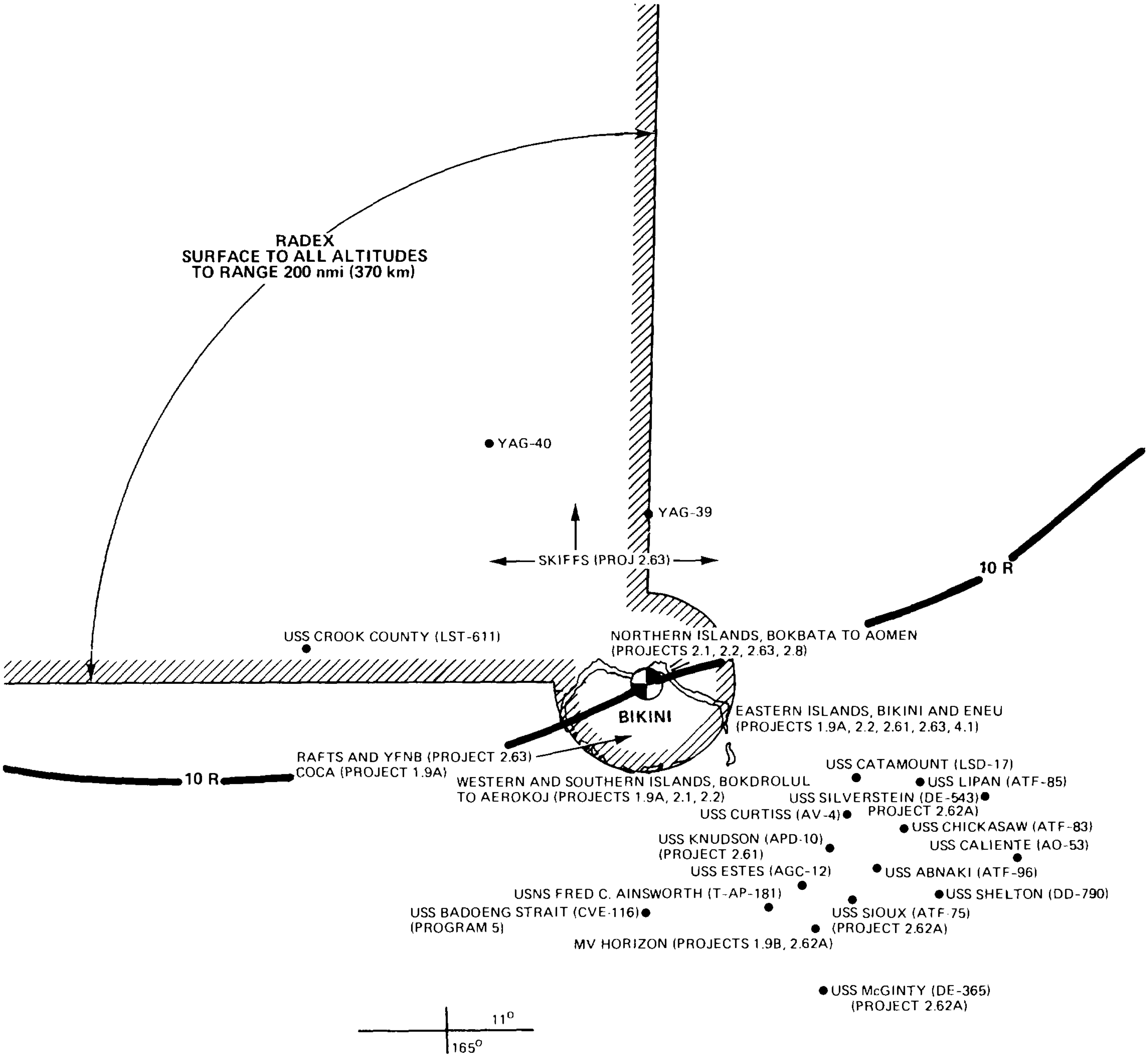


Figure 43. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for NAVAJO , REDWING. Heavy line defines a predicted fallout area of 10-roentgen infinite gamma exposure. Ship positions are shot time except YAG-39 (<u>USS George Eastman</u>), YAG-40 (<u>USS Granville S. Hall</u>), and <u>USS Crook County</u> (LST-611), which are positions at times of maximum fallout activity. (continued)

Table 22. H-hour positions of effects aircraft, NAVAJO, REDWING.

	A3D	F-84F	F-84F	B-47E	F-101A[a]	B-52
Direction from burst (°)	---	124	205	360	307	---
Slant range (km)	8	9.2	29.3	12.5	8.7	12.8
Altitude (km)	11	5.2	9.8	10.4	4.5	11.6
Heading (°)	---	120	033	270	122	---

Note:

[a]F-101A pilot received 0.03 R.

Table 23. Summary of Bikini radiological surveys after NAVAJO, REDWING.

	Survey Reading (R/hr) (on ground except as noted)				Unshielded Exposure (R)
Island	H+3-5[a]	H+7-8[b]	D+1[c]	D+2[c]	H+48[d]
Bokbata	---	6.2	0.62	0.25	310
Nam	---	6.0	0.7	0.45	108
Iroij	5.5	8.0	0.9	0.26	228
Lomilik	---	6.0	0.7	0.20	180
Aomen	2.4	4.5	---	---	---
Bikini	1.5	0.11	0.05	0.01	---
Aerokoj	---	background	0.005	0.005	---
Lele	---	---	0.015	0.015	---
Eneman	---	---	0.010	0.050	---
Jelete	---	---	0.015	0.015	---
Oroken	---	---	0.035	0.035	---

Sources:

[a]Helicopter survey at 15 to 25 feet (4.5 to 7.6 meters) altitude (Reference C.1.7.2).

[b]Detailed survey (Reference C.1.7.2).

[c]Reference C.1.7.1.

[d]Reference C.1.3.1317.

An increase in the radioactive level was detected on Parry Island, Enewetak, in the early afternoon of NAVAJO shot day. This persisted for only 2 hours before dropping back to the previous reading. Parry readings (R/hr) on D+1 (11 July) are listed below (Reference C.1.7.2):

Time	Reading	Time	Reading
0652	0.00052	1600	0.0018
1435	0.00052	1615	0.0015
1450	0.00094	1630	0.001
1500	0.0015	1645	0.00058
1520	0.002	1700	0.00052
1545	0.0018	1715	0.00052
		1800	0.00052

On 12 July at 0800 the reading was 0.00043 R/hr.

During this same period, Ujelang to the southwest recorded a steady background of 0.00005 R/hr. Wotho to the southeast of Bikini and Utirik to the east were steady at about 0.00010 R/hr. Rongerik's background was zero during this same period (Reference C.1.7.2).

TEWA

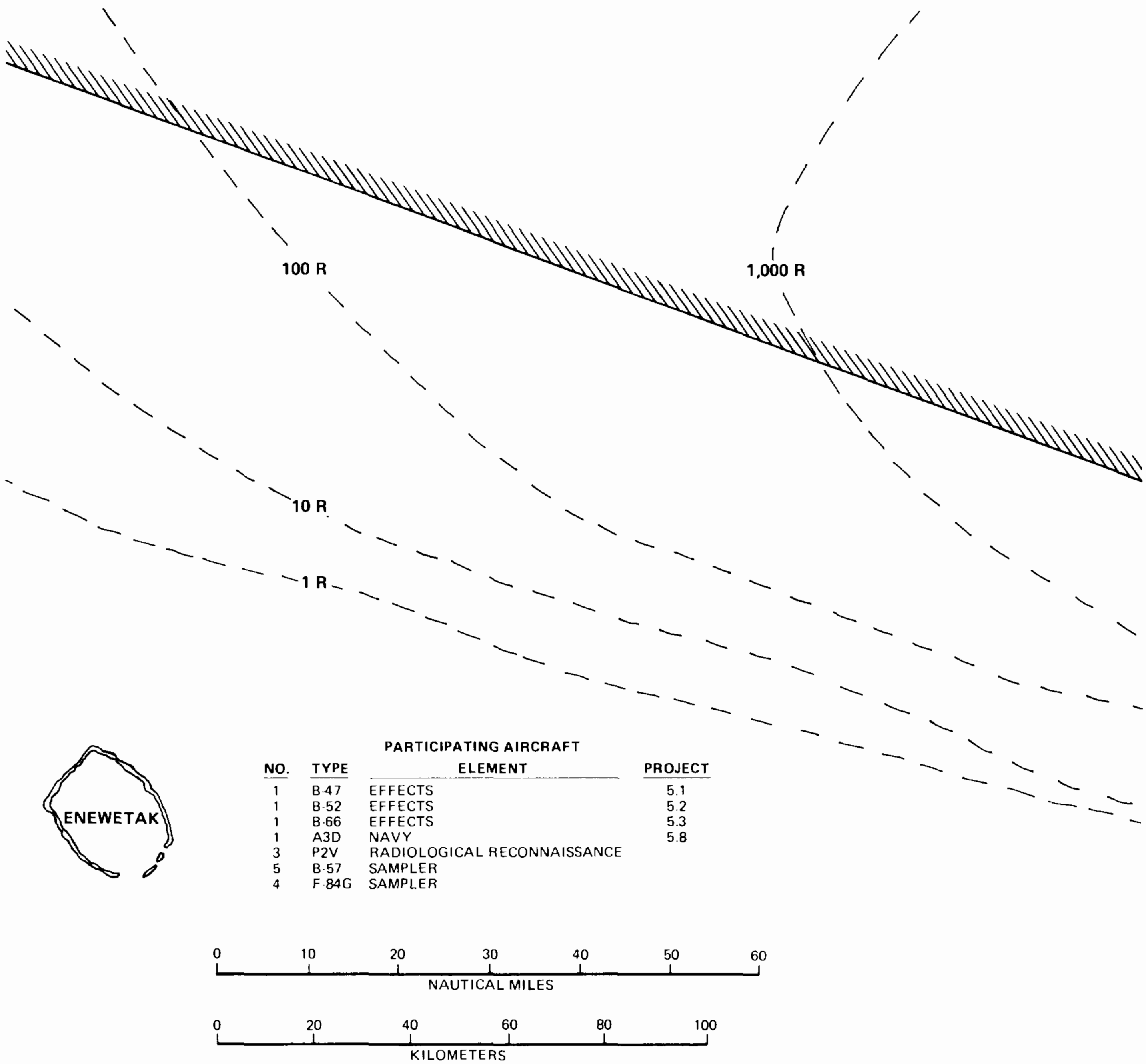
The UCRL 5-MT TEWA device was fired on a barge anchored on the reef west of Iroij Island on 21 July 1956.

The DOD scientific experiments for TEWA are listed below.

- Program 2 -- Nuclear Radiation: Projects 2.1, 2.61, 2.62, 2.63, 2.64, 2.65, 2.66, 2.71, 2.72, 2.8, 2.9, 2.10
- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.7, 5.8
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4, 6.5
- Program 9 -- Photography: Project 9.1.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 44.

Twenty-four aircraft, including three concerned with effects experiments and eight sampling aircraft, participated in the shot. Table 24 gives the known positions of the effects aircraft.



PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-47	EFFECTS	5.1
1	B-52	EFFECTS	5.2
1	B-66	EFFECTS	5.3
1	A3D	NAVY	5.8
3	P2V	RADIOLOGICAL RECONNAISSANCE	
5	B-57	SAMPLER	
4	F-84G	SAMPLER	

Figure 44. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for TEWA, REDWING. Dashed lines define predicted fallout areas (infinite gamma exposure, roentgens). Ship positions are shot time except YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall), and USS Crook County (LST-611), which are positions at times of maximum fallout activity.

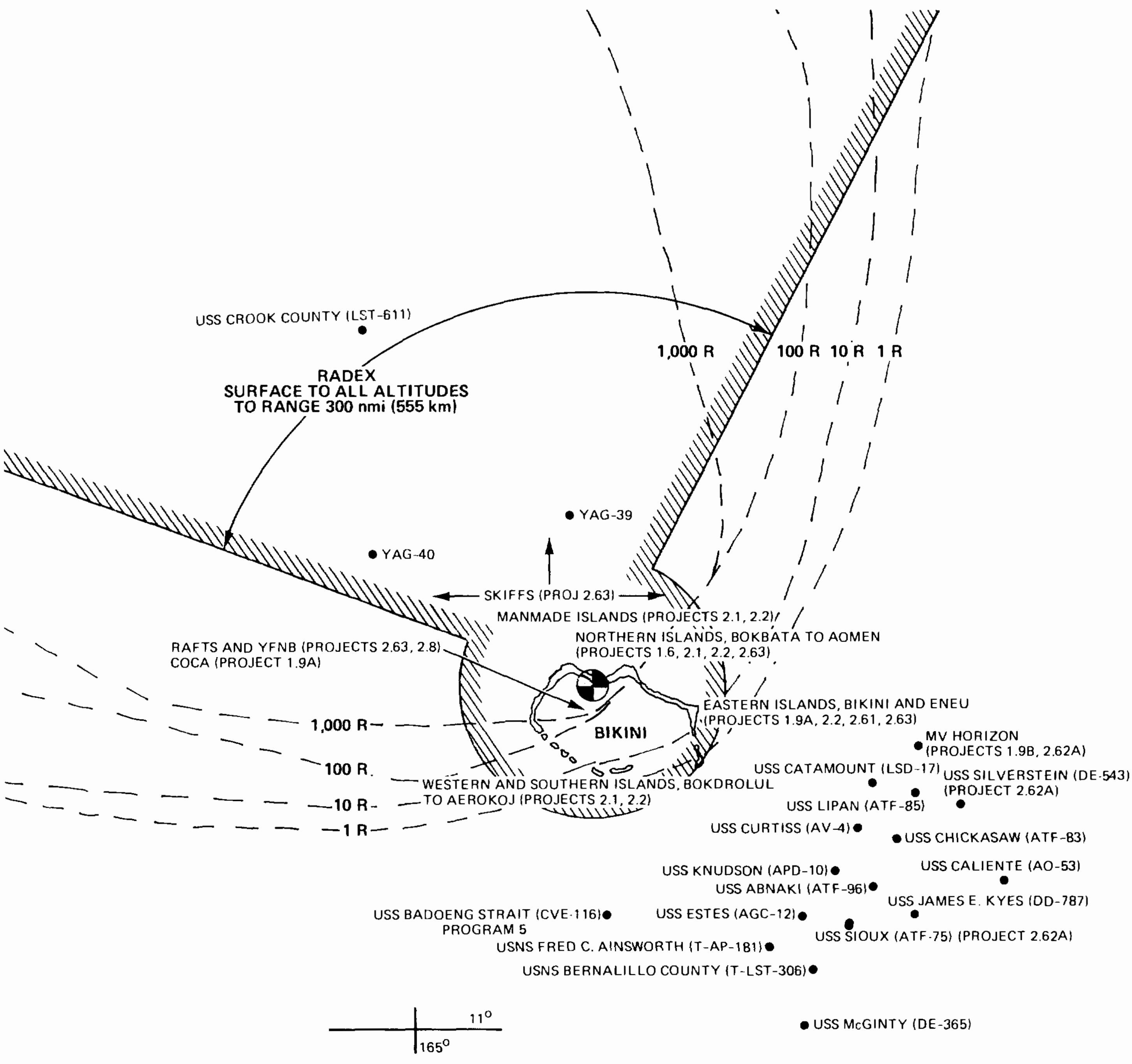


Figure 44. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for TEWA, REDWING. Dashed lines define predicted fallout areas (infinite gamma exposure, roentgens). Ship positions are shot time except YAG-39 (USS George Eastman), YAG-40 (USS Granville S. Hall), and USS Crook County (LST-611), which are positions at times of maximum fallout activity. (continued)

Table 24. H-hour positions of effects aircraft, TEWA, REDWING.

	A3D	B-47E	B-66	B-52
Direction from burst (^{o})	---	000	121	---
Slant range (km)	9.1	13.8	10.0	14.9
Altitude (km)	11.1	10.4	5.8	12/5
Heading (^{o})	---	270	121	---

The air radex areas effective from H-hour to H+6 enclosed an area bearing 290^{o} to 30^{o}T from the surface to all altitudes to a range of 300 nmi (555 km). The surface radex was an area around ground zero with a radius of 15 nmi (28 km) from H-hour to H+1.

The TEWA cloud reached 99,000 feet (30 km), with its base at about 30,000 feet (9 km). The lower 10,000 feet (3 km) of cloud moved to the east, but the stem and upper portion of cloud moved west toward Enewetak.

TEWA heavily contaminated the northern islands at Bikini. Bikini radsafe surveys began at H+4 and are summarized in Table 25. The southern islands (except Eneu) were also contaminated. Because of the heavy fallout, recovery and rollup were delayed.

Early-penetration sampling pilots received a maximum exposure of 3.1 R (Reference C.1.1T). The maximum contamination levels were 25 R/hr at H+4.5 on YAG-39, and 5.2 R/hr at H+7 on YAG-40 (Reference C.1.3.1312).

A slight change in predicted postshot winds caused a shift in TEWA fallout toward Enewetak. A small vortex that had not been forecast appeared over Bikini at shot time at the 30,000- to 40,000-foot (9- to 12-km) level, reducing appreciably the southerly component of the winds. This development had the effect of bringing the "hot" line counterclockwise to about 290^{o} and placing Enewetak in the fringe of the fallout pattern. Figure 45 is a photograph of the TEWA cloud approaching Enewetak backlit by the morning sun.

As the cloud approached Enewetak it was carefully monitored by as many as four aircraft. Cloud track results from the WB-50 Wilson aircraft noted a

Table 25. Summary of Bikini radiological surveys after TEWA, REDWING.

	Survey Reading (R/hr) (on ground except as noted)		
Island	H+4[a]	D+1[b]	D+2[b]
Bokbata	---	18[c]	10d
Nam	---	20[c]	10d
Iroij	50	7.5[c]	4.5[d]
Lomilik	---	---	3.5[d]
Aomen	30	4.500[d]	4[d]
Bikini	0.25	0.150	0.050
Eneu	---	---[e]	---
Aerokoj	0.060	0.30	0.015
Lele	---	0.060[d]	0.075
Eneman	---	0.100[d]	0.100
Jelete	50	2.5[d]	1.4[d]
Oroken	---	4.2[d]	2.6[d]

Sources:

[a]At 25 feet (7.6 meters) altitude (Reference C.1.7.2).

[b]Reference C.1.7.1.

[c]At 5 feet (1.5 meters).

[d]At 10 feet (3.1 meters).

[e]At H+18 Eneu had fallout reading of 0.004 R/hr (Reference C.1.7.1).

Figure 45. TEWA cloud viewed from Enewetak Atoll, REDWING.

number of contacts with the radioactive cloud between Bikini and Enewetak and over both atolls. A cloud track WB-50 coming eastward at 10,000 feet (3.1 km) altitude toward Bikini first noted a low reading about 90 nmi (165 km) due west of Bikini (about the halfway point) at about H+5. Twelve minutes later it recorded 0.120 R/hr 30 nmi west of Bikini. Just north of Bikini Island, the aircraft measured 0.100 R/hr 34 minutes later at 10,500 feet (3.3 km). Crossing the lagoon the aircraft measured 0.500 R/hr at 10,000 feet (3.1 km) at a point about 10 nmi (18.5 km) west of Bikini Atoll 8 minutes later. South 20 nmi (37 km) and slightly west of this point at the same altitude readings had dropped to 0.150 R/hr. The aircraft then headed westward toward Enewetak and at about the point at which it had noted 0.00005 R/hr almost exactly 1 hour before it now read 0.160 R/hr, albeit at an altitude 500 feet (153 meters) lower. The aircraft then proceeded westward to a point about 30 nmi (56 km) south of Parry, at which it read 0.040 R/hr at 10,000 feet. A reading of

0.040 R/hr was taken south of Bikini 45 minutes later at 10,000 feet (3.1 km). This was about 190 nmi (350 km) due east of the last mentioned reading and may not have been made by the same WB-50.

At H+11 a WB-50 tracker observed radioactivity about 50 nmi (93 km) due south of Parry at 10,000 feet (3.1 km). Probably the same flight proceeded eastward and noted readings of 0.040 to 0.090 R/hr about 30 nmi (56 km) south of Bikini at H+12. At the same time other readings at the same altitude, 50 nmi (93 km) southwest of Bikini, showed 0.090 R/hr. The flight proceeded eastward to a point about 50 nmi (93 km) north and slightly east of Rongerik where it read 0.035 R/hr at 10,500 feet (3.3 km) altitude. On its return toward Enewetak, the flight registered 0.050 R/hr at 8,000 feet (2.4 km) altitude at the midway point between Bikini and Enewetak at about H+14.

Readings about 30 nmi (56 km) north of Enewetak and over the atoll itself at 10,000 feet (3.1 km) were 0.030 R/hr at H+12. At this same time readings north of Rongerik, 340 nmi (630 km) east of Enewetak, showed 0.035 R/hr at the same altitude. The cloud was at least this extensive. The recorded fallout on Ujelang (R/hr) is listed below (Reference C.1.7.2):

Date	Time	Reading	Date	Time	Reading
21 July	0700	0.00004	22 July	1500	0.0012
	1200	0.00004		1600	0.0015
	1600	0.00004		1800	0.0015
	2000	0.00004		1900	0.0012
	2300	0.00004		2000	0.0012
22 July	0000	0.00004		2100	0.0012
	1000	0.00004		2200	0.0012
	1100	0.00018		2300	0.0012
	1200	0.00037	23 July	0700	0.0015
	1300	0.00035		1200	0.0015
	1400	0.001			

Note that the Ujelang radiation log record does show an increase at about H+30, which may have been due to the arrival of the TEWA cloud. It may, however, signal the arrival of the cloud from the HURON event detonated 24 hours after TEWA in the MIKE crater at Enewetak.

Fallout on Enewetak commenced at approximately H+9. Two peak intensities in air concentrations were observed, as shown in Figure 46. The increase in the background was quite rapid, with a peak of 0.100 to 0.120 R/hr throughout Parry Island. The same intensities were noted for Enewetak Island, but no radiation was reported for other islands in the atoll (Reference D.3). During the fallout period, which lasted approximately 17 hours, several rain showers occurred; rain samples assayed showed counts in excess of 5,000,000 disintegrations per minute per liter. Puddles of rainwater, especially on the Enewetak runway and parking area, indicated activities up to ten times the general area level.

Three ships, Curtiss, Ainsworth, and Knudson, were dispatched from Bikini to Enewetak to be available for atoll evacuation if necessary.

In a teletype message to the Director of Military Applications of the AEC, on 27 July 1956 (Reference D.3) (6 days after the TEWA fallout incident), the acting commander of TG 7.1 described the situation confronting Curtiss during the trip from Bikini:

> Ainsworth, Curtiss, [and] Knudson ran into fallout while traveling to Enewetak for possible use in [an] emergency evacuation. [There is] no information on details for Ainsworth and Knudson. . . . Curtiss sailed with [the] ship buttoned up and activated [the] washdown equipment every fifteen minutes and all night long as he stood off [the atoll] southeast of Parry. By noon Sunday local time he had reduced background to about five Mike Roger/How Roger [mR/hr].

The acting commander went on to say that he currently had no further information on the other ships concerned.

The first of the ships to enter the lagoon was Curtiss. At 0651 the ship anchored at mooring C-1 at 0749. Ainsworth anchored in the lagoon at 0749 and the crew began decontaminating exposed surfaces on the ship at 0800. Beginning at 0825 and continuing for the next hour, the passengers on board Ainsworth left the ship for unspecified destinations. Knudson was last to anchor, entering the lagoon at 0753 and proceeding to mooring C-2 at 0825.

When USS Agawam (AOG-6) arrived at Enewetak in the early afternoon following the TEWA detonation, the Parry reading was about 0.040 R/hr. Agawam had

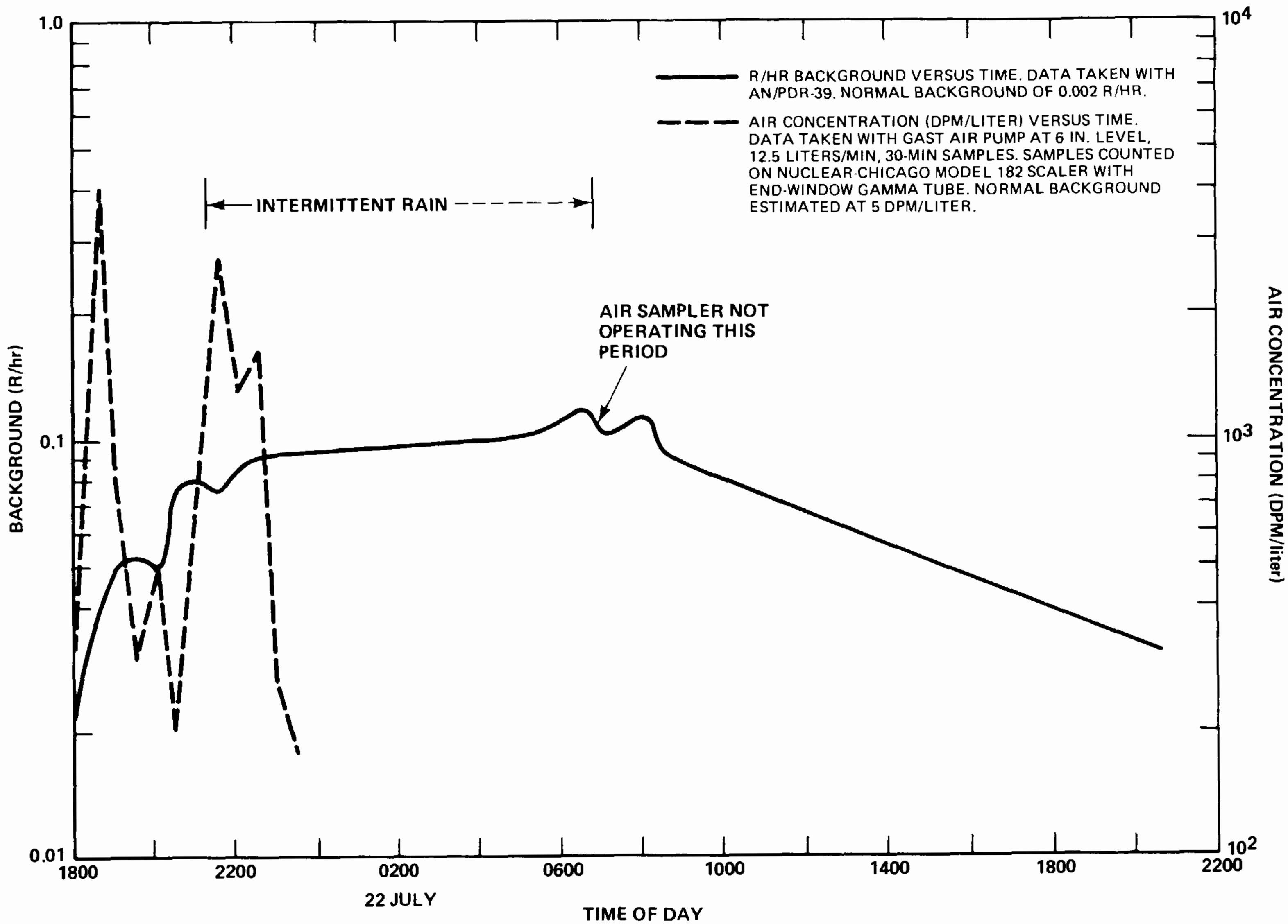


Figure 46. TEWA fallout on Parry, Enewetak Atoll, REDWING.

come from Guam and the last 90 nmi (165 km) had been a due north run. As the extent of the TEWA cloud in that direction is not defined, the extent of any exposure is not clear. Agawam log does not note the presence of fallout, the activation of washdown systems, or decontamination activities.

Heavy rain squalls throughout the fallout period probably increased the fallout rate by a large factor. They also tended to wash the radioactive particles from the roofs of buildings where personnel were billeted or worked but, at the same time, concentrated the contamination in the areas under the eaves of the buildings.

At a conference on the evening of 21 July at Hq JTF 7, it was decided:

1. Not to attempt evacuation until the gamma levels exceeded 0.250 R/hr and probably not before 0.500 R/hr
2. To secure the mess hall prior to the midnight feeding.

Initial estimates (Reference C.1.7.2) indicated that exposures of personnel would be "a probable maximum of 2.5 roentgens." Later estimates indicated about 10 R infinity dose (e.g., the exposed person remaining outdoors in the fallout field forever) and about 3 to 6 R actual exposure (Reference D.3).

JTF 7 later authorized raising the maximum permissible exposure from 3.9 R to 7 R for the REDWING operation. Under this waiver, it was not necessary to evacuate H&N personnel with high exposures to Eneu Island, Bikini Atoll. Prior to receiving this waiver, it had been planned to evacuate about 50 persons per day to Bikini and have others, who were necessary for recovery and rollup, live aboard LCUs anchored in the Enewetak Lagoon.

After the fallout, a survey was made of Parry, and work orders for decontamination of hot spots were initiated. Because of lack of equipment and personnel, however, little was accomplished until all recovery for the HURON detonation the morning of 22 July and some of the rollup was finished. Living quarters and the movie theater area were decontaminated. Owing to planned deactivation within 1 week, the tent area was not decontaminated.

Grading adjacent to barracks and offices reduced exposure rates by an average factor of three. At the outdoor theater, removal of the seats and removal of the top layer of dirt, with subsequent backfilling with clean dirt, reduced the gamma levels by a factor of about ten.

During the actual fallout period, personnel were requested to remain indoors as much as possible and to take full advantage of shower facilities. There was "no evidence of gross personnel contamination . . . as a result of this fall-out" (Reference C.1.3.1). Film badges located within aluminum buildings showed reduction to about 60 percent of outside integrated exposure. Exposure-rate survey meters indicated about 30 percent of the outside exposure at positions greater than 8 feet (2.4 meters) from interior building walls. Film badges worn by office workers indicated an exposure of about 60 percent of the outside integrated exposure, while personnel working outside most of the day accumulated about 80 percent of the outside integrated exposure (Reference D.3). A report sent to the AEC 6 days after TEWA (Reference D.3) indicated that no fallout was observed at weather station islands, on Eneu, or on Rongelap.

CHAPTER 5

ENEWETAK TEST OPERATIONS

Test shots fired at Enewetak during REDWING were smaller than those fired at Bikini and required evacuation of personnel from only the northern islands. (See Table 1 for a listing of all REDWING shots.) Permanent living and working areas on Enewetak, Parry, and Japtan islands were occupied throughout, although provisions were made for emergency evacuation. The MOHAWK detonation is shown as viewed from Japtan in Figure 47.

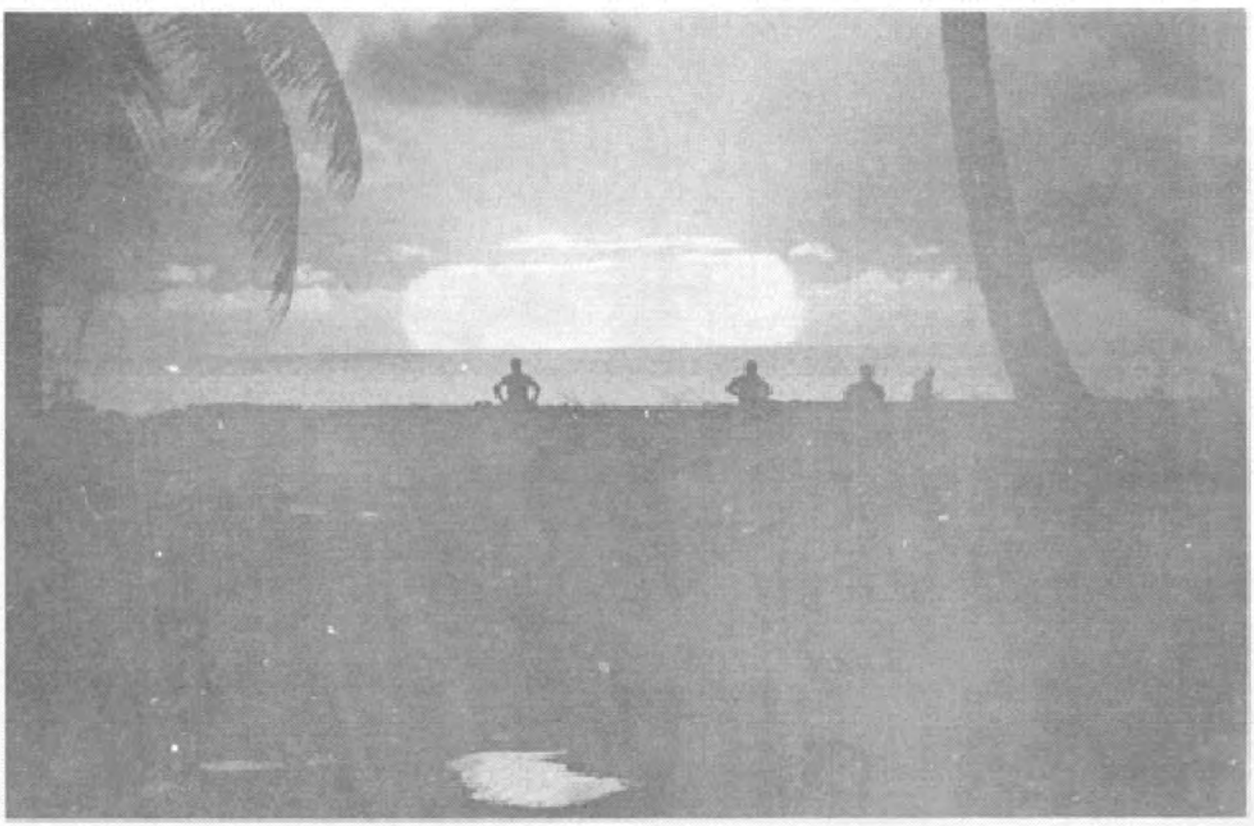


Figure 47. MOHAWK detonation viewed from Japtan Island, Enewetak Atoll REDWING.

DOD EXPERIMENTAL PROGRAM

Enewetak experiments were definitely less important to the Department of Defense (DOD) than those at Bikini, and the DOD was involved in fewer projects and shots at Enewetak than at Bikini. However, three DOD projects were unique to the Enewetak experimental program.

Project 1.10

Although a DOD project, this experiment was staffed by Sandia Corporation, an Atomic Energy Commission (AEC) contractor. Blast gauges were placed on the shot island for INCA and differences in blast parameters over land cleared of vegetation versus uncleared land were observed.

Project 5.9

This project concentrated on the fireball's effect on missile materials. During two events, sample materials and self-recording instruments were suspended on lightweight towers near the shot towers. Data evaluation required recovery of these materials, which proved difficult because of the radiologically hot environment after the shot. Because of this environment, most of the sample-recovery work was actually done in September and October of 1956, well after the series concluded.

Project 6.6

This project tested telemetry links close to burst point and involved setting up such a link using a transmitter very close to ground zero. The data were recorded at Parry, and the project did not expose project personnel to ionizing radiation.

EVACUATION AND TEST PREPARATION

As evacuation of Enewetak involved only camps in the upper islands, it was considerably simpler than the Bikini evacuation. Scheduling of Enewetak evacuation is shown in Table 26; test preparations were similar to those at Bikini and are listed in Table 27.

The nearest manned island to the shots was Ananij, where a small experimental team operated from a trailer. The rest of the Enewetak contingent of the task force was on Enewetak, Parry, or Japtan islands, or on the few naval units at Enewetak.

Table 26. Enewetak test preparations, REDWING.

Activity	Day/Time
Ship Movement	
Weather ships on station and begin weather observations	D-3/0600
Fleet sortie (if required)	D-1/1700
USNS Fred C. Ainsworth (T-AP-181) leaves Bikini for standby (if required)	D-1/1800
Weather and Fallout Prediction	
Command weather-radsafe briefing	D-1/0830
Command weather-radsafe briefing	D-1/2130
Command weather-radsafe briefing	D-day/0230
H-18 advisory on cloud trajectories and fallout	D-1/1145
Forecast of air and surface radex areas	D-1/1200
Command	
Joint Operations Center in operation at Parry	D-1/1200
Aircraft Movement	
Weather reconnaissance flights (3 per day)	D-4
Begin scientific aircraft takeoffs	D-day/H-2
Patrol Squadron One radiological reconnaissance planes from Kwajalein	D-day/H-2
Search and rescue units in position	D-day/0400

Table 27. Enewetak evacuation activities, REDWING.

Activity	Day/Time
Security	
P2V aerial surveillance	Begin D-6
Surface vessel sweep	D-1
Commander, Task Group 7.3 reports Danger Area clear	D-1
Physical Plant Closedown -- Camps	
Dismantle unneeded camps	Begin D-5
Personal equipment removed from camps	D-5
Secure trailers not being evacuated	D-3
Last P.O., P.X., etc. at advance camps	D-3/2000
Physical Plant Closedown -- Afloat	
Evacuate houseboats and helicopter barges	D-1
Small boats to safe anchorage if not needed	D-1/1300
Personnel Evacuation	
All personnel except vital scientific from upper islands	D-1/1600
Mustering for all personnel	Begin D-1
Report task group evacuation officer to task force evacuation officer (final)	D-1/1800
Report task group evacuation officer to Commander, Joint Task Force 7	D-1/2000
USNS *Fred C. Ainsworth* (T-AP-181) leaves Bikini to standby Enewetak	D-1/1800
Fleet sortie (if required)	Begin D-1/1700

Details of the safety-related preparation of personnel on the base islands are covered in Chapter 2. Figure 48 shows a group on Enewetak faced away from the burst point of ERIE as the predawn darkness was dissipated by the detonation light.

RECOVERY

At H+1, Task Group 7.4 (TG 7.4) helicopters began the radiological safety (radsafe) survey of the atoll, with a report available by H+2. Recovery of

Figure 48. ERIE detonation, REDWING; observers facing away from burst.

experimental data then commenced. A typical planned sequence for data-recovery operations is presented in the TG 7.1 Operation Letter INCA-7 (see Appendix A).

RADIOLOGICAL SAFETY SERVICES

Control points for entry and exit from radiation-contaminated areas were established by Task Unit 7 (TU 7) of TG 7.1. All persons entering or returning from contaminated areas were processed through these points. Main checkpoints were located at the air dispatcher's office and the boat landing on Parry. Other checkpoints were established at the personnel pier and on other islands as the situation demanded.

Personnel decontamination facilities were established on the beach across the road from the Radsafe Center. The facilities consisted of clean and "hot" change areas and showers. Altogether, 1,560 parties, with 1 to 50 men in each, were processed through the Enewetak checkpoints from 5 May to 20 July 1956. Of this group, approximately 1,600 individuals were processed through the personnel decontamination station. Laundry services necessary to maintain the protective clothing were provided by Holmes & Narver (H&N) under the direction of the Supply Section of the Radsafe Center. Two complete laundry units consisting of washers and driers were used for contaminated clothing only (Reference C.1.3.1).

The equipment decontamination station on Parry processed a total of 225 vehicles, ranging from jeeps to large mobile cranes. In addition, numerous pieces of small equipment were cleaned for the various projects and for H&N. Normal procedure called for all heavy equipment returning from shot islands to be monitored upon removal from the boats at the landing and directed to the decontamination station if necessary. Versene and citric acid were the common decontaminating agents employed, and a steam generator was used to provide hot solutions for the necessary washing. When equipment was not needed immediately, the vehicles were held in a "hot" parking lot for varying lengths of time before decontamination, in order to reduce contamination levels by radioactive decay of the contaminants.

TU 7 was responsible for the conduct of all radiological surveys on the atoll, the majority of which were made by helicopter. Normal operations included a preentry survey with CTG 7.1 at H+1 and H+3, a detailed survey of the entire atoll at H+4 and H+8, and detailed surveys on the mornings of D+1 and D+2. Additional surveys were made as required. When necessary, data were radioed back to the Radsafe Center from the survey helicopter. Plotting and briefing stations were maintained in the Radsafe Center and the J-3 office. Ground surveys of islands in the atoll were reported to be conducted when required; however, no indication was made regarding when this occurred (Reference C.1.3.1).

TU 7 also provided radsafe monitors for the experiment recovery parties when necessary. The demand was reported to be small, usually not more than two or three after each shot, since the projects generally included their own monitors as members of the recovery team. The monitors were responsible to the party leaders, who were expected to accept their advice (Reference C.1.3.1). The records show no indication of conflict between a monitor's advice and the actual recovery operations.

An Army radiochemistry trailer (AN/MDQ-7) was used for radsafe sample preparation and counting. The work load was reported as small (Reference C.1.3.1). No chemical analyses were performed, but samples were analyzed for gross beta-gamma activity or total alpha activity. Major analyses included samples of lagoon water after APACHE, HURON, and MOHAWK detonations. Rain samples were reportedly collected periodically and analyzed, and several tritium urinanalyses were performed; however, the data have not been located.

During the operational phase, the contamination from any one shot did not interfere with preparations for the next. It was reported that occasionally crude decontamination measures were necessary to reduce radioactive contamination to a point where normal labor would not result in excessive exposure. Road-scraping and bulldozing operations were used for this field decontamination, but there is no indication of where or when it occurred (Reference C.1.3.1).

Fallout on Enewetak and Parry islands was observed after one detonation at Enewetak. Approximately 2 hours after the MOHAWK detonation, radiation was noted at Parry. Peak intensity at about H+3, near the end of the fallout period, was reported to be about 0.022 R/hr. Rain showers later in the day were said to have removed most of the contamination (Reference C.1.3.1). Enewetak Atoll was significantly contaminated by the TEWA detonation at Bikini. Fallout commenced about 9 hours after detonation and lasted approximately 17 hours. Peak radiation intensity was about 0.120 R/hr.

LACROSSE

The LACROSSE device, designed and developed by Los Alamos Scientific Laboratory (LASL), was fired at ground level on the north end of Runit Island at 0625 on 5 May 1956. The yield was 40 KT.

The DOD scientific experiments for LACROSSE are listed below.

- Program 1 -- Blast Effects: Projects 1.1, 1.2, 1.3, 1.5, 1.6, 1.8
- Program 2 -- Nuclear Radiation: Projects 2.64, 2.65
- Program 4 -- Biological Effects: Project 4.1
- Program 5 -- Aircraft Effects: Projects 5.3, 5.4, 5.5, 5.6, 5.7

- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4, 6.5
- Program 8 -- Thermal Radiation: Projects 8.1, 8.5
- Program 9 -- Photography: Project 9.1.

The surface radiological exclusion (radex) area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 49.

A total of 25 aircraft participated, including 2 Navy planes. Six F-84Gs and one B-57B were used as the cloud samplers, and one B-57B served as sampler control aircraft. The sampler aircraft entered the cloud at 1.5 to 2 hours after the burst and encountered exposure rates of 10 to 20 R/hr during initial penetrations. Specific locations at burst time for all of the 25 participating aircraft cannot be determined; however, there is information on some effects aircraft, as shown on Table 28.

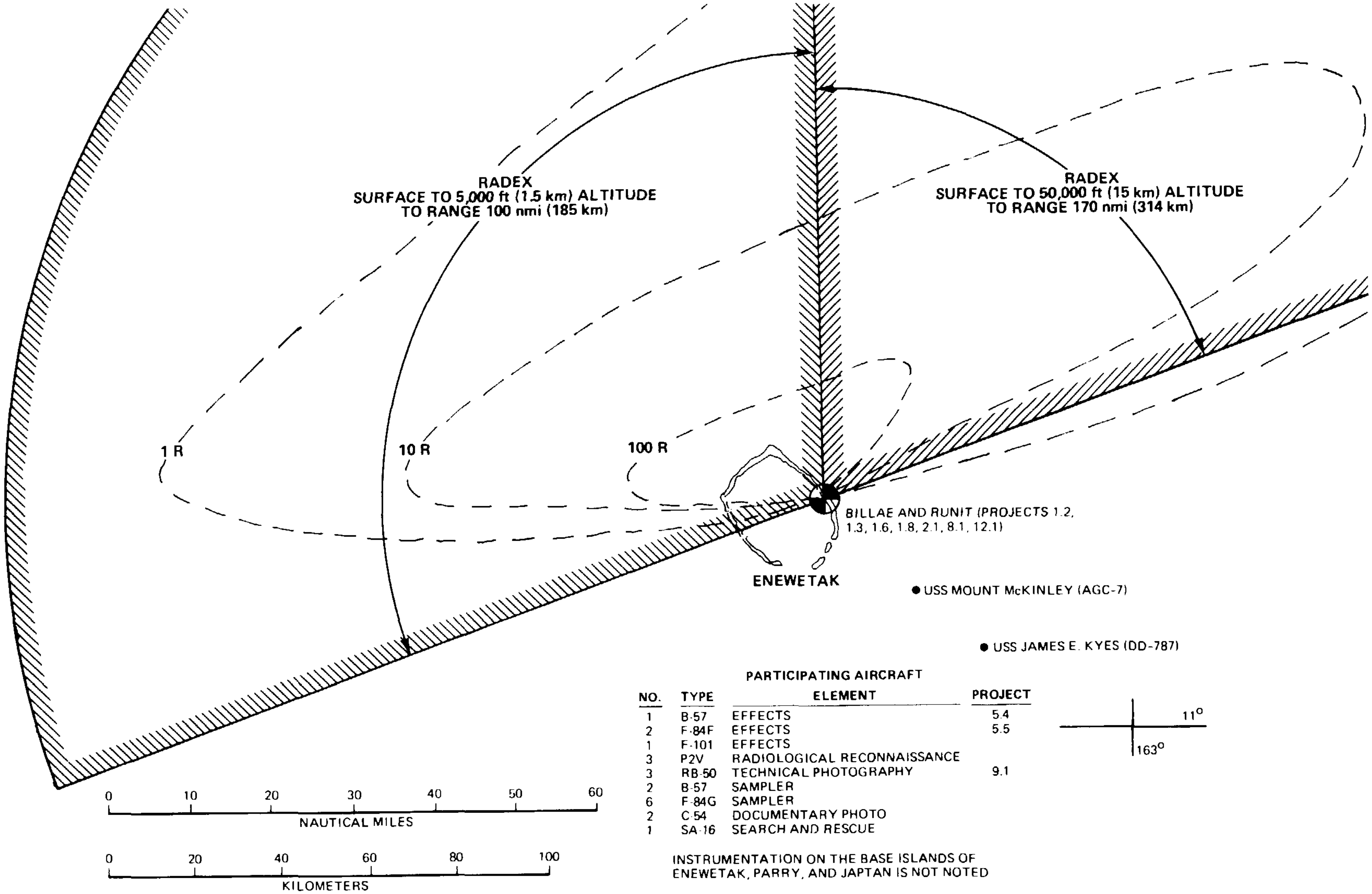
Nonmission TG 7.4 aircraft supported the operational and administrative requirements of the other task groups. Flight service to Runit, Dridrilbwij, and Bijire was suspended on D-1. Four L-20s were provided to TG 7.1 at 1300 on D-1. Two H-19s were provided to TG 7.1 on D-day for radsafe survey, damage assessment, and priority recovery. For the LACROSSE shot all Enewetak Atoll islands were evacuated except Ananij, Japtan, Parry, and Enewetak.

Surface and air radex areas in force from H-hour to H+6 were:

Surface to 5,000 feet (1.5 km) altitude:	Bearing 250° to 360°T; 100-nmi (185-km) range
Surface to 50,000 feet (15 km) altitude:	Bearing 0° to 70°T; 170-nmi (315-km) range.

All radex notices were withdrawn at 1310 and the area opened to aircraft.

The LACROSSE cloud reached only about 35,000 feet (10.7 km), about 10,000 to 15,000 feet (3.1 to 4.5 km), less than average for similar weapons tested at the Nevada Test Site. After about half an hour, the cloud separated into a thin upper portion and a thicker, pancake-like portion at between 20,000 and 22,000 feet (6.1 to 6.7 km). The two portions were joined by a patchy zigzag tail. The lower portion of the cloud was a pronounced brown color and easily distinguished from natural clouds in the area.



PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-57	EFFECTS	5.4
2	F-84F	EFFECTS	5.5
1	F-101	EFFECTS	
3	P2V	RADIOLOGICAL RECONNAISSANCE	
3	RB-50	TECHNICAL PHOTOGRAPHY	9.1
2	B-57	SAMPLER	
6	F-84G	SAMPLER	
2	C-54	DOCUMENTARY PHOTO	
1	SA-16	SEARCH AND RESCUE	

INSTRUMENTATION ON THE BASE ISLANDS OF ENEWETAK, PARRY, AND JAPTAN IS NOT NOTED

Figure 49. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for LACROSSE, REDWING. Dashed lines define predicted fallout areas (infinite gamma exposure, roentgens). Ship positions are shot time.

Table 28. H-hour positions of effects aircraft, LACROSSE, REDWING.

	F-84F	F-84F	B-57B[a]	F-101A[b]
Direction from burst (°)	230	288	---	000
Slant range (km)	5.3	8.6	4.6	3.7
Altitude (km)	4.6	3.1	4.2	3.7
Heading (°)	047	049	134	138

Notes:

[a]B-57B pilot received 0.08 R; engineer received 0.045 R.

[b]F-101A pilot received 0.585 R.

The initial radsafe survey by helicopter began at H+0.5. Exposure rates as high as 24 R/hr (measured at 500 feet [153 meters] altitude) were found south of Dridrilbwij (Reference C.1.7.2). The entire northern set of islands was contaminated to a level of 9 to 10 R/hr gamma radiation at H+4 (Reference C.1.3.1). Table 29 shows the results of the Enewetak surveys.

Because of contamination of all islands north of Runit, the camps on Lojwa and Dridrilbwij were permanently closed after this shot. The camp on the south end of Runit, however, was not significantly contaminated and it was reoccupied. The H+1 Runit radiation levels are shown in Figure 50. Decontamination around the air dispatcher's office on Bijire and along the roads within the Aomon-Lojwa complex was accomplished by using road scrapers and bulldozers. This materially reduced the exposure that personnel received in transit to working sites. In addition, the areas around the tower sites on Runit, Eleleron, and Aomon were decontaminated by scraping and filling, which permitted personnel to continue working there in a normal manner without exceeding the maximum permissible exposure (MPE).

YUMA

YUMA was fired on a tower at the north end of Aomon Island at 0756 on 28 May, 1 hour after the ZUNI detonation at Bikini. This was the first instance of near-simultaneous detonation on two atolls. The device was designed and developed by the University of California Radiation Laboratory (UCRL).

Table 29. Summary of Enewetak radiological surveys after LACROSSE, REDWING.

Island	Survey Reading (R/hr) (on ground except as noted)		
	H+8[a]	D+1[b]	D+2[b]
Bokoluo	---	1.8[c]	0.9[c]
Dridrilbwij	4.2	1.0	0.5
Enjebi	2.0[c]	0.8	0.48
Lujor	2.0[c]	---	0.26[c]
Eleleron	3.0[c]	0.5	0.18[c]
Aomon	1.6[d]	0.5	0.2[c]
Bijire	2.0[d]	0.5	0.1[c]
Billae	0.5[d]	0.08[c]	0.03[c]
Runit			
North	1.0[e]	1.0	1.0
South	0.005	0.001	0.010
Ananij	---	0	0
Japtan	---	0	0
Parry	---	0	0

Notes and Sources:

[a]Reference C.1.7.2.

[b]Reference C.1.1L

[c]Survey made at 25 feet (7.6 meters) altitude.

[d]Survey made at 50 feet (15.2 meters) altitude.

[e]Survey made at 1,000 feet (305 meters).

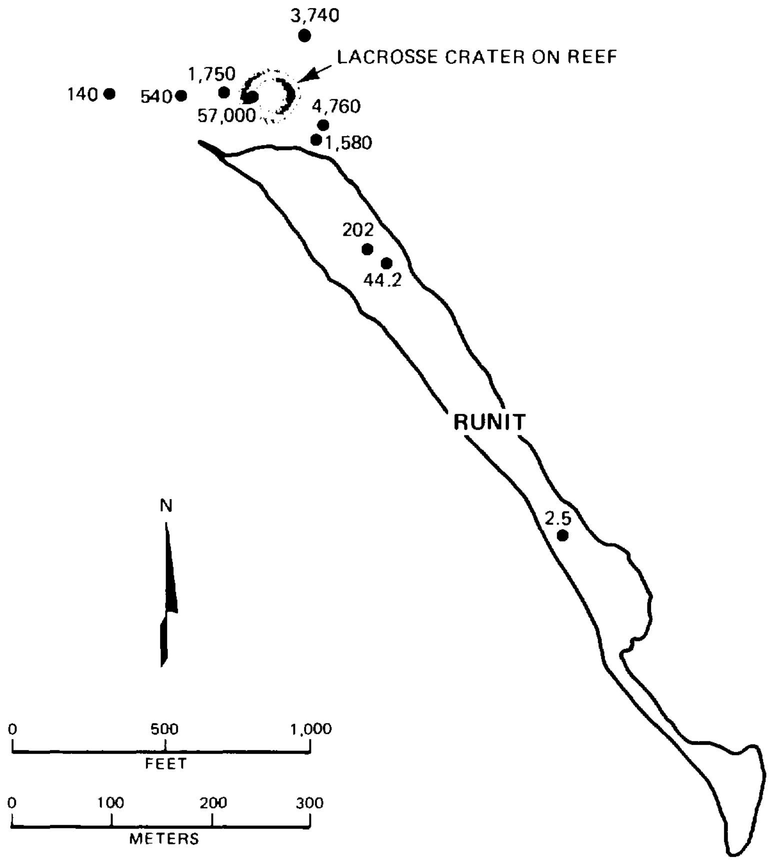


Figure 50. Radiation levels (R/hr) on Runit Island, Enewetak, after LACROSSE, REDWING.

The few DOD scientific experiments are listed below.

- Program 1 -- Blast Effects: Projects 1.1, 1.5
- Program 2 -- Nuclear Radiation: Project 2.51
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4, 6.5.

The surface radex, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are given in Figure 51.

Equipment was evacuated from the northern islands commencing D-5; personnel evacuation began on D-1. All islands were evacuated except Ananij, Enewetak, and Parry. Two L-20s and two H-19s were provided to TG 7.2 by TG 7.4 on D-1 for special missions. H-19s were used on D-day for radsafe surveys, damage assessment, and recovery of high-priority experiments. Regular air service to Lojwa, Runit, and Dridrilbwij was terminated at approximately 1200 on

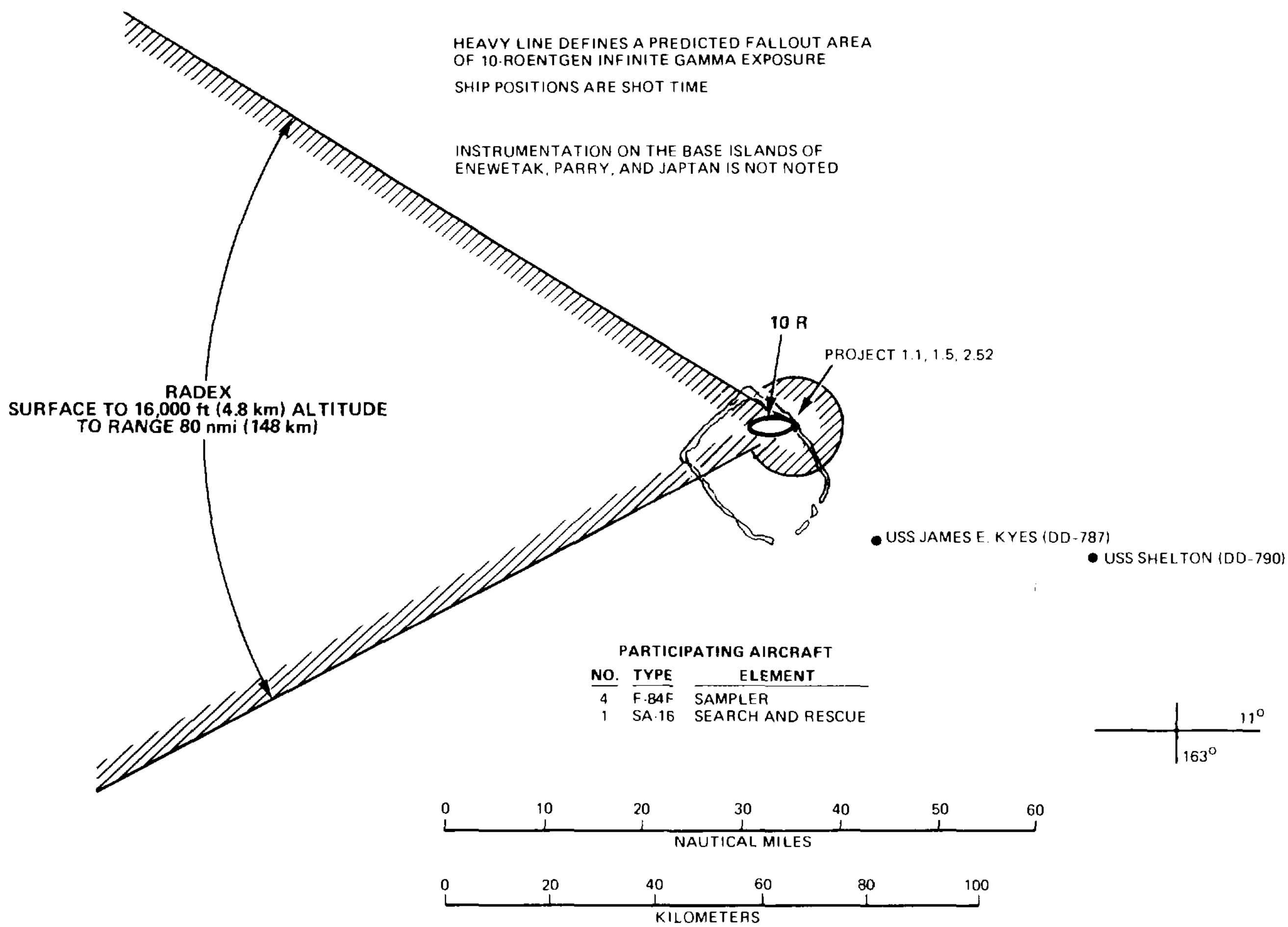


Figure 51. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for YUMA, REDWING.

D-1. H-19s and L-20s ferried 37 persons on D-3, 44 persons on D-2, 40 persons on D-1, 23 persons on D-day and 2 persons on D+1. These personnel were from TG 7.1 on device placement and project recovery missions.

The YUMA cloud reached an estimated height of 10,000 feet (3 km), and the base was at about 5,000 feet (1.5 km). The cloud moved to the northwest at approximately 10 knots (18.5 km/hr).

Eleven aircraft, including four F-84G cloud samplers, participated in the event. No data could be found on the shot-time location of these aircraft. Exposures to the pilots flying the sampling F-84Gs ranged from 0.150 to 0.323 R.

The Yoke P2V aircraft made a preliminary radiation survey at H+1 and reported very light to no fallout on the islands on either side of the shot site (Reference C.1.7.2). Reentry hour was established at H+1.5.

Radsafe monitoring indicated a maximum intensity of 3.3 R/hr north of Runit at H+4; however, this was probably residual radiation from LACROSSE. The exposure intensity on the shot island was 0.800 R/hr at H+4. No detectable increase in radiation background was noted at the radsafe monitoring stations located on Parry (Reference C.1.7.2). Radiological survey results are shown in Table 30.

Table 30. Summary of Enewetak radiological surveys after YUMA, REDWING.

	Ground Survey Reading (R/hr)		
Island	H+1[a]	H+4[b]	D+2[b]
Bokoluo	0.08	0.08	0.08
Dridrilbwij	0.04	0.037	0.035
Boken	0.04	0.036	0.035
Enjebi	0.04	0.036	0.032
Mijikadrek	0.04	0.04	0.04
Lujor	0.02	0.02	0.02
Eleleron	0.02	0.02	---
Aomon	0.80	0.30	0.14
Bijire	0.05	0.02	0.02
Lojwa	0.02	0.02	0.015
Billae	0.01	0.01	---
Runit	0.01-1.5	0.01-1.5	0.01-1

Sources:

[a]Reference C.1.7.2.

[b]Reference C.1.7.1.

Although YUMA's firing left radioactivity only at the shot area, added precautions were taken in checking personnel returning from recovery operations because some of this contamination was alpha-emitting. Aomon was also the site for the planned test of KICKAPOO, but preparations were little affected (Reference C.1.3.1).

ERIE

The LASL-designed ERIE device was detonated on a tower near the center of Runit at 0615 on 31 May.

The DOD scientific projects are listed below.

- Program 4 -- Biological Effects: Project 4.1
- Program 5 -- Aircraft Effects: Projects 5.3, 5.4, 5.5, 5.6, 5.7, 5.9
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.5
- Program 8 -- Thermal Radiation: Project 8.5.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 52.

Seventeen TG 7.4 aircraft were involved in the experiment in addition to two P2Vs from Kwajalein. Effects aircraft included the B-57, F-101, and F-84F. Table 31 indicates the location of these aircraft at detonation time. Six F-86Gs and one B-57 cloud sampler aircraft were under positioning control of a B-57.

Nonmission TG 7.4 aircraft supported TG 7.1 personnel extensively in preparation for the shot. H-19 aircraft were used at H+1 for radsafe surveys and damage assessment and later for recovery of high-priority experiments.

Surface and air radex areas from H-hour to H+6 enclosed an area bearing 240° to 300°T from the surface to 30,000 feet (9 km) altitude, to a range of 150 nmi (280 km). In addition, an area with a radius of 5 nmi (9 km) around the shot island to 30,000 feet (9 km) altitude was established as a radex area from H-hour to H+1.

The cloud reached an estimated altitude of 32,000 feet (9.8 km) in about 10 minutes. The portion below 20,000 feet (6.1 km) moved to the west, and the upper portion moved to the east. Strong directional wind shears stretched the

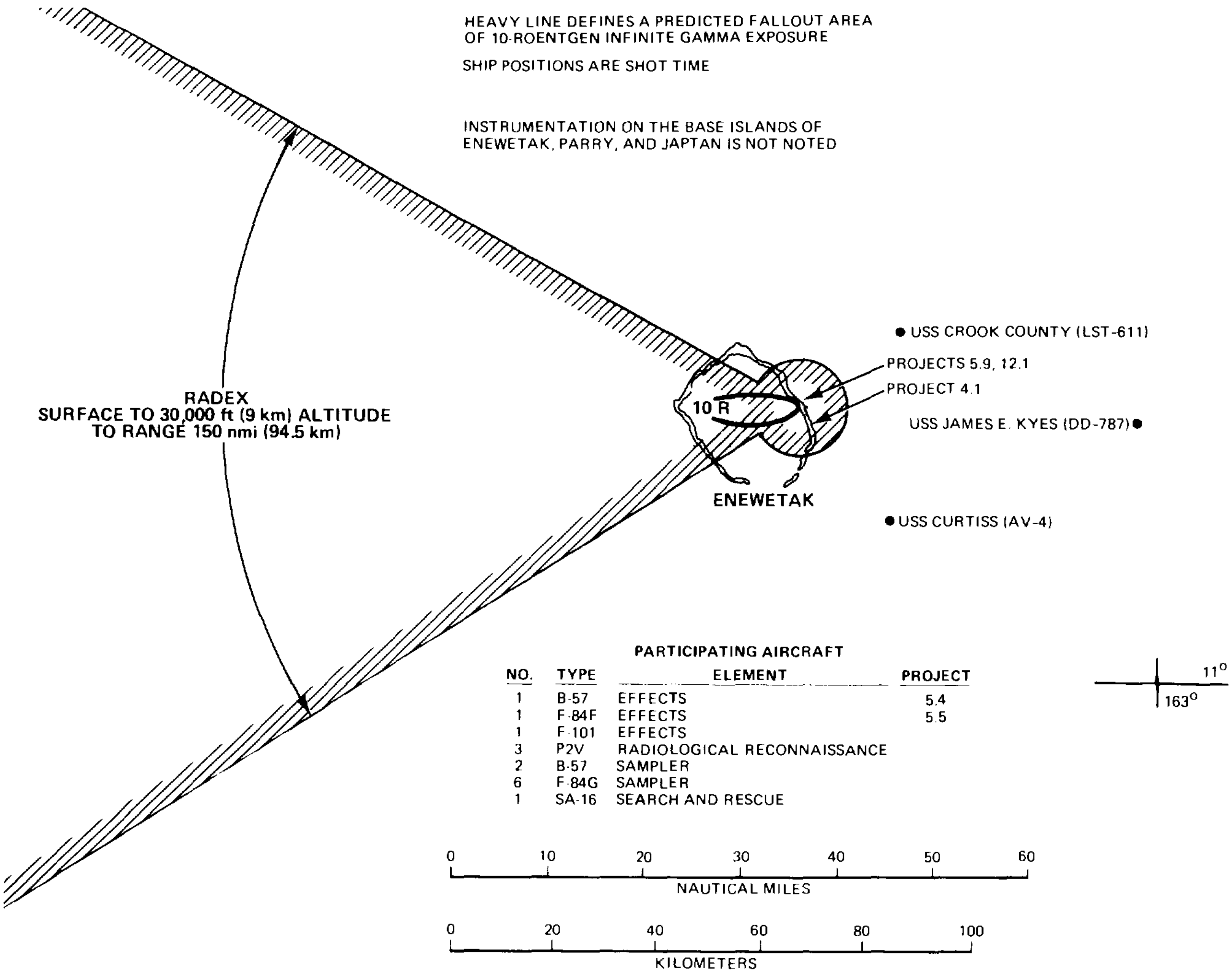


Figure 52. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for ERIE, REDWING.

Table 31. H-hour positions of effects aircraft, ERIE, REDWING.

	F-84F	B-57B[a]	F-101A[b]
Direction from burst (°)	172	---	274
Slant Range (km)	4.8	3.4	4.3
Altitude (km)	1.9	3.2	3.6
Heading (°)	051	049	049

Notes:

[a]B-57B pilot received 1.07 R; engineer received 0.68 R.

[b]F-101A pilot received 0.130 R.

cloud into a long, thin spiral shape. The cloud had a pronounced red color, making it easy for sampling pilots to find their targets.

The postshot radiation survey was performed from H+1.5 to H+3. Based on this survey, reentry hour was set as 0830, 31 May.

ERIE produced high radioactivity only on the shot island. North of Runit only slight radioactivity was left, and preparations for later shots were not delayed. Radiation surveys are summarized in Table 32. The area around the BLACKFOOT tower on the southern end of Runit was bulldozed to reduce radiation to acceptable levels (Reference C.1.3.1).

Monitoring stations at Wotho, Utirik, and Ujelang reported no significant increase in radiation background during the three days following ERIE (Reference C.1.7.2).

SEMINOLE

SEMINOLE was fired at ground level on the west side of Boken Island at 1255, 6 June 1956. The LASL device was detonated in a chamber within a tank of water.

The DOD scientific experiments for SEMINOLE are listed below.

- Program 1 -- Blast Effects: Projects 1.3, 1.8, 1.9
- Program 2 -- Nuclear Radiation: Project 2.64
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.5
- Program 8 -- Thermal Radiation: Project 8.5.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 53.

Six F-84G cloud samplers, one B-57 sampler, and one B-57 controller participated.

Effective surface and air radex areas from H-hour to H+6 enclosed an area bearing 230° to 320°T from the surface to 30,000 feet (9 km) altitude to a range of 150 nmi (280 km). In addition, an area with a radius of 5 nmi (9 km)

Table 32. Summary of Enewetak radiological surveys after ERIE, REDWING.

Island	Survey Reading (R/hr) (on ground except as noted)				
	H+1.5-3[a]	H+4[b]	H+7[a]	H+3[c]	H+58[c]
Bokoluo	---	0.190	0.070	0.070	0.070
Dridrilbwij	---	0.070	0.030	0.029	0.028
Boken	0.030	0.070	0.033	0.028	0.028
Enjebi	0.022	0.040	0.022	0.021	0.020
Mijikadrek	---	---	0.038	---	---
Lujor	---	0.040	0.020	0.020	0.020
Eleleron	---	0.040	0.020	0.020	0.020
Aomon	---	0.165	0.085	0.060	0.050
Bijire	0.020	---	---	---	---
Billae	0.100[d]	0.100	0.050	0.040	0.008
Runit					
North	0.040[e]	---	---	---	---
South	80.000[d]	200.000	100.000	100.000	70.000

Notes and Sources:

[a]Reference C.1.7.2.

[b]Reference C.1.7.1.

[c]Reference C.1.1E.

[d]Survey at 25 feet (7.6 meters) altitude.

[e]Survey at 200 feet (61 meters) altitude.

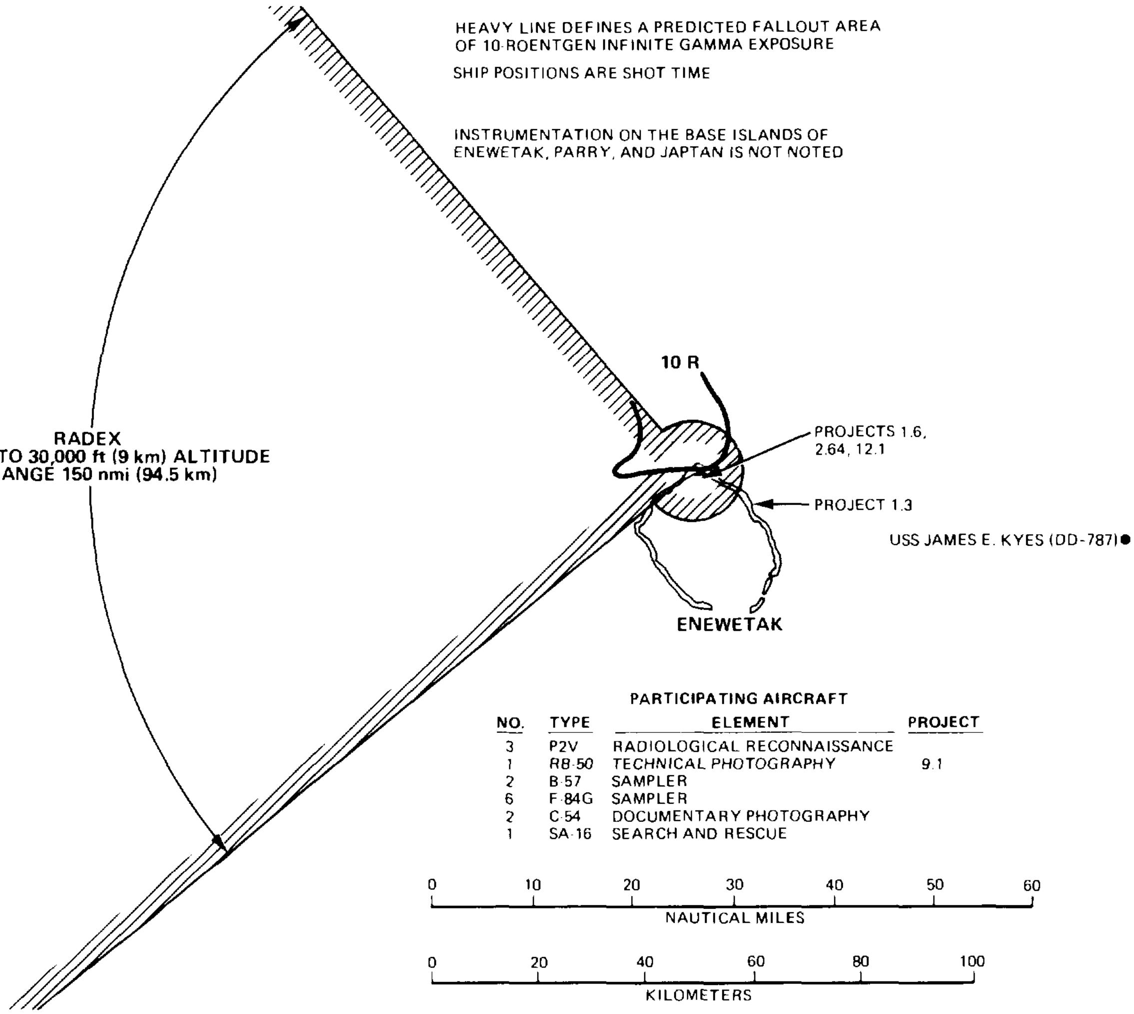


Figure 53. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for SEMINOLE, REDWING.

around the shot point to 30,000 feet (9 km) altitude was established as a radex area from H-hour to H+1.

The cloud rose in a uniform cylinder to 16,000 feet (4.9 km) with no mushrooming and considerable initial fallout of entrained water. By 45 minutes after burst, the cloud had separated into three portions: (1) a cloud at 5,000 feet (1.5 km) moving slowly north, (2) a portion at 10,000 feet (3 km) moving slowly north, and (3) a portion at 15,000 feet (4.6 km) moving very slowly northeast and remaining partially over surface zero.

The initial radsafe survey was made at H+1.5. Ground-level readings of 600 to 900 R/hr were noted (Reference C.1.7.2). Reentry hour was announced as 1530.

The radioactivity on Boken and Dridrilbwij was very high and recoveries on the south end of Dridrilbwij were delayed for two days; however, the bunker of Boken was visited on schedule by helicopter. Radiological surveys are summarized in Table 33.

Table 33. Summary of Enewetak radiological surveys after SEMINOLE, REDWING.

Island	Ground Survey Reading (R/hr)			
	H+1.5[a]	H+3[b]	D+1[b]	D+2[b]
Bokoluo	0.05	0.08	0.06	0.06
Dridrilbwij	900.0	900.0	100.0	50.0
Bokaidrikdrik	---	---	300.0	170.0
Boken	600.0	600.0	20.0	4.2
Enjebi	0.020	0.020	0.02	0.015
Lujor	---	0.020	0.02	0.015
Eleleron	---	0.015	0.016	0.015
Aomon	---	0.4	0.35	0.33
Bijire	---	0.02	0.02	0.02
Lojwa	---	0.015	0.02	0.15
Billae	---	0.007	0.008	0.005
Runit	---	0.005-16	0.005-13	0.003-3.2
Ananij	---	---	0	---
Japtan	---	---	0	---
Parry	---	---	0	---

Sources:

[a]Reference C.1.7.2.

[b]Reference C.1.1S.

The Yoke flight, a P2V from Kwajalein, flew radiological reconnaissance southeast of Enewetak and encountered no radiation by 1700 when the pattern was completed. Yoke I flew a pattern over Enewetak Lagoon calculated to intercept movement of fallout in the direction of the task force ships. No radiation was encountered. Yoke I also conducted a lagoon and atoll survey. No increase in background was noted by off-atoll radsafe stations, "in view of this, no cloud tracking missions were flown" (Reference C.1.7.2).

BLACKFOOT

The BLACKFOOT device, provided by LASL, was detonated on a tower at Runit Island at 0626, 12 June 1956. It was detonated simultaneously with FLATHEAD at Bikini.

The DOD scientific experiments for BLACKFOOT are listed below.

- Program 1 -- Blast Effects: Project 1.9
- Program 2 -- Nuclear Radiation: Project 2.51
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4, 6.5, 6.6.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 54.

Nine aircraft participated; none were effects aircraft. Cloud samples were obtained by six F-84G sampler aircraft. TG 7.4 provided an H-19 for the radsafe and damage survey; a second H-19 was used to recover high-priority experiments.

Effective surface and air radex areas from H-hour to H+6 enclosed an area bearing 230° to 320°T from the surface to 30,000 feet (9 km) altitude to a range of 100 nmi (185 km). In addition, an area with a radius of 5 nmi (9 km around the shot point to 30,000 feet (9 km) altitude was established as a radex area from H-hour to H+1. Reentry hour was set at 0830.

The detonation produced an anvil-headed cloud, rising to about 32,000 feet (9.8 km), about 10,000 feet (3.1 km) higher than expected. The bottom of the cloud was at about 15,000 feet (4.6 km). Initial cloud movement was to the west. The cloud separated into three major portions, all reddish-brown, making them readily visible to sampling pilots. At sampling time, the three portions were at 15,000 feet (4.6 km), 25,000 feet (7.6 km), and 30,000 feet (9.1 km).

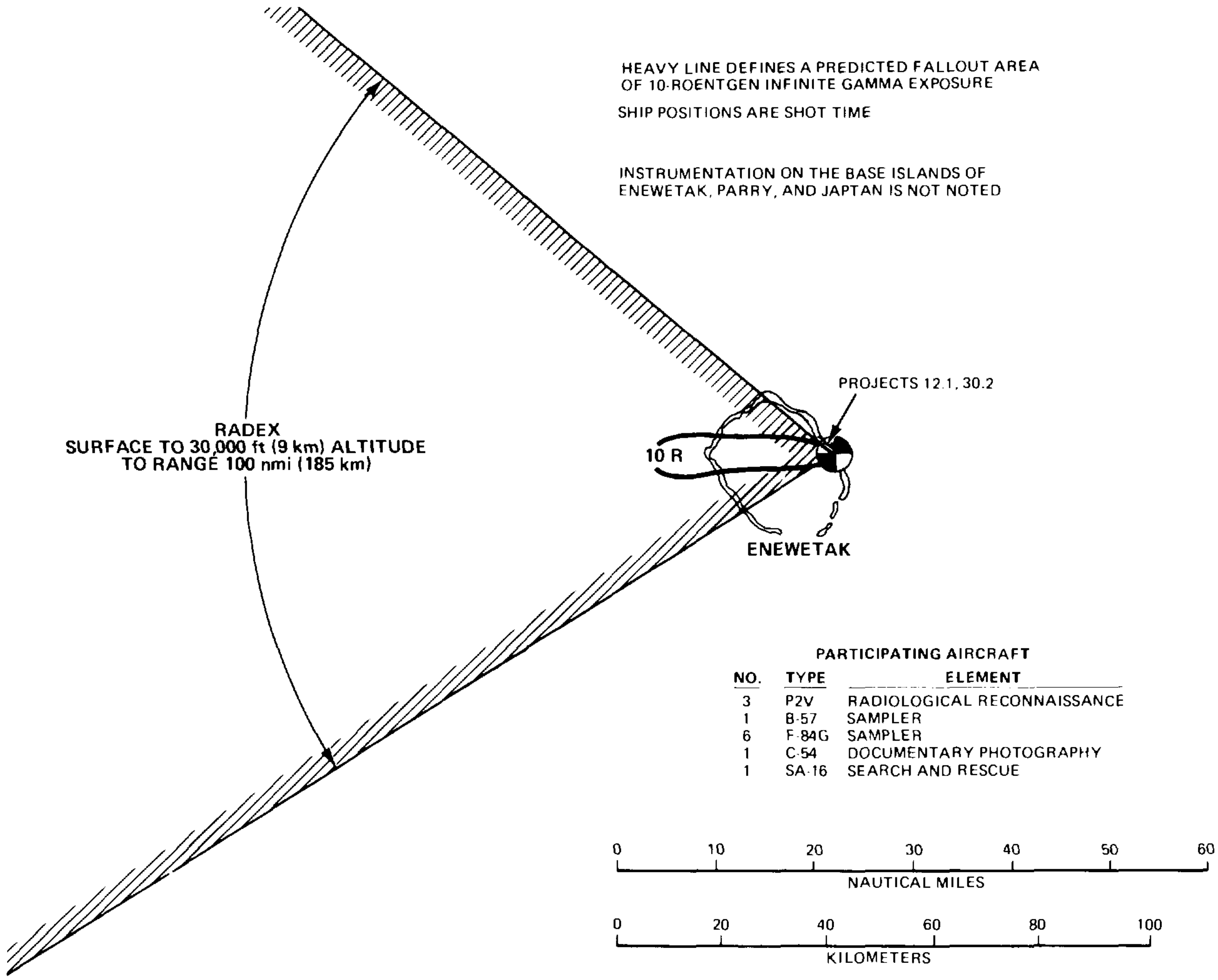


Figure 54. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for BLACKFOOT, REDWING.

The initial radsafe survey began at H+1.5. The north end of Runit and the northernmost islands of the atoll showed the highest radioactivity, but the radioactivity at the northernmost islands was residual from SEMINOLE. Levels of 2,000 R/hr at H+1 were determined. High radioactivity from BLACKFOOT was limited mostly to Runit, but the photography tower on Unibor was badly contaminated. This complicated preparations for later tests because it interferred with work on the tower. Summary of the Enewetak surveys is shown in Table 34.

KICKAPOO

The KICKAPOO device was provided by UCRL and was detonated on a tower on Aomon at 1126, 14 June 1956. DOD participation was primarily remotely sited

Table 34. Summary of Enewetak radiological surveys after BLACKFOOT, REDWING.

Island	Ground Survey Reading (R/hr) H+4[a]	H+1.5-5.5[b]
Bokoluo	0.050	---
Dridrilbwij	13.000	---
Bokaidrikdrik	47.000	---
Boken	140.000	1.200
Enjebi	0.015	
Aomon	---	0
Bijire	---	0
Lojwa	0.010	0
Billae	0.005	0
Runit		
North	17.000	6.000
Center	34.000	80.000
South	0.015	0.450
Unibor	6.400	2.200
Japtan	0	---
Parry	0	---

Sources:

[a]Reference C.1.7.1.

[b]Reference C.1.7.2.

projects except for some neutron measurements and one effects aircraft experiment.

The DOD scientific experiments are listed below.

- Program 2 -- Nuclear Radiation: Project 2.51
- Program 5 -- Aircraft Effects: Project 5.6
- Program 6 -- Electromagnetic Effects: Projects 6.1, 6.3, 6.4

The surface radex area, predicted fallout pattern, and locations of DOD instrumentation and task force ships are shown in Figure 55.

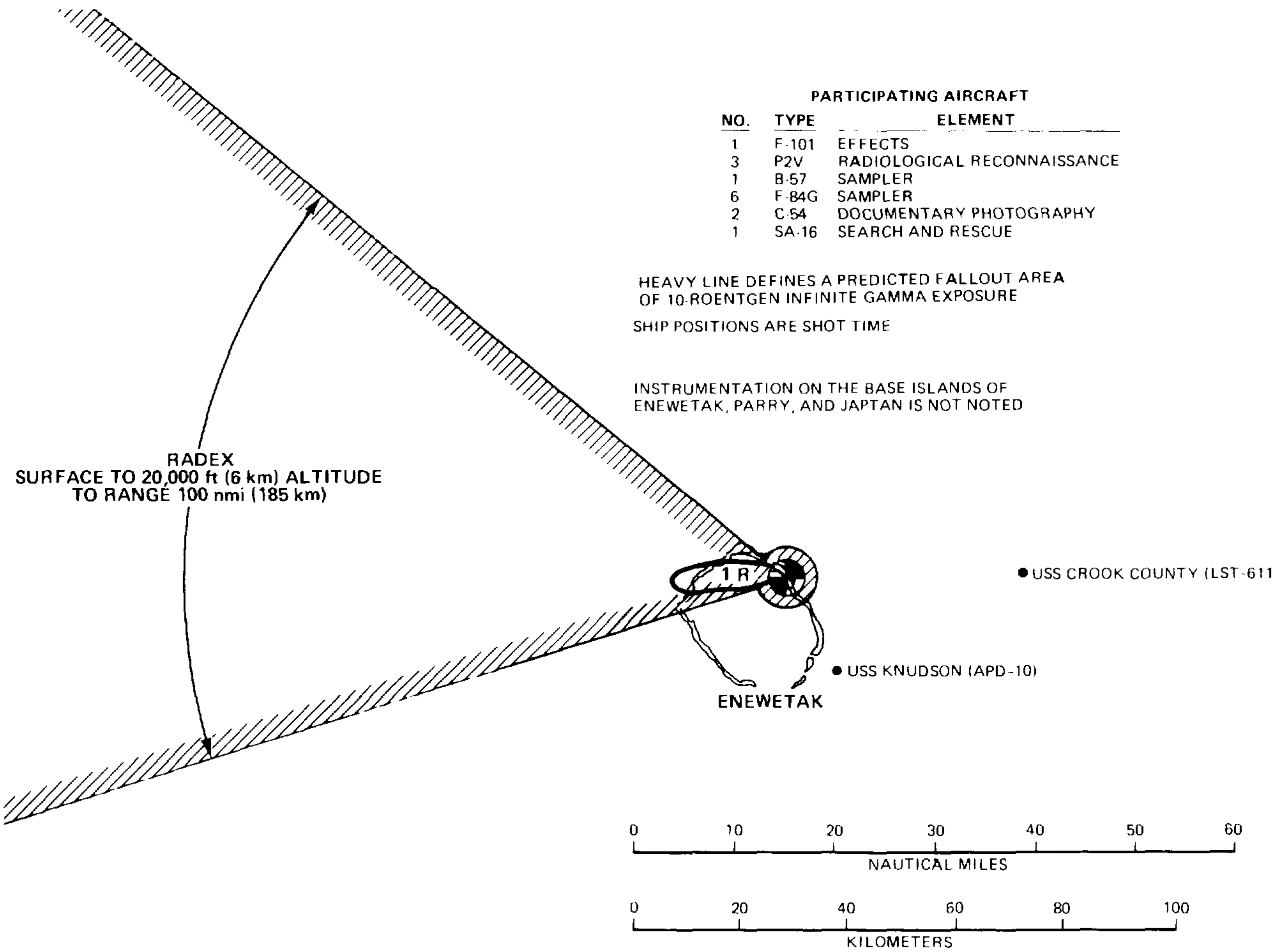


Figure 55. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for KICKAPOO, REDWING.

A total of eleven aircraft participated. Six F-84G samplers, their B-57 controller, and the F-101A effects aircraft participated. Table 35 gives some specifics about the effects aircraft at detonation time. The F-101A was almost directly over ground zero at detonation time. It was supersonic and outran the blast effect.

Effective surface and air radex areas from H-hour to H+6 enclosed an area bearing 250° to 320°T from the surface to 20,000 feet (6 km) altitude to a

Table 35. H-hour positions of effects aircraft, KICKAPOO, REDWING.

	F-101A[a]
Direction from burst (^{o})	218
Slant Range (km)	2.4
Altitude (km)	2.3
Heading (^{o})	038

Note:

[a]The F-101A pilot received 1.6 R.

range of 100 nmi (185 km). In addition, an area with a radius of 2 nmi (4 km) around the shot point to 20,000 feet (6 km) altitude was established as a radex area from H-hour to H+1.

The cloud top was at 18,000 feet (5.5 km) and the base about 12,000 feet (3.7 km). Initial movement was to the west. The six sampler aircraft pilots received exposures of between about 0.4 and 0.7 R from cloud penetrations.

Yoke and Yoke I flights were flown following the detonation until 1400 for radiological reconnaissance. Cloud-tracking WB-50 aircraft were not flown.

Initial radsafe measurements were made at H+5. High radioactivity was noted only on Aomon, and the tower sites for the MOHAWK and INCA shots on Eleleron and Lujor were not materially affected (Reference C.1.3.1). Results of the radsafe surveys (R/hr) at H+10 are summarized below (Reference C.1.7.2):

Bokoluo	0.05	Eleleron	0.003
Dridrilbwij	6.3	Aomon	0.2-170
Bokaidrikdrik	33.	Bijire	0.150
Boken	0.9-78	Lojwa	0.004
Lujor	0.22	Runit	0.7-17.5

Local alpha contamination was heavy on Aomon, and a special checkpoint and personnel decontamination facility was set up on the south end of that island. Air-breathing devices were used on occasion because of this.

Off-atoll stations, with the exception of Ujelang, reported no increases in background. Ujelang reported an increase to 0.00003 R/hr, which was quite low (Reference C.1.7.2).

OSAGE

OSAGE was dropped from a B-36 and detonated at 1314 on 16 June 1956. The target island was Runit and the burst altitude about 700 feet (214 meters).

The DOD scientific experiments for OSAGE were all concerned with electromagnetic effects: Projects 6.1, 6.3, 6.4, 6.5, and 6.6. The surface radex area, predicted fallout pattern, and the locations of DOD project instrumentation and task force ships are shown on Figure 56.

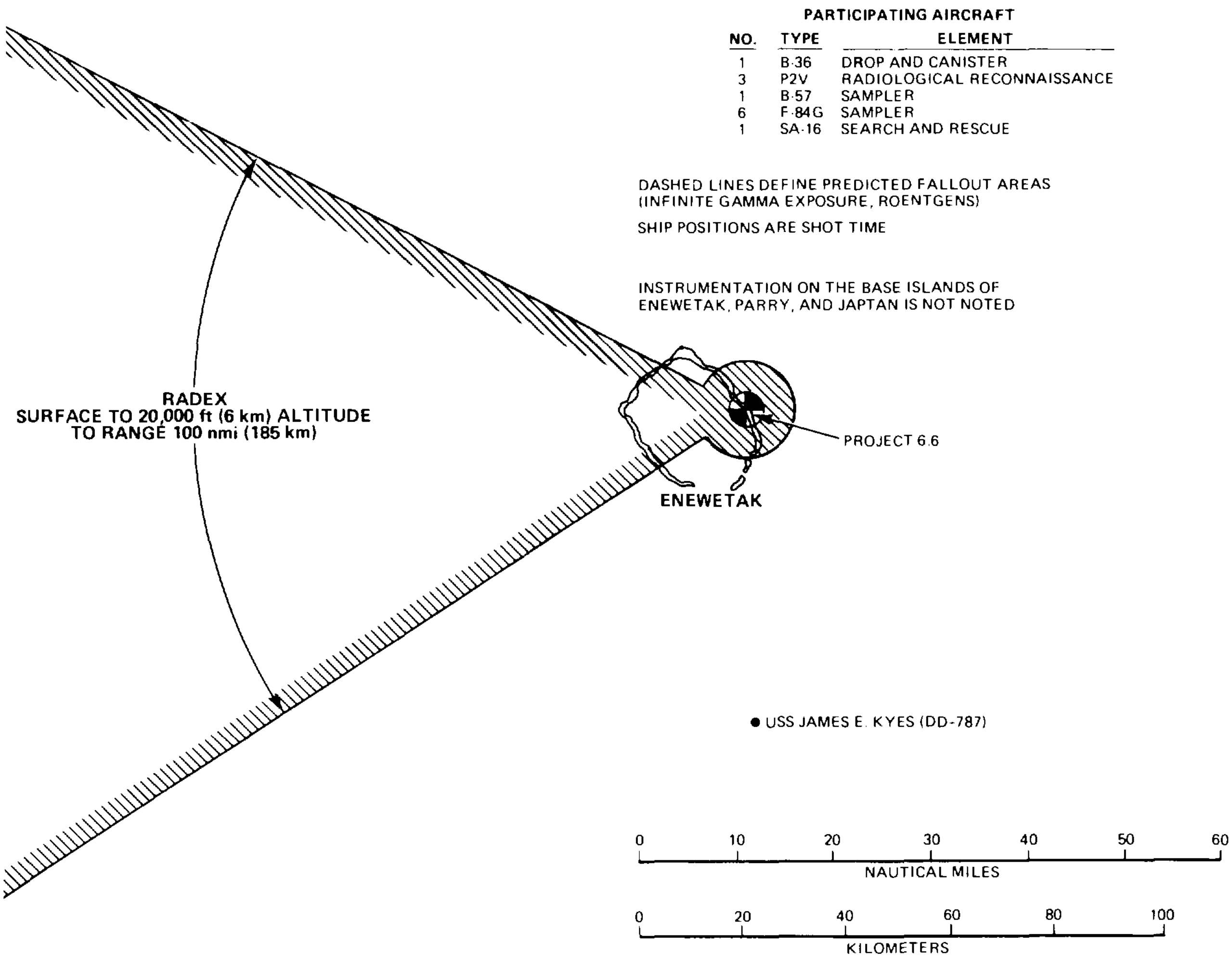


Figure 56. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for OSAGE, REDWING.

A total of 12 aircraft took part in the operation, including six F-84G sampler aircraft and the B-57 controller.

The predicted cloud trajectory was southwest of the burst point. Effective surface and air radex areas from H-hour to H+6 enclosed an area bearing 240° to 300°T from the surface to 20,000 feet (6 km) altitude to a range of 100 nmi (185 km). In addition, an area with a radius of 5 nmi (9 km) around the intended ground zero to an altitude of 20,000 feet (6 km) was declared a radex area from H-hour to H+1.

The detonation cloud stabilized with its top at about 21,000 feet (6.5 km), 8,000 feet (2.4 km) higher than predicted. The cloud spread out widely and, being nearly transparent, was hard to see. There were three layers: at 21,000 feet (6.4 km), at 19,000 to 20,000 feet (5.6 to 6.1 km), and at 16,000 feet (4.9 km). Movement of the cloud was not apparent to observers on Parry, but aircraft reported it moving north at less than 10 knots (18.5 km/hr).

The P2V aerial reconnaissance aircraft surveyed the islands north of Japtan at H+1. This survey indicated OSAGE deposited very little fallout on Enewetak (Reference C.1.7.2). Surface and air radex notices were withdrawn and reentry hour was set at 1500, 16 June. A summary of the Enewetak surveys is shown in Table 36.

Off-atoll ground-monitoring stations reported an increase in background through D+2.

INCA

INCA was a UCRL device detonated on a tower on Lujor at 0926 on 22 June 1956.

The DOD scientific experiments for INCA are listed below.

- Program 1 -- Blast Effects: Projects 1.3, 1.8, 1.10
- Program 5 -- Aircraft Effects: Projects 5.4, 5.6, 5.7
- Program 6 -- Electromagnetic Effects: Projects 6.1a, 6.1b, 6.3, 6.4, 6.5, 6.6
- Program 9 -- Photography: Projects 9.1a, 9.1b.

Table 36. Summary of Enewetak radiological surveys after OSAGE, REDWING.

Island	Ground Survey Reading (R/hr) H+2[a]	Ground Survey Reading (R/hr) D+2[b]
Bokoluo	---	0.04
Dridrilbwij	---	5.5
Bokaidrikdrik	---	20
Boken	---	48
Enjebi	---	0.012
Lujor	0.06	0.02
Aomon	0.06	7
Bijire	0.02	0.007
Lojwa	0.002	0.005
Billae	0.04	0.002
Runit	0.008-8.8	0.003-3

Sources:

[a]Reference C.1.7.2.

[b]Reference C.1.10.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 57.

A total of 12 aircraft was used, including three effects planes and six F-84G cloud-sampling aircraft. Table 37 provides position information for two of the effects aircraft on this shot.

Effective surface and air radex areas from H-hour to H+6 enclosed an area bearing 270° to 360°T from the surface to 30,000 feet (9 km) altitude to a range of 100 nmi (185 km). In addition, an area with a radius of 5 nmi (9 km) around the shot island to an altitude of 30,000 feet (9 km) was established as a radex area from H-hour to H+1.

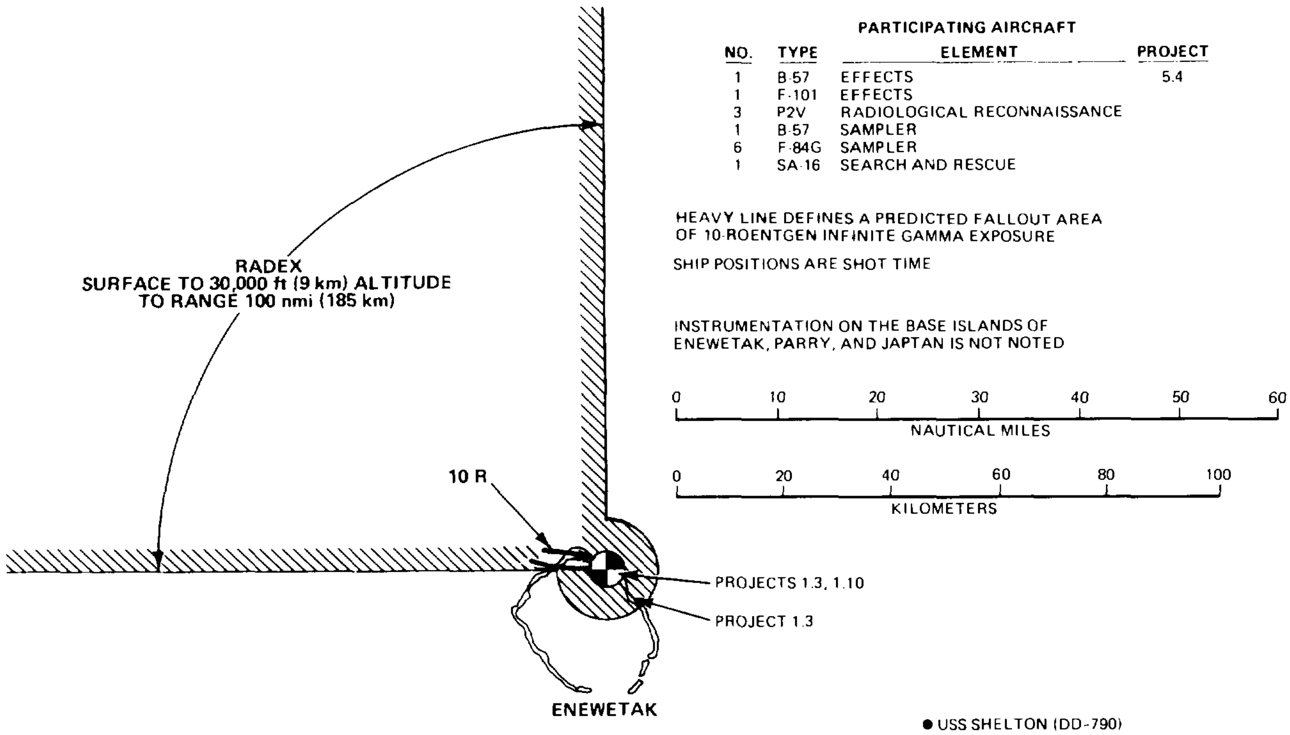


Figure 57. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for INCA, REDWING.

Table 37. H-hour positions of effects aircraft, INCA, REDWING.

	B-57B[a]	F-101A[b]
Direction from burst (°)	---	060
Slant range (km)	3.1	3.2
Altitude (km)	3.0	27
Heading (°)	050	041

Notes:

[a]The B-57B pilot received 2.66 R; the engineer received 1.71 R (Reference C.1.3.1330).

[b]The F-101A pilot received 2.005 R (Reference C.1.3.1332).

The cloud reached 42,000 feet (12.8 km), with the bottom at 30,000 feet (9.1 km). The stem and cloud moved to the west at approximately 10 knots (18.5 km). The stem appeared to contain more surface debris than usual for similar-yield tower shots (Reference C.1.7.2).

The shot island and lagoon were the only areas showing appreciable radiation during the initial radsafe survey made at H+1 to H+3.5. Exposure rates of 2700 R/hr were reported at H+1 from the shot island, but adjoining islands gave H+1 values of about 1 R/hr (Reference A.4). Contamination on the adjacent island of Eleleron did not interfere with preparations for firing MOHAWK (Reference C.1.3.1). Enewetak Atoll surveys are summarized in Table 38.

The radioactive cloud was tracked by P2V aircraft to a range of 100 nmi (185 km). At that point the cloud was approximately 50 nmi (93 km) long and 15 nmi (28 km) across, with an average radiation intensity of 0.050 R/hr at 10,000 feet (3.1 km).

The pilot of the F-101A and the pilot and engineer of the B-57B effects aircraft all received exposures on this shot (see Table 37). No detailed information concerning their flight plans has been found, but it seems probable that they received this radiation exposure from "initial radiation" and not from subsequent cloud debris. The following extract from the report detaling the effects on the B-57B aircraft indicates that operational adjustments were made to maximize test results and still stay within the limits of the MPE (Reference C.1.3.1330).

> In the preceding events, the one rem positions were not limiting and gust remained the limiting factor (for aircraft positioning). It was desired that gust loading be limiting for this event (Inca) also. The total radiation received up to this time was 1.15 rem from Shots Lacrosse and Erie. Since Shot Blackfoot participation was cancelled and none of the remaining devices were expected to result in the receipt of measurable radiation, this permitted a total of 2.75 rem to be received from this detonation before the 3.9 rem specified limit would be attained. The aircraft was thus positioned for the limiting gust loads and an actual value of 2.66 rem of nuclear radiation was received by the pilot of the aircraft.

Table 38. Summary of Enewetak radiological surveys after INCA, REDWING.

Island	Survey Reading (R/hr) (on ground except as noted)			
	H+1.5[a]	H+3.5[b]	D+1[c]	D+2[c]
Bokoluo	---	0.010	0.03	0.5
Dridrilbwij	---	---	3	---
Bokaidrikdrik	---	---	12	---
Boken	---	0.01-0.05	30.0	27
Enjebi	---	0-0.1	0.010	0.02
Aej	---	---	0.2	0.12
Lujor	0.2	5-10	1-70	30
Eleleron	0.01	0.5-1	0.01	---
Aomon	0.008	---	2	2.5
Bijire	0.008	0.01-0.05	0.05	---
Lojwa	0.008	---	0.006	---
Billae	0	---	0.003	---
Runit	0	0.01-0.05	0.05-3	3
Ananij	---	0.01-0.05	---	---
Mut	---	0-0.1	---	---
Biken	---	0	---	---

Notes and Sources:

[a]Reference C.1.7.2.

[b]Yoke flight readings at 1,000 feet (305 meters); (Reference C.1.7.2)

[c]Reference C.1.1I.

MOHAWK

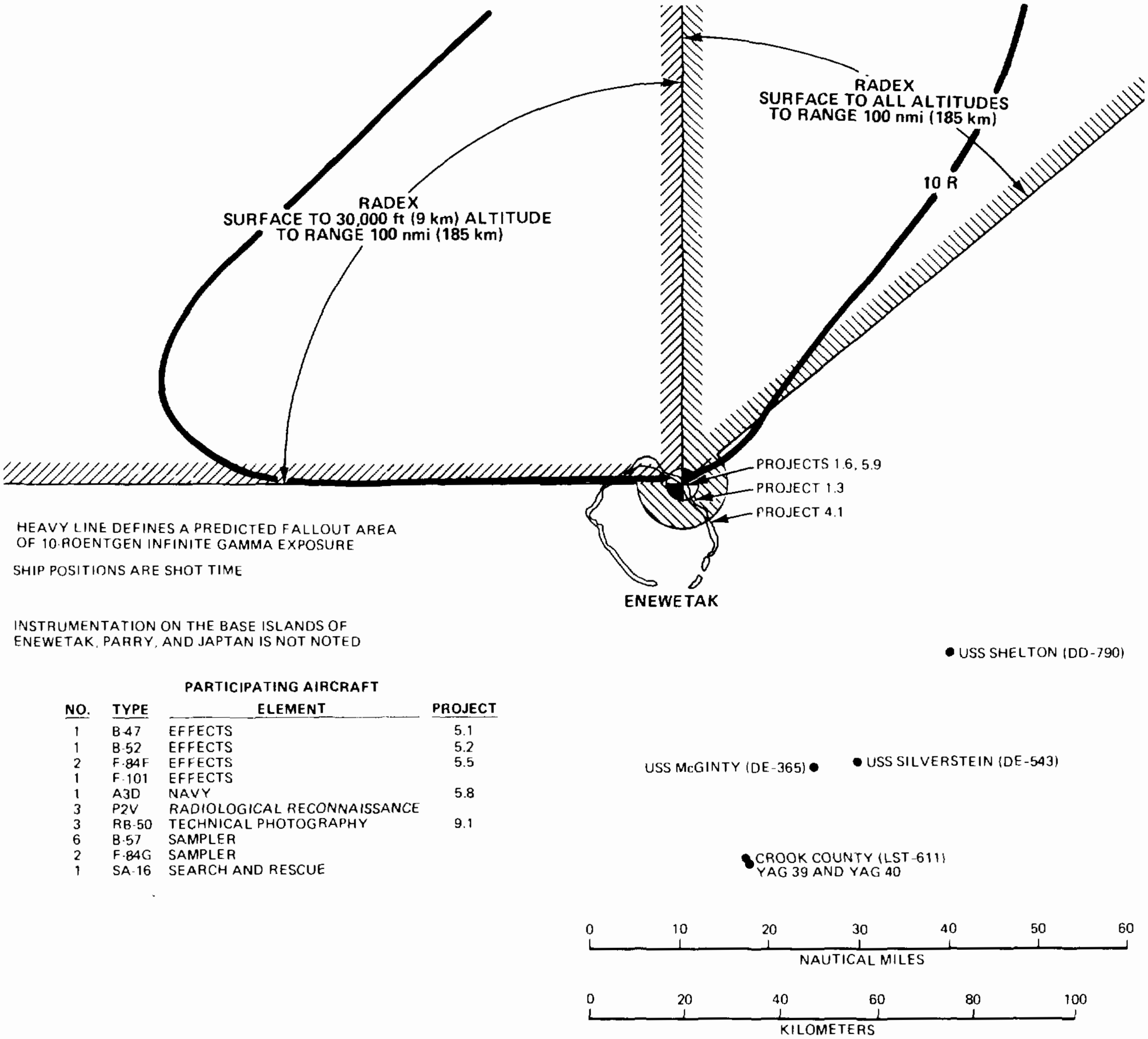
MOHAWK, a UCRL device, was fired on a tower on Eleleron Island. The shot was detonated at 0606, 3 July 1956.

The DOD scientific experiments for MOHAWK are listed below.

- Program 1 -- Blast Effects: Projects 1.3, 1.8, 1.9
- Program 2 -- Nuclear Radiation: Projects 2.64, 2.65

- Program 4 -- Biological Effects: Project 4.1
- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.5, 5.6, 5.7, 5.9
- Program 6 -- Electromagnetic Effects: Projects 6.1a, 6.1b, 6.3, 6.4, 6.5
- Program 9 -- Photography: Project 9.1.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 58.



PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-47	EFFECTS	5.1
1	B-52	EFFECTS	5.2
2	F-84F	EFFECTS	5.5
1	F-101	EFFECTS	
1	A3D	NAVY	5.8
3	P2V	RADIOLOGICAL RECONNAISSANCE	
3	RB-50	TECHNICAL PHOTOGRAPHY	9.1
6	B-57	SAMPLER	
2	F-84G	SAMPLER	
1	SA-16	SEARCH AND RESCUE	

Figure 58. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for MOHAWK, REDWING.

Twenty-seven aircraft participated in this shot, five of which were effects aircraft. Table 39 shows locations and headings for these effects aircraft at shot time. The F-101A was about 4 nmi (7.4 km) from the detonation and the pilot received no radiation exposure. Sampler aircraft consisted of five F-84Gs and five B-57s. There was one B-57 controller aircraft.

Table 39. H-hour positions of effects aircraft, MOHAWK, REDWING.

	F-84F	F-84F	B-47E	F-101A	B-52
Direction from burst (^{o})	072	187	123	220	--
Slant range (km)	6.1	11	19.1	7.1	8.1
Altitude (km)	6.1	7.1	11.2	6.9	7.6
Heading (^{o})	071	061	020	040	--

The effective surface and air radex areas from H-hour to H+6 were:

Surface to 30,000 feet (9 km) altitude:	Bearing 270^{o} to 360^{o}T; 100-nmi (185-km) range.
Surface to all altitudes:	Bearing 0^{o} to 50^{o}T; 100-nmi (185-km) range
Surface to all altitudes:	5 nmi (9 km) around shot island.

The cloud rose to 65,000 feet (19.8 km). Cloudy conditions at Enewetak Atoll prevented early lagoon and atoll survey by P2V aircraft. The P2Vs established barrier monitoring patterns on bearings of 260^{o} and 80^{o}, 20 nmi (37 km) west and 5 nmi (9 km) east of Japtan. No radiation above background was noted on these flights and reentry was set for 0800 (Reference C.1.7.2).

High radioactivity on the shot island was measured. In addition, radioactive fallout was deposited on the northern islands of the atoll. Intensity was such that the aircraft taking photographs for Project 1.8 had fogged film at H+2. Sampler pilot exposures were from 2.4 to 3.2 R. Recovery operations on Eleleron and adjacent islands were delayed for several days as a result of the contamination.

An unforecast wind shift at about shot time at the 15,000- to 20,000-foot (4.6- to 6.1-km) level brought radioactive material, along with intermittent

Off-atoll stations, with the exception of Ujelang, reported no increases in background. Ujelang reported an increase to 0.00003 R/hr, which was quite low (Reference C.1.7.2).

OSAGE

OSAGE was dropped from a B-36 and detonated at 1314 on 16 June 1956. The target island was Runit and the burst altitude about 700 feet (214 meters).

The DOD scientific experiments for OSAGE were all concerned with electromagnetic effects: Projects 6.1, 6.3, 6.4, 6.5, and 6.6. The surface radex area, predicted fallout pattern, and the locations of DOD project instrumentation and task force ships are shown on Figure 56.

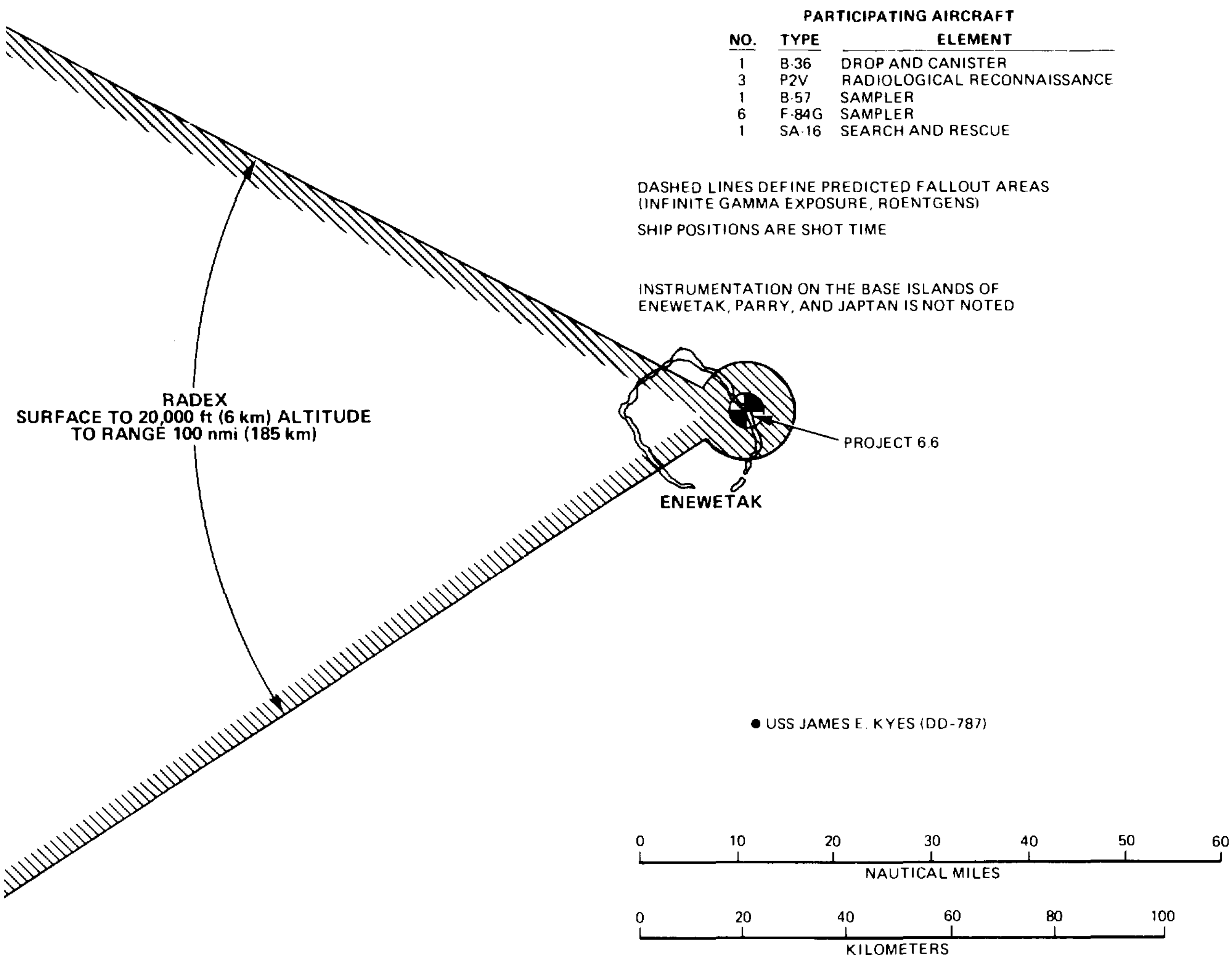


Figure 56. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for OSAGE, REDWING.

A total of 12 aircraft took part in the operation, including six F-84G sampler aircraft and the B-57 controller.

The predicted cloud trajectory was southwest of the burst point. Effective surface and air radex areas from H-hour to H+6 enclosed an area bearing 240° to 300°T from the surface to 20,000 feet (6 km) altitude to a range of 100 nmi (185 km). In addition, an area with a radius of 5 nmi (9 km) around the intended ground zero to an altitude of 20,000 feet (6 km) was declared a radex area from H-hour to H+1.

The detonation cloud stabilized with its top at about 21,000 feet (6.5 km), 8,000 feet (2.4 km) higher than predicted. The cloud spread out widely and, being nearly transparent, was hard to see. There were three layers: at 21,000 feet (6.4 km), at 19,000 to 20,000 feet (5.6 to 6.1 km), and at 16,000 feet (4.9 km). Movement of the cloud was not apparent to observers on Parry, but aircraft reported it moving north at less than 10 knots (18.5 km/hr).

The P2V aerial reconnaissance aircraft surveyed the islands north of Japtan at H+1. This survey indicated OSAGE deposited very little fallout on Enewetak (Reference C.1.7.2). Surface and air radex notices were withdrawn and reentry hour was set at 1500, 16 June. A summary of the Enewetak surveys is shown in Table 36.

Off-atoll ground-monitoring stations reported an increase in background through D+2.

INCA

INCA was a UCRL device detonated on a tower on Lujor at 0926 on 22 June 1956.

The DOD scientific experiments for INCA are listed below.

- Program 1 -- Blast Effects: Projects 1.3, 1.8, 1.10
- Program 5 -- Aircraft Effects: Projects 5.4, 5.6, 5.7
- Program 6 -- Electromagnetic Effects: Projects 6.1a, 6.1b, 6.3, 6.4, 6.5, 6.6
- Program 9 -- Photography: Projects 9.1a, 9.1b.

Table 36. Summary of Enewetak radiological surveys after OSAGE, REDWING.

Island	Ground Survey Reading (R/hr) H+2[a]	Ground Survey Reading (R/hr) D+2[b]
Bokoluo	---	0.04
Dridrilbwij	---	5.5
Bokaidrikdrik	---	20
Boken	---	48
Enjebi	---	0.012
Lujor	0.06	0.02
Aomon	0.06	7
Bijire	0.02	0.007
Lojwa	0.002	0.005
Billae	0.04	0.002
Runit	0.008-8.8	0.003-3

Sources:

[a]Reference C.1.7.2.

[b]Reference C.1.10.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 57.

A total of 12 aircraft was used, including three effects planes and six F-84G cloud-sampling aircraft. Table 37 provides position information for two of the effects aircraft on this shot.

Effective surface and air radex areas from H-hour to H+6 enclosed an area bearing 270° to 360°T from the surface to 30,000 feet (9 km) altitude to a range of 100 nmi (185 km). In addition, an area with a radius of 5 nmi (9 km) around the shot island to an altitude of 30,000 feet (9 km) was established as a radex area from H-hour to H+1.

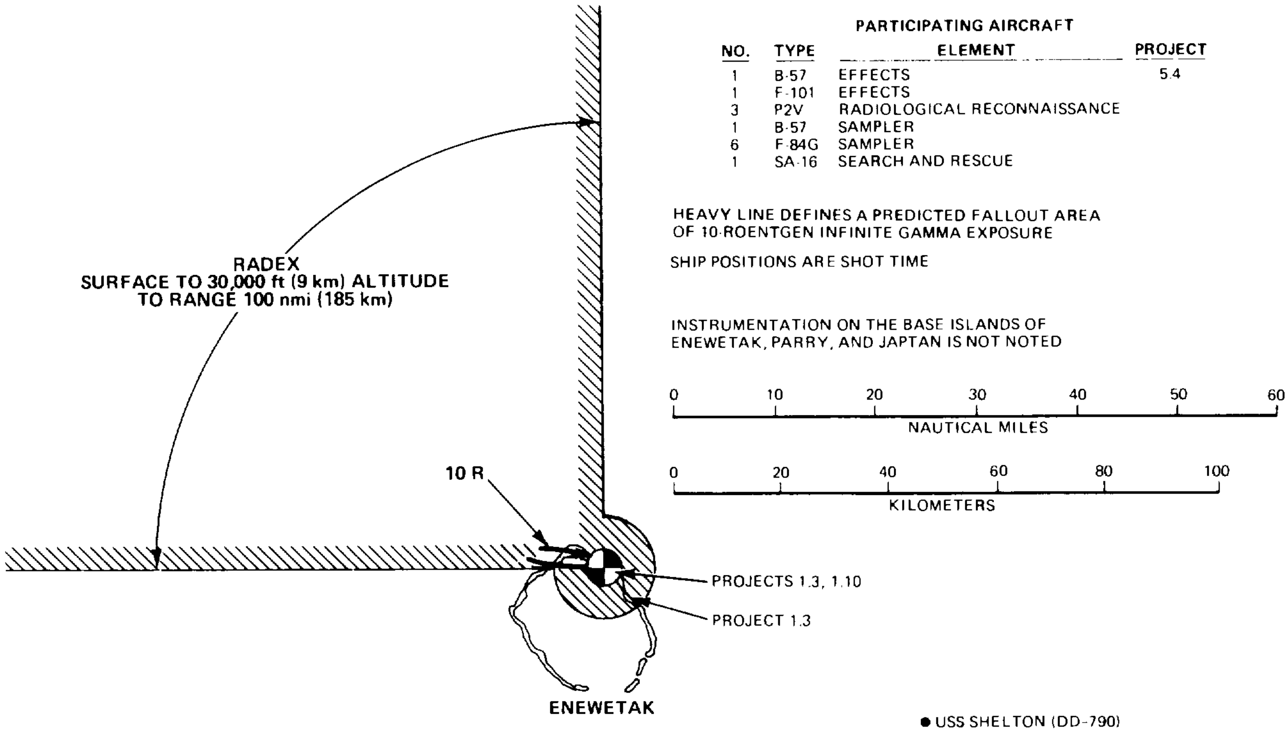


Figure 57. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for INCA, REDWING.

Table 37. H-hour positions of effects aircraft, INCA, REDWING.

	B-57B[a]	F-101A[b]
Direction from burst (°)	---	060
Slant range (km)	3.1	3.2
Altitude (km)	3.0	27
Heading (°)	050	041

Notes:

[a]The B-57B pilot received 2.66 R; the engineer received 1.71 R (Reference C.1.3.1330).

[b]The F-101A pilot received 2.005 R (Reference C.1.3.1332).

The cloud reached 42,000 feet (12.8 km), with the bottom at 30,000 feet (9.1 km). The stem and cloud moved to the west at approximately 10 knots (18.5 km). The stem appeared to contain more surface debris than usual for similar-yield tower shots (Reference C.1.7.2).

The shot island and lagoon were the only areas showing appreciable radiation during the initial radsafe survey made at H+1 to H+3.5. Exposure rates of 2700 R/hr were reported at H+1 from the shot island, but adjoining islands gave H+1 values of about 1 R/hr (Reference A.4). Contamination on the adjacent island of Eleleron did not interfere with preparations for firing MOHAWK (Reference C.1.3.1). Enewetak Atoll surveys are summarized in Table 38.

The radioactive cloud was tracked by P2V aircraft to a range of 100 nmi (185 km). At that point the cloud was approximately 50 nmi (93 km) long and 15 nmi (28 km) across, with an average radiation intensity of 0.050 R/hr at 10,000 feet (3.1 km).

The pilot of the F-101A and the pilot and engineer of the B-57B effects aircraft all received exposures on this shot (see Table 37). No detailed information concerning their flight plans has been found, but it seems probable that they received this radiation exposure from "initial radiation" and not from subsequent cloud debris. The following extract from the report detaling the effects on the B-57B aircraft indicates that operational adjustments were made to maximize test results and still stay within the limits of the MPE (Reference C.1.3.1330).

> In the preceding events, the one rem positions were not limiting and gust remained the limiting factor (for aircraft positioning). It was desired that gust loading be limiting for this event (Inca) also. The total radiation received up to this time was 1.15 rem from Shots Lacrosse and Erie. Since Shot Blackfoot participation was cancelled and none of the remaining devices were expected to result in the receipt of measurable radiation, this permitted a total of 2.75 rem to be received from this detonation before the 3.9 rem specified limit would be attained. The aircraft was thus positioned for the limiting gust loads and an actual value of 2.66 rem of nuclear radiation was received by the pilot of the aircraft.

Table 38. Summary of Enewetak radiological surveys after INCA, REDWING.

Island	Survey Reading (R/hr) (on ground except as noted)			
	H+1.5[a]	H+3.5[b]	D+1[c]	D+2[c]
Bokoluo	---	0.010	0.03	0.5
Dridrilbwij	---	---	3	---
Bokaidrikdrik	---	---	12	---
Boken	---	0.01-0.05	30.0	27
Enjebi	---	0-0.1	0.010	0.02
Aej	---	---	0.2	0.12
Lujor	0.2	5-10	1-70	30
Eleleron	0.01	0.5-1	0.01	---
Aomon	0.008	---	2	2.5
Bijire	0.008	0.01-0.05	0.05	---
Lojwa	0.008	---	0.006	---
Billae	0	---	0.003	---
Runit	0	0.01-0.05	0.05-3	3
Ananij	---	0.01-0.05	---	---
Mut	---	0-0.1	---	---
Biken	---	0	---	---

Notes and Sources:

[a]Reference C.1.7.2.

[b]Yoke flight readings at 1,000 feet (305 meters); (Reference C.1.7.2)

[c]Reference C.1.1I.

MOHAWK

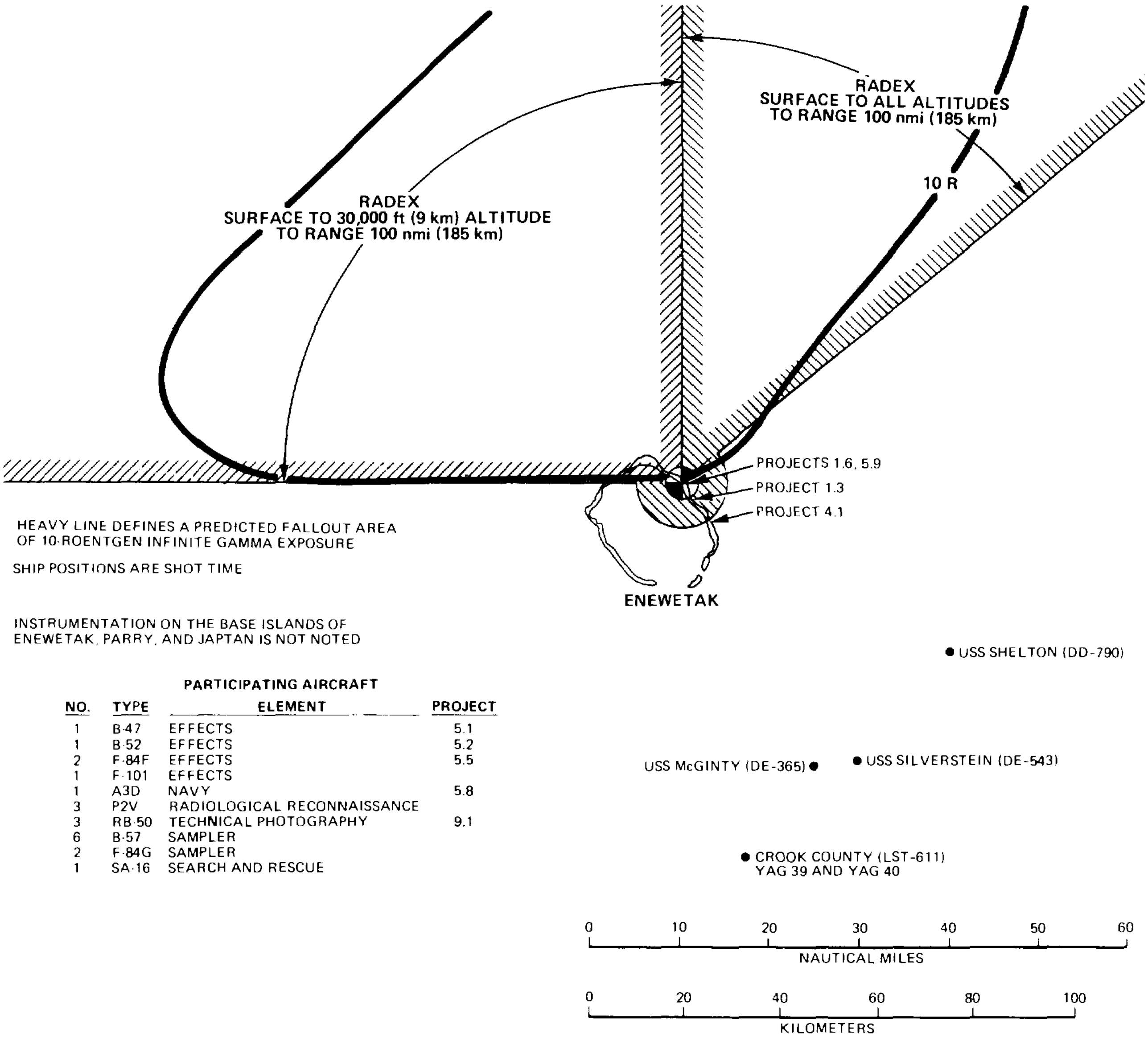
MOHAWK, a UCRL device, was fired on a tower on Eleleron Island. The shot was detonated at 0606, 3 July 1956.

The DOD scientific experiments for MOHAWK are listed below.

- Program 1 -- Blast Effects: Projects 1.3, 1.8, 1.9
- Program 2 -- Nuclear Radiation: Projects 2.64, 2.65

- Program 4 -- Biological Effects: Project 4.1
- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.5, 5.6, 5.7, 5.9
- Program 6 -- Electromagnetic Effects: Projects 6.1a, 6.1b, 6.3, 6.4, 6.5
- Program 9 -- Photography: Project 9.1.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 58.



PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-47	EFFECTS	5.1
1	B-52	EFFECTS	5.2
2	F-84F	EFFECTS	5.5
1	F-101	EFFECTS	
1	A3D	NAVY	5.8
3	P2V	RADIOLOGICAL RECONNAISSANCE	
3	RB-50	TECHNICAL PHOTOGRAPHY	9.1
6	B-57	SAMPLER	
2	F-84G	SAMPLER	
1	SA-16	SEARCH AND RESCUE	

Figure 58. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for MOHAWK, REDWING.

Twenty-seven aircraft participated in this shot, five of which were effects aircraft. Table 39 shows locations and headings for these effects aircraft at shot time. The F-101A was about 4 nmi (7.4 km) from the detonation and the pilot received no radiation exposure. Sampler aircraft consisted of five F-84Gs and five B-57s. There was one B-57 controller aircraft.

Table 39. H-hour positions of effects aircraft, MOHAWK, REDWING.

	F-84F	F-84F	B-47E	F-101A	B-52
Direction from burst (°)	072	187	123	220	--
Slant range (km)	6.1	11	19.1	7.1	8.1
Altitude (km)	6.1	7.1	11.2	6.9	7.6
Heading (°)	071	061	020	040	--

The effective surface and air radex areas from H-hour to H+6 were:

Surface to 30,000 feet (9 km) altitude:	Bearing 270° to 360°T; 100-nmi (185-km) range.
Surface to all altitudes:	Bearing 0° to 50°T; 100-nmi (185-km) range
Surface to all altitudes:	5 nmi (9 km) around shot island.

The cloud rose to 65,000 feet (19.8 km). Cloudy conditions at Enewetak Atoll prevented early lagoon and atoll survey by P2V aircraft. The P2Vs established barrier monitoring patterns on bearings of 260° and 80°, 20 nmi (37 km) west and 5 nmi (9 km) east of Japtan. No radiation above background was noted on these flights and reentry was set for 0800 (Reference C.1.7.2).

High radioactivity on the shot island was measured. In addition, radioactive fallout was deposited on the northern islands of the atoll. Intensity was such that the aircraft taking photographs for Project 1.8 had fogged film at H+2. Sampler pilot exposures were from 2.4 to 3.2 R. Recovery operations on Eleleron and adjacent islands were delayed for several days as a result of the contamination.

An unforecast wind shift at about shot time at the 15,000- to 20,000-foot (4.6- to 6.1-km) level brought radioactive material, along with intermittent showers, to Parry throughout the morning (Reference C.1.7.2). The radioactivity was first recorded about 2 hours after burst and continued for 1 hour. Peak intensity was 0.002 R/hr (Reference A.4). Off-atoll stations reported no increase in background through D+3 (Reference C.1.7.2). Enewetak radsafe surveys are summarized in Table 40.

Table 40. Summary of Enewetak radiological surveys after MOHAWK, REDWING.

Island	Ground Survey Reading (R/hr)		
	H+3[a]	H+9[b]	D+2[b]
Bokoluo	0.2	0.54	0.2
Dridrilbwij	3	2.4	2.4
Bokaidrikdrik	4.4	4.5	4.4
Boken	0.8	2.7	---
Enjebi	0.4	0.9	0.3
Aej	1	---	0.07
Lujor	20	---	3.6
Eleleron	320	560	49
Aomon	1.2	12	3
Runit	---	4	1.2-4
Parry	0.012	---	---

Sources:

[a]Reference C.1.7.2.

[b](Reference C.1.1M).

APACHE

APACHE was a UCRL device detonated on a barge anchored in the MIKE crater between Bokinwotme and Dridrilbwij islands. The event was fired at 0606 on 9 July 1956.

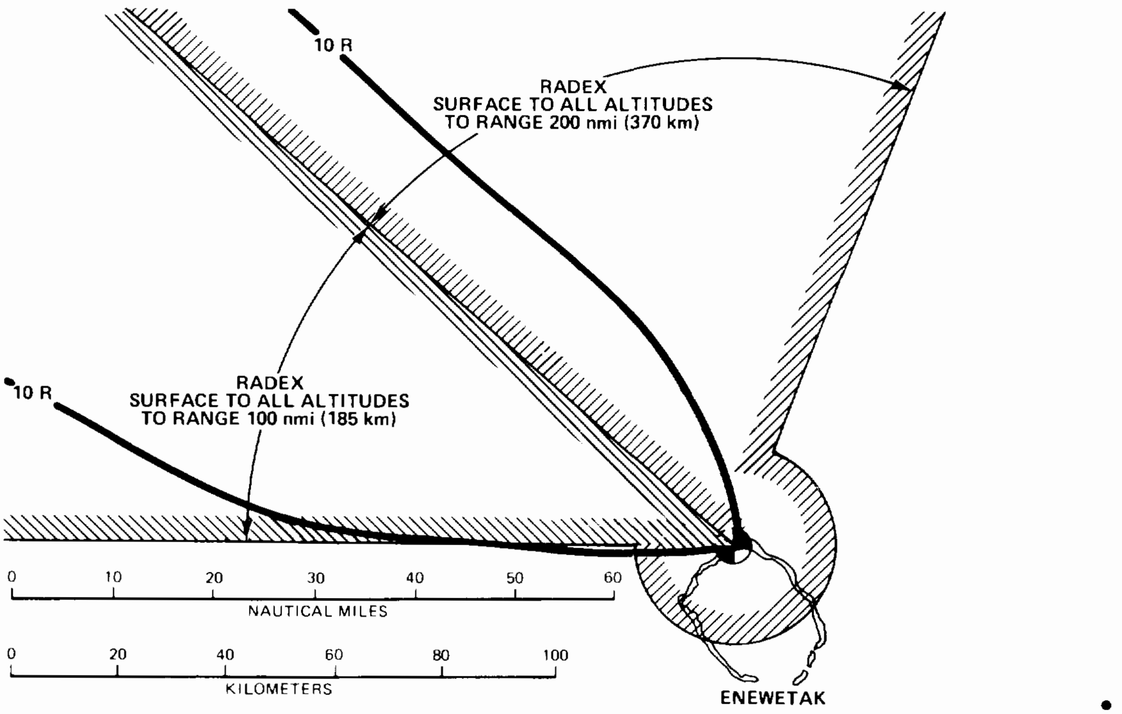
The DOD scientific experiments for APACHE are listed below.

- Program 1 -- Blast Effects: Project 1.9
- Program 2 -- Nuclear Radiation: Project 2.65

- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
- Program 6 -- Electromagnetic Effects: Projects 6.1a, 6.1b, 6.3, 6.4, 6.5
- Program 9 -- Photography: Projects 9.1a, 9.1b.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown in Figure 59.

Thirty-five aircraft took part in the shot, seven of which were effects aircraft. The positions and headings of these effects aircraft are shown in Table 41.



USS JAMES E. KYES (DD-787)

USNS FRED C. AINSWORTH (T-AP-181)

PARTICIPATING AIRCRAFT

NO.	TYPE	ELEMENT	PROJECT
1	B-47	EFFECTS	5.1
1	B-52	EFFECTS	5.2
1	B-57	EFFECTS	5.4
1	B-66	EFFECTS	5.3
2	F-84F	EFFECTS	5.5
1	F-101	EFFECTS	
2	B-47	IBDA	
1	C-97	IONOSPHERE	6.3
1	A3D	NAVY	5.8
3	P2V	RADIOLOGICAL RECONNAISSANCE	
4	B-57	EARLY PENETRATION	
3	RB-50	TECHNICAL PHOTOGRAPHY	9.1
5	B-57	SAMPLER	
4	F-84G	SAMPLER	
2	C-54	DOCUMENTARY PHOTOGRAPHY	
1	SA-16	SEARCH AND RESCUE	

HEAVY LINE DEFINES A PREDICTED FALLOUT AREA OF 10-ROENTGEN INFINITE GAMMA EXPOSURE

SHIP POSITIONS ARE SHOT TIME

INSTRUMENTATION ON THE BASE ISLANDS OF ENEWETAK, PARRY, AND JAPTAN IS NOT NOTED

Figure 59. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for APACHE, REDWING.

Table 41. H-hour positions for effects aircraft, APACHE, REDWING.

	A3D	F-84F	F-84F	B-47E	B-66	B-57B	F-101A	B-52
Direction from burst (^{o})		078	187	360	080	--	220	--
Slant range (km)	7.9	11.2	17.3	12.5	7.5	9.2	7.6	11.8
Altitude (km)	7.9	9.6	10.9	9.1	2.4	3.1	4.5	10.4
Heading (^{o})	--	072	060	320	080	055	040	--

The effective surface and air radex areas from H-hour to H+6 were:

Surface to all altitudes:	Bearing 270^{o} to 310^{o}T; 100-nmi (185-km) range.
Surface to all altitudes:	Bearing 310^{o} to 20^{o}T; 200-nmi (370-km) range
Surface to all altitudes:	10 nmi (19 km) around shot island until H+1.

The cloud reached an altitude of about 67,000 feet (20.4 km). It retained a symmetrical shape in low winds for about an hour, then the section of stem below 15,000 feet (4.6 km) began to drift west-northwest. Radar observed the major portion of the cloud drifting on a course of about 30^{o}. The cloud center was about 65 nmi (120 km) from surface zero in about 4 hours.

While conducting the lagoon and atoll survey, a P2V aircraft encountered a radiation field of 1.1 R/hr in the vicinity of the shot site at 1020 while flying at 1,000 feet (305 km). The aircraft was contaminated to a level of about 1 R/hr until the pilot was able to fly through a rain shower and reduce his aircraft background to about 0.15 R/hr. The aircraft immediately returned to base (Reference C.1.7.2). It is unknown if the P2V returned to Kwajalein or to Enewetak Island for decontamination.

A rise in radioactivity was recorded at Parry at 2300 (H+17). A maximum level of 0.0011 R/hr occurred at 0200 (H+20) (Reference C.1.7.2).

The APACHE detonation produced exceptionally heavy fallout throughout the northern islands of the atoll. Water in the northern end of the lagoon was also highly radioactive (Reference A.4). On D+2, the swimming beach at Japtan was closed because of lagoon radioactivity. On D+3, beaches at Parry and Enewetak islands were also closed (Reference C.1.3.1).

No fallout was reported at any of the offsite monitoring stations. Survey information for Enewetak Atoll is summarized in Table 42.

Table 42. Summary of Enewetak radiological surveys after APACHE, REDWING.

Island	Ground Survey Reading (R/hr)		
	H+4[a]	H+9[b]	D+2[b]
Bokoluo	71	28	2.6
Dridrilbwij	3,000	1,200	10
Boken	91	38	3
Enjebi	61	24	3
Lujor	41	16	2.2
Eleleron	41	---	2.2
Aomon	18	---	0.9
Bijire	10.5	---	0.7
Lojwa	12.5	---	0.7
Billae	4	---	---
Runit			
North	10.5	4	0.5
Center	7.8	3	0.5
South	0.020	0.008	0.003
Ananij	0.020	0.008	---
Parry	0	---	---

Sources:

[a]Reference C.1.7.2.

[b]Reference C.1.1A.

Measurement of the APACHE fireball required that a line of sight be constructed across the SEMINOLE crater. Radiation levels at the crater were 4 to 5 R/hr at the time construction was required, and a shielded bulldozer was used to move the earth. Operators were frequently changed. The highest exposure reportedly received by any one operator was 0.7 R after about 6 hours of bulldozer operation (Reference C.1.3.1).

HURON

HURON, the last shot of the REDWING series was detonated at 0612, 22 July 1956, from a barge moored in the MIKE crater off Dridrilbwij at Enewetak.

A circular surface radex area was in force until H+1, centered on the burst point with a radius of 10 nmi (19 km) and extended upward. Effective surface and air radex areas for H-hour to H+6 were the sector bearing 270° to 360° to all altitudes to a range of 100 nmi (185 km).

DOD scientific experiments are listed below.

- Program 5 -- Aircraft Effects: Projects 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
- Program 6 -- Electromagnetic Effects: Projects 6.1a, 6.1b, 6.3, 6.4, 6.5
- Program 9 -- Photography: Projects 9.1a, 9.1b.

The surface radex area, predicted fallout pattern, and locations of DOD project instrumentation and task force ships are shown are Figure 60.

Twenty-one aircraft participated in the shot (Reference C.4.3). Five effects aircraft were in position for this shot, as shown in Table 43. Three B-57s and four F-84F sampler aircraft were used for this shot. As usual, there was one B-57 control plane. Ships were not withdrawn from the lagoon for this event.

Nonmission TG 7.4 aircraft supported TG 7.1 special missions as before. Eighteen personnel were ferried back and forth on D-1 and twenty-one on D-day. Helicopters performed radsafe surveys at H+1 and were used to recover high-priority experiments.

Cloud tracking by radar showed the major portion of the cloud at H+2 was centered on a bearing of 275° with the tip at a distance of 39 nmi (72 km). The southern edge was on a bearing of 255°, and there was a bulge to the north at 315° at 30 nmi (56 km) (Reference C.1.7.2).

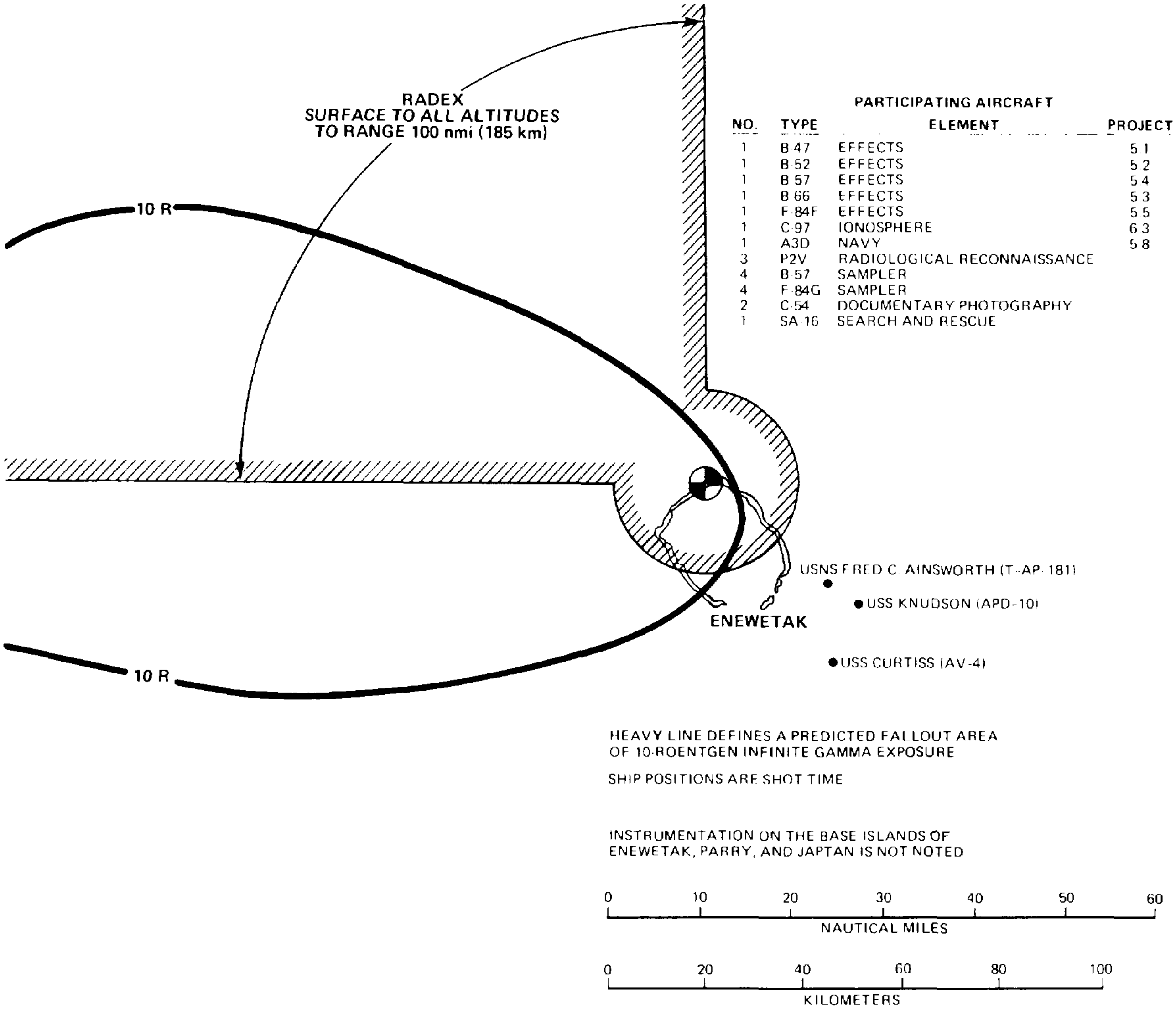


Figure 60. Radex areas, predicted fallout areas, locations of task force ships and DOD project instrument sites, and list of participating aircraft for HURON, REDWING.

Table 43. H-hour positions for effects aircraft, HURON, REDWING.

	A3D	B-84F	B-47E	B-66	B-57B	B-52
Direction from burst (°)	--	192	117	040	--	--
Slant range (km)	5.1	6.8	15.9	4	5.8	6.3
Altitude (km)	3.7	5.5	6.7	2.65	4.9	6.1
Heading (°)	--	058	000	040	051	--

Fallout on the northern islands was heavy (2 R/hr). At Enjebi at H+4 it was 2 R/hr. Closer into the detonation point it was about 200 R (Reference C.1.7.1). Surveys of the Enewetak radiological condition are summarized in Table 44.

Table 44. Summary of Enewetak radiological surveys after HURON, REDWING.

Island	Survey Reading (R/hr) (on ground except as noted)			
	H+2-3[a]	D+1[b]	D+2[b]	D+3[b]
Bokoluo	---	0.2	0.2	0.19
Dridrilbwij	0.5[c]	8.8-25	4.4-60	18-53
Bokaidrikdrik	---	2.3	2.4	4.4
Boken	---	0.115	0.140	0.170
Enjebi	0.6	0.17-0.24	0.15-0.20	0.14-0.18
Eleleron	---	1.1	1.1	0.12
Aomon	0.2	0.04	---	---
Bijire	0.16	---	0.05	0.04
Billae	0.15	0.05	0.38	0.25
Runit	---	0.50	---	---

Notes and Sources:

[a]Reference C.1.1H.

[b]Reference C.1.7.2.

[c]At 1,000 feet (305 meters) over shot area.

HURON was fired while the base islands were still receiving radioactive fallout from the TEWA cloud, but HURON did not add any more to this. The fallout from HURON apparently did not reach farther south on Enewetak Atoll than Runit, which was showing 0.5 R/hr at H+4 (Reference C.1.7.1). Off-atoll fallout may have reached Ujelang, although the increased radioactivity there about 6 hours after the shot could have resulted from TEWA. A summary of the Ujelang radiation is given in Chapter 4 with the discussion of TEWA.

ANOMALOUS RADIATION EXPOSURES

In connection with Project 2.51, a plutonium foil spilt open, releasing an estimated 100 mg of oxidized plutonium into the counting trailer. Alpha contamination was spread to other areas, unfortunately, as project personnel continued to use the trailer after the accident. Monitoring subsequently showed that ten persons had been contaminated. Twenty-hour urine specimens contained low levels of plutonium. One barracks and four tents required decontamination, and some clothing and personal belongings were confiscated and destroyed. Mess hall and latrine facilities were monitored, but did not reveal contamination. Three contaminated trailers were sealed and moved to the decontamination pad, and contaminated equipment and other items were disposed of at sea (Reference C.1.7.1).

A second incident was the 5-R exposure of a dental technician aboard USS Badoeng Strait from X-rays, apparently due to faulty X-ray equipment (Reference C.3.2).

POST-REDWING ACTIVITY

Some post-REDWING activity involving DOD personnel probably posed a potential for radiological exposure, but this was delayed data-recovery activity, not activity associated with closing down the operation. TG 7.1 Project 5.9 (WADC and contractors) returned to Enewetak in September and October of 1956 to recover material samples on the islands of Runit and Eleleron. These samples had been exposed on lightweight towers near the ERIE and MOHAWK shots, and the completion of the project required recovery and direct inspection of the samples. The area in which the samples were expected to be found was too radioactive immediately after the test to permit work, and so the later recovery was done. This later recovery involved digging in the surface layers of the island.

CHAPTER 6

U.S. ARMY PARTICIPATION IN OPERATION REDWING

Army participation in REDWING involved about 1,600 men. The primary function of the Army units involved was garrisoning Enewetak Island. Army units had been at Enewetak since the first nuclear tests there in 1948. When tests were not being conducted, these units remained and provided a continuing military presence. After the establishment of the permanent task force organization in 1953, the commander of the major Army unit at Enewetak, who was commander of the task force's Task Group 7.2 (TG 7.2), acted as Atoll Commander for Commander, Joint Task Force 7 (JTF 7).

Army units also provided long-distance communications facilities and military police for the task force. Various Army laboratories conducted experiments during REDWING, and one unit provided radiological safety (radsafe) services for TG 7.1 and for the rest of the task force.

Army units at REDWING and Army units having representatives badged during the series are listed below. Table 45 summarizes personnel exposures for the men identified as U.S. Army or civilian personnel employed by Army organizations except the men assigned to joint Department of Defense (DOD) agencies and the Army observers discused in Chapter 10.

Anti-Aircraft Artillery and Guided Missile (AA&GM) Center, Fort Bliss, Texas. AA&GM was represented by one person badged with Hq JTF 7. This organization had provided radsafe personnel for CASTLE, and this man may have served in this capacity or, perhaps, as liaison or observer. His exposure is combined with Misc Army in Table 45.

Army War College, Carlisle Barracks, Pennsylvania. A single representative from this organization was badged with Hq JTF 7. His function is not known. His exposure is combined with Misc Army in Table 45.

Ballistic Research Laboratories (BRL), Aberdeen Proving Ground, Maryland. Twenty-nine men from this organization participated in Projects 1.1 and

Table 45. REDWING personnel exposure, U.S. Army organizations.

Element	No. of Persons Badged	Exposure Ranges (roentgens) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	Over 3.9[a]	High (R)	Collective Exposure (man-R)	Mean Exposure (man-R)
Ballistic Research Laboratories															
Military	12	1	7	1		1	2						2.1	8.8	0.729
Civilian	17		5	5	3	3	1						2.4	16.3	0.956
Total	29	1	12	6	3	4	3						2.4	25.0	0.862
Chemical Corps															
Military[b]	27		4	3			1	1	6	9	3	12	6.9	92.3	3.417
Civilian	18		4	2		1	1	3	6	1		1	4.7	40.3	2.236
Total	45		8	5		1	2	4	12	10	3	13	6.9	132.5	2.944
Engineer R&D Laboratories	1				1								1.1	1.1	1.1
Signal Corps Pictorial Ctr (Mil)	6			3				1	1	1		1	4.6	13.0	2.167
Signal Laboratories															
Military[b]	15	1	1	1	1	1	1	2	2	5		5	4.6	41.3	2.750
Civilian	19	1	3		2	1	2		4	4	2	4	5.0	56.5	2.974
Total	34	2	4	1	3	2	3	2	6	9	2	9	5.0	97.8	2.875
Southeastern School (Military)	3	2			1								1.2	1.2	0.400
1st RSSU	135	1	9	8	18	19	11	10	21	19	19	42	7.6	417.8	3.094
Company "C" 505th MP Battalion	255	1	10	67	12	28	52	42	24	16	3	20	5.2	527.8	2.020
902nd CIC Detachment	8		1	1			3	2	1				3.5	16.8	2.094
7126th Army Unit															
Hq & Hq Detachment	518	4	42	67	10	17	39	89	167	72	11	94	5.7	1,427	2.754
Service Detachment	305	2	13	58	1	2	24	40	135	25	5	39	6.9	838.0	2.748
Transport Detachment	164	1	6	30	2		3	18	64	38	2	42	5.9	492.8	3.005
Military Police Detachment	48	1		7		2	4	5	23	6		8	4.6	139.0	2.896
Total 7126th AU	1,035	8	61	162	13	21	70	152	389	141	18	183	6.9	2,896	2.798
8452nd AAU, Sandia Base	1					1							1.8	1.8	1.8
8600th AU, 2nd ASA	43		1	28	14								1.3	38.8	0.901
Misc Army Organizations[c]	17	4	10	1		1	1						1.7	7.3	0.427
Total Army	1,612	19	115	282	65	77	145	213	454	196	45	268	7.6	4,177	2.591

Notes:

[a]Basic Maximum Permissible Exposure (MPE) was 3.9 R (gamma) per 13-week period.

[b]Two badges not returned.

[c]One badge not returned.

Source: Reference C.1.7.3.

1.5 and provided instrumentation for Projects 1.2, 1.9, 1.10, 3.1, and Sandia experiments as part of TG 7.1.

Chemical Corps Activities, Edgewood Arsenal, Maryland. Several related organizations participated and were designated variously "ACC," "Chemical Research Lab," or "Chemical Warfare Lab." This group of 45 was responsible for Projects 2.4, 2.51, 2.65, and 8.3, together with the "9710th TU CC." In the presentation of their exposures (Table 45), all personnel with these designations have been grouped under the Chemical Corps personnel. Over one-quarter of these men exceeded the series maximum permissible exposure (MPE) of 3.9 R.

Continental Army Command (CONARC). Two representatives were badged with Hq JTF 7, but their duties have not been established. Their exposures have been included in Misc Army in Table 45.

Department of the Army. Two representatives were badged simply as "DEPTAR" in the Hq JTF 7 group. No further identification is available. Exposures are included with Misc Army.

Engineer Research and Development Laboratory (ERDL), Fort Belvoir, Virginia. ERDL was responsible for the Project 1.8 crater survey, although only one person has been found in the Consolidated List for this agency. Actual project measurements were made by Holmes & Narver (H&N) personnel.

Naval Supply Center (NSC), Oakland, California. Two men identified as Army by serial number were noted as being affiliated with this organization on the Hq JTF 7 list. Their exposures are included with Misc Army.

Office of Chief Signal Officer (OSCIGO). One man was identified who was affiliated with this office in the Hq JTF 7 list. His exposure is included under Misc Army.

Pictorial Center, Long Island City, New York. This agency operated a TV transmitter that brought weather information from Enewetak to Parry, and six men, three on the TG 7.1 and three on the TG 7.4 lists, have been identified as either "SCPC" or "Army Pictorial Center." However, a sampling of the 5x8 dosimetry cards (Reference C.1.7.4) showed that one of the TG 7.1 "SCPC" men had several mission badges, which is inconsistent with Enewetak-Island-only duty. Exposures for this group are included in Table 45 under Signal Corps Pictorial Center.

Signal laboratories and test units including, Signal Corps Engineering Laboratory, Evans Signal Laboratory, 9045th and 9677th Test Units, and simply Fort Monmouth. These designations were used to identify the men listed with a 33-man group that staffed Projects 2.1, 2.2, and 6.5. Exposures have been combined in Table 45 under Signal Laboratories.

Signal Plant Engineering Agency. This agency surveyed the radio communication facilities of TG 7.2 and oversaw their improvements in the pre-REDWING phase. One person with this affiliation was badged with Hq JTF 7 and his exposure has been included under Misc Army.

Southeastern Signal School, Fort Gordon, Georgia. This group provided "operating teams" for radio stations at Wotho, Utirik, and Ujelang (Reference C.2.2). Three men from the "9600 S.E. School Camp Gordon" were listed on the Hq JTF 7 list.

Walter Reed Medical Center, Washington, D.C. One man from this organization was badged with Hq JTF 7, and his exposure is included in Table 45 with Misc Army.

1st Radiological Safety Support Unit, Fort McClellan. This unit provided 135 men for TU 7 (Radiological Safety) of TG 7.1. This unit's activities are the subject of Chapter 2 of this report.

8th Signal Co., 8th Infantry Division. One person was included in the TG 7.1 list and may have either been involved with Signal Corps experimental activity or with communications. His exposure is in Table 45 included with Signal Laboratories.

505th Military Police Battalion Co. "C". The organization was brought in to supplement the military police detachment of the 7126th Army Unit. It was part of TG 7.2 and reported to the TG 7.2 Provost Marshal. Personnel arrived in three groups in February and March. They were stationed throughout both Bikini and Enewetak atolls, and in early April the guard posts were located as follows:

Enewetak Atoll		Bikini Atoll	
Enewetak Island	17	Eneu	39
Runit	20	Lomilik	16
Lojwa	20	Eneman	30
Dridrilbwij	29		

An additional guard post was set up 27 June at Ananij (Enewetak). The policy of CTG 7.2 was to rotate the personnel among the guard posts (Reference C.2.2).

As the advance camps were progressively closed, the requirements for guard posts were reduced, and as early as June 1956, 71 of these Company C MPs had been withdrawn. Following HURON, all but 24 returned to the United States and the last group left on about 1 August.

902nd CIC Detachment, Sub Detachment C. Eight men from this organization were part of Hq JTF 7. Five were stationed at Enewetak, three were on Parry, and one on Eneu. Exposure data are given in Table 45.

4054th SU, Fort Bliss, Texas. One scientific officer was affiliated with this group on the TG 7.1 list. He may have been a scientific observer or an unacknowledged project participant. His exposure is in Table 45 under Misc Army.

7126th Army Unit. This organization provided the bulk of the personnel for TG 7.2. It was the permanent garrison force at Enewetak between CASTLE and REDWING. Except for its military police detachment and several mail clerks on Eneu and Parry, the 7126th was stationed on the island of Enewetak. Military police were used throughout the atoll. The 7126th Army Unit was reorganized for REDWING into the following four detachments: Headquarters, Service, Transportation, and Military Police. The 7126th operated base facilities on Enewetak Island for tenant units and its own components. It provided security and ground defense for the atoll, operated the military communications system, and conducted radsafe functions on Enewetak Island.

8452nd AAU, Sandia Base. One man, whose organization was noted as "8542 Sandia Base," was probably from this Army unit, which provided administrative services to Army personnel serving with the Armed Forces Special Weapons Project (AFSWP) Field Command at Sandia Base, or at LASL.

8600th Army Unit of the 2nd Army Security Agency Detachment. The 8600th provided security support for CJTF 7 as an element of TG 7.2. This group arrived at Enewetak in January 1956 and established monitoring stations on Enewetak Island that month and one on Eneu in February. The total strength of the unit was four officers and thirty-eight enlisted men.

The Enewetak detachment consisted of three officers and twenty-six enlisted men. This unit discontinued operations on 14 July. The Eneu detachment of one officer and twelve enlisted men discontinued Eneu operations on 10 July and moved to Bikini. The entire group was evacuated from Enewetak to the United States by air on 15 July.

In addition, several Army personnel were present whose only permanent unit identification was a notation of an Army post. These have been grouped under Misc Army and include one from Fort Eustis, Virginia, two from Fort Lewis, Washington (these three were badged with TG 7.1), one from Fort Gordon, Georgia (badged with TG 7.5), and one from Fort Shafter, Hawaii (badged with Hq JTF 7).

CHAPTER 7

U.S. NAVY PARTICIPATION IN OPERATION REDWING

Navy participation in REDWING involved about 5,700 men, primarily based on ships operating around Bikini Atoll. Other Navy personnel served ashore at Enewetak in various command, scientific, and support capacities.

Important functions performed by the Navy were surveillance of the test area by air and sea, provision of ship-based scientific instrumentation stations, movement of test devices and supplies, weather observations, and bulk logistic support. The Commander of Joint Task Force 7 (CJTF 7) was a naval officer.

Personnel from Navy organizations participated in REDWING primarily in Task Group 7.3 (TG 7.3). The organization of TG 7.3 is described in Chapter 1 in detail. Naval laboratories provided personnel for scientific projects in TG 7.1, which are detailed in Chapter 3.

These naval units are discussed below in two groupings. The first is Navy ship units, and the second is composed of the various Navy aircraft units, laboratories, bureaus, and specialized support agencies that participated in REDWING. For each organization treated a brief description of its REDWING activities is given. Table 46, which is arrayed in the same order as the discussion, presents a summary of the available exposure information for the personnel from each unit.

NAVY SHIPS

The following ships participated in REDWING. Most of the ship units participated in Bikini operations. The standard operating area for the ships during the shots and until Eneu Anchorage was given a radiological clearance was southeast of the atoll at ranges from 20 to 40 nmi (37 to 74 km). The summary of activities provided in this chapter for the most part comes from ships' deck logs (Reference C.3.1.1) and occasionally from the <u>TG 7.3 History</u> (Reference C.1.3.1), the <u>TG 7.3 Commander's Report</u> (Reference C.1.3.2), and other sources as noted.

Table 46. REDWING personnel exposure, U.S. Navy organizations.

Element	No. of Persons Badged	No Reading	Exposure Ranges (roentgens) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	Over 3.9[a]	High (R)	Collective Exposure (man-R)	Mean Exposure (R)
OTHER NAVAL UNITS (continued)																
Bureau of Aeronautics																
Military[b]	8			2	1			1	1	3			1	4.0	16.75	2.094
Civilian	6		1	3		1	1							2.0	3.75	0.625
Total	14		1	5	1	1	1	1	1	3			1	4.0	20.5	1.464
Bureau of Medicine & Surg (Mil)	1				1									0.7	0.7	0.7
Bureau of Ships																
Military	1										1		1	4.7	4.7	4.7
Civilian[b]	5			2		1		1		1				3.4	7.5	1.5
Total	6			2		1		1		1	1		1	4.7	12	2
Fleet Weather Centers	3								2	1				3.3	9	3
Naval Air Special Weapons Facility (Military)[c]	37	1	2	7	6	1		6	4	8	2		2	4.9	69	1.865
Naval Air Station, Kwajalein	8		2	6										0.1	1.5	0.188
Naval Ordnance Laboratory																
Military[d]	3		1	1	1									0.5	1	0.333
Civilian[b]	12		1	11										0.3	2.75	0.229
Total	15		2	12	1									0.5	3.75	0.25
Naval Radiological Defense Laboratory																
Military[e]	37			3	2	5	3	4	9	5	5	1	6	5.9	95	2.568
Civilian[e]	107	1	2	24	12	13	19	9	8	12	4	3	7	5.4	189.3	1.769
Total	144	1	2	27	14	18	22	13	17	17	9	4	13	5.9	284.3	1.974
Naval Research Lab (Civilian)[d]	29		10	12	2	4	1							1.2	11.25	0.388
Naval Shipyards (Civilian)[d]	37			1	5	16	3	1	8	3				3.6	64	1.73
Patrol Squadron One (VP-1)	354	3	1	5	158	141	43	2		1				3.5	379.3	1.071
Transport Squadron Three (VR-3), Moffett NAS	181		29	98	23	14	5	5	6	1					99.25	0.548
Transport Squadron Eight (VR-8)	10	9	1											0	0	0
MISC NAVY	6			1			2	1		2				3.8	13	2.167
Total REDWING Navy[f]	5,721	40	312	1,953	1,752	909	354	134	112	109	38	8	53	6.2	4,780	0.836

Notes:

[a] Basic Maximum Permissible Exposure (MPE) was 3.9 R (gamma) per 13-week period.

[b] One badge not returned.

[c] Five badges not returned.

[d] Two badges not returned.

[e] Four badges not returned.

[f] Includes 66 Marine Corps personnel on USS Curtiss (AV-4) and 17 Marine Corps personnel on USS Estes (AGC-12).

Source: Reference C.1.7.3.

Table 46. REDWING personnel exposure, U.S. Navy organizations (continued).

Element	No. of Persons Badged	No Reading	Exposure Ranges (roentgens) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	Over 3.9[a]	High (R)	Collective Exposure (man-R)	Mean Exposure (R)
OTHER NAVAL UNITS (continued)																
Bureau of Aeronautics																
Military[b]	8			2	1			1	1	3			1	4.0	16.75	2.094
Civilian	6		1	3		1	1							2.0	3.75	0.625
Total	14		1	5	1	1	1	1	1	3			1	4.0	20.5	1.464
Bureau of Medicine & Surg (Mil)	1				1									0.7	0.7	0.7
Bureau of Ships																
Military	1										1		1	4.7	4.7	4.7
Civilian[b]	5			2		1		1		1				3.4	7.5	1.5
Total	6			2		1		1		1	1		1	4.7	12	2
Fleet Weather Centers	3								2	1				3.3	9	3
Naval Air Special Weapons Facility (Military)[c]	37	1	2	7	6	1		6	4	8	2		2	4.9	69	1.865
Naval Air Station, Kwajalein	8		2	6										0.1	1.5	0.188
Naval Ordnance Laboratory																
Military[d]	3		1	1	1									0.5	1	0.333
Civilian[b]	12		1	11										0.3	2.75	0.229
Total	15		2	12	1									0.5	3.75	0.25
Naval Radiological Defense Laboratory																
Military[e]	37			3	2	5	3	4	9	5	5	1	6	5.9	95	2.568
Civilian[e]	107	1	2	24	12	13	19	9	8	12	4	3	7	5.4	189.3	1.769
Total	144	1	2	27	14	18	22	13	17	17	9	4	13	5.9	284.3	1.974
Naval Research Lab (Civilian)[d]	29		10	12	2	4	1							1.2	11.25	0.388
Naval Shipyards (Civilian)[d]	37			1	5	16	3	1	8	3				3.6	64	1.73
Patrol Squadron One (VP-1)	354	3	1	5	158	141	43	2		1				3.5	379.3	1.071
Transport Squadron Three (VR-3), Moffett NAS	181		29	98	23	14	5	5	6	1					99.25	0.548
Transport Squadron Eight (VR-8)	10	9	1											0	0	0
MISC NAVY	6			1			2	1		2				3.8	13	2.167
Total REDWING Navy	5,721	40	312	1,953	1,752	909	354	134	112	109	38	8	53	6.2	4,780	0.836

Notes:

[a]Basic Maximum Permissible Exposure (MPE) was 3.9 R (gamma) per 13-week period.

[b]One badge not returned.

[c]Five badges not returned.

[d]Two badges not returned.

[e]Four badges not returned.

Source: Reference C.1.7.3.

USS Abnaki (ATF-96)

An ocean-going tug with a normal complement of 73, Abnaki arrived at the PPG on 15 April and departed on 27 July. It was an element of the Utility Unit (TU 7.3.2). It participated in Bikini shots only. It decontaminated YFNBs after shot ZUNI. Exposure data are summarized in Table 46. Operational activities for each shot are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). No data available.
- CHEROKEE (Bikini, 21 May, 0551). In assigned operating area at time of detonation. Anchored in Bikini Lagoon at 1200, according to USS Curtiss Deck Log (Reference C.3.1.1).
- ZUNI (Bikini, 28 May, 0556). On 27 May at 1150 underway with Holmes & Narver POL barge 352 in tow; at 1731 arrived in operating area. In assigned operating area at time of detonation. On 28 May at 1200 anchored in Bikini Lagoon, according to the Curtiss Deck Log (Reference C.3.1.1). Assisted USS Lipan in decontaminating YFNB-13 and YFNB-29.
- YUMA (Enewetak 28 May 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). Anchored at mooring N-15. At 1134 underway from alongside USS Catamount at mooring N-4, Bikini, to transfer fuel; then moored alongside USS Navasota at mooring N-17, Bikini, to take on fuel. At 1644 reanchored mooring N-15, Bikini.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored in Bikini Lagoon, Eneu anchorage, based on log weather observation sheet coordinates.
- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 2008 recovered YCV-10 from FLATHEAD shot site off Iroij Island and anchored mooring N-3, Bikini. Underway for operating area at 2036. On 12 June at 0550 all hands on atomic defense stations in assigned operating area; at 0626 observed nuclear detonation bearing 333°, 25 nmi (46 km). At 0631 secured from atomic defense stations; at 0851 maneuvered to reenter lagoon. Anchored mooring N-17, Bikini, at 0917.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored in Bikini Lagoon, Eneu mooring, according to log weather observation sheet coordinates.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring N-15, Bikini.
- INCA (Enewetak, 22 June, 0956). Anchored mooring N-15, Bikini. At 1249 took YCV-10 in tow and moved to DAKOTA shot site off Iroij Island. Arrived off Iroij at 1616.
- DAKOTA (Enewetak, 26 June, 0606). On 25 June moved YCV-10 from DAKOTA shot site off Iroij Island to an unspecified anchorage in

lagoon. Underway for sortie at 1807. On 26 June at 0545 crew stationed on atomic defense stations in assigned operating area; at 0606 observed nuclear detonation bearing 320°, 25 nmi (46 km). At 0610 secured from atomic defense stations; at 0625 formed column with Catamount as a guide ship. Reentered lagoon at 0900; anchored mooring N-15, Bikini, at 0923.

- MOHAWK (Enewetak, 3 July, 0606). Anchored at NAVAJO shot site off Iroij Island YCV-10 in tow.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-15, Bikini. At 0815 underway with YCV-10 in tow to NAVAJO shot site off Iroij Island; at 1026 anchored off Iroij at shot site. Underway at 1708 with YCV-10 in tow; anchored YCV-10 in lagoon at 1905 en route to securing tow of Holmes & Narver POL barge 352. Underway at 1941 with barge 352 on shot NAVAJO sortie. Returned to Bikini anchorage the following morning, after postponement of shot NAVAJO.
- NAVAJO (Bikini, 11 July, 0556). On 10 July at 0710 cast off barge 352 with assistance of Boat Pool LCM-41 and LCM-35 and proceeded to YCV-10 anchorage. Underway at 0828 with YCV-10 in tow; at 1034 anchored at NAVAJO shot site off Iroij Island. Underway on sortie for assigned operating area at 1955 with YCV-10 in tow. On 11 July at 0545 stationed crew on atomic defense stations in assigned operating area; at 0556 observed nuclear detonation bearing 310°, 30 nmi (56 nmi). At 0603 secured from atomic defense stations. Left operating area at 0625 to take station in reentry formation. At 0800 astern USS Shelton with Catamount as guide ship reentering lagoon. Within lagoon at 0917; anchored mooring N-15, Bikini, at 1015.
- TEWA (Bikini, 21 July, 0546). On 20 July anchored off TEWA shot site on reef between Nam and Iroij islands. Underway at 2045 to tow YCV-10 to Eneu anchorage; at 2247 moored YCV-10, secured YFN-994 and underway for sortie to assigned operating area. On 21 July at 0531 crew stationed on atomic defense stations in assigned opererating area; secured atomic defense station at 0533. At 0546 observed nuclear detonation bearing 350°, 35 nmi (65 km). Departed operating area at 0619. Reentered lagoon at 0947; anchored mooring N-15, Bikini, at 1023. Underway at 1730 to go alongside USS Caliente (AO-53).
- HURON (Enewetak, 22 July, 0616). Anchored mooring N-15, Bikini; at 0616 observed nuclear detonation bearing 260°T.

AF-33. See USS Karin

AF-38. See USS Merapi

USS Agawam (AOG-6)

USS Agawam (AOG-6)

A gasoline tanker with a normal complement of 131, Agawam was in the PPG during 21, 27, 28, 31 May and 11 July and possibly remained through 16 July, returning 20 July and remaining until 26 July. The location of Agawam is of considerable interest because of the possibility that she was in the TEWA fallout zone for some time. Agawam arrived at Enewetak when the Radsafe Building on Parry was reading about 0.050 R/hr, but the extent of this fallout zone toward the south is not established. Agawam crew did not have film badges, or the records have not survived. There is no information if the ship was equipped with a washdown system. It is therefore possible that the crew received an exposure from TEWA.

AGC-7. See USS Mount McKinley

AGC-12. See USS Estes

USNS Fred C. Ainsworth (T-AP-181)

This troop transport vessel participated as the Accommodation Ship Unit (TU 7.3.9), arriving in the PPG on 25 April and departing on 23 July. It was the hotel ship for TG 7.5 evacuees during Bikini shots. Ainsworth encountered TEWA fallout when sailing to Enewetak for possible evacuation of the atoll on 21 July. The crew of 188 was primarily civilian. Exposure data are presented in Table 46. Operational activities for each shot are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). At sea in assigned operating area with five passengers embarked on duty assigned by SOPA, Bikini. Engines stopped and drifting between 0445 and 1118, approximately halfway between Enewetak and Bikini. Underway at 1118 en route to Bikini.
- CHEROKEE (Bikini, 21 May, 0551). Took on 225 passengers at Bikini and sortied for assigned operating area. Between 0536 and 0550 all persons were instructed in safety precautions, put on goggles and faced away from ground zero; at 0551 all persons were cautioned about shock wave. At 0611 all hands went below; turned sprinkler system on between 0618 and 0644; weather decks remained off limits from 0644 until 0934. Reentered lagoon at 0956; at 1049 anchored mooring N-1.
- ZUNI (Bikini, 28 May, 0556). At sea in assigned operating area with 173 passengers embarked. Between 0528 and 0554 all persons

were instructed in safety precautions, put on goggles, and faced away from ground zero; at 0556 all persons were cautioned about shock wave. At 0616 all hands went below; sprinkler system turned on between 0628 and 0702; maintained station until 1019. Reentered lagoon and anchored mooring N-1. Radsafe barge moored alongside from 1320 to 1620.

- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). On 30 May departed Bikini Lagoon at 1654. On 31 May between 0400 and 0721 in designated area halfway between Bikini and Enewetak. At 0721 en route to Bikini Atoll. On 1 June anchored mooring N-1, Bikini. Monitoring of decks between 0800 and 1200 showed decrease from 0.0012 to 0.00104 R/hr.
- SEMINOLE (Enewetak, 6 June, 0626). Anchored mooring N-1, Bikini.
- FLATHEAD (Bikini, 12 June, 0626). At sea in assigned area with 145 passengers embarked. Between 0605 and 0624 passengers instructed in safety procedures, and put on goggles. At 0645 sprinkler system connected and all passengers sent below deck; weather decks off limits; sprinkler system on between 0702 and 0722. Returned to Bikini at 0845. Anchored mooring N-1 at 0909; all passengers ashore by 1100.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored mooring N-1, Bikini.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring N-1, Bikini.
- INCA (Enewetak, 22 June, 1314). Anchored mooring N-1 at 0614 following sortie for aborted shot DAKOTA.
- DAKOTA (Bikini, 26 June, 0606). At sea in assigned area with 134 passengers embarked. Between 0550 and 0604 all persons instructed in safety procedures and put on goggles. At 0626 passengers and crew sent below; sprinkler system on at 0645; maneuvering on various courses; sprinkler system turned off at 0655. Moved astern of USS Curtiss prior to reentry and reentered lagoon at 0844; anchored mooring N-1 at 0952.
- MOHAWK (Enewetak, 3 July, 0606). At sea on MOHAWK sortie. In assigned operating area at time of detonation, probably halfway between Bikini and Enewetak. At 0719 left operating area en route to Bikini. Arrived at Bikini at 1845; anchored in the lagoon at 1904.
- APACHE (Enewetak, 9 July, 0606). At sea on APACHE sortie proceeding to assigned Enewetak operating area. At 0603 all hands put on goggles; continuous monitoring of bridge. At 0635 began closing on Deep Entrance, Enewetak Lagoon; at 0744 lying to on assigned station. At 0921 proceeded en route to Bikini; arrived at Bikini at 2132; at 2240 anchored mooring N-1, Bikini.

USNS Fred C. Ainsworth (T-AP-181)

- NAVAJO (Bikini, 11 July, 0556). Underway at 0236 from Bikini Lagoon for assigned operating area with 104 passengers embarked. At 0536 all hands to quarters. At 0617 all passengers sent below decks. Prepared to reenter lagoon at 0722; anchored mooring N-1, Bikini, at 0913 and debarked passengers. Radsafe barge moored alongside between 1040 and 1523.
- TEWA (Bikini, 21 July, 0546). At sea in assigned area with 103 passengers embarked. Ainsworth, Curtiss, and USS Knudson dispatched in late morning for possible evacuation of Enewetak Atoll due to TEWA fallout. Employed sprinkler system freely through 2400 while underway to Enewetak.
- HURON (Enewetak, 22 July, 0616). At sea off Enewetak in operating area EG 1014. At 0625 en route to Deep Entrance, Enewetak; entered lagoon at 0655; at 0729 anchored in lagoon. Commenced decontamination at 0800. Passengers debarked between 0825 and 0925.

Additional Ainsworth source: Reference C.1.2.

AK-213. See USS Sussex

AO-53. See USS Caliente

AO-105. See USS Mispillion

AO-106. See USS Navasota

AOG-6. See USS Agawam

AOG-7. See USS Elkhorn

AOG-9. See USS Kishwaukee

AOG-10. See USS Nemasket

AOG-53. See USS Namakagon

AOG-59. See USS Natchaug

APD-10. See USS Knudson

ATF-75. See USS Sioux

ATF-83. See USS Chickasaw

ATF-85. See USS Lipan

ATF-96. See USS Abnaki

AV-4. See USS Curtiss

USS Badoeng Strait (CVE-116)

This escort carrier with a complement of 767 men for REDWING was the carrier element of the Carrier Unit (TE 7.3.1.1), arriving in the PPG on 16 March and departing on 26 July. Badoeng Strait participated in Bikini shots only, assisting in evacuating personnel from the atoll and providing afloat decontamination facilities to Marine Helicopter Transport Squadron-363 (HMR-363). The ship carried a Raydist navigational positioning system on the foredeck to position aircraft of the TG 7.4 Aircraft Effects Element (TG 7.1, Program 5) for the Bikini shots. Exposure data for the crew are in Table 46. Operational activities for each shot are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). Anchored mooring N-14A, Bikini.
- CHEROKEE (Bikini, 21 May, 0551). On 20 May sortied from Bikini late in the evening. On 21 May in assigned operating area at time of detonation; at 0551 saw detonation over Bikini; at 0552 felt shock wave. Between 0814 and 1310 conducted helicopter flight operations. Reentered the lagoon at 0920; anchored mooring N-14A at 1002.
- ZUNI (Bikini, 28 May, 0556). On 27 May underway from Bikini at 1857 for assigned operating area. On 28 May observed detonation bearing 355°, 27 nmi (50 km); at 0558 felt shock wave. At 0645 set flight quarters. Reentered lagoon at 0850. At 0905 began helicopter flight operations. Anchored mooring N-14A at 0944. Secured from flight quarters at 1603.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). On 30 May between 0000 and 0400 anchored mooring N-14A, Bikini; repair parties standing by in the event of radioactive fallout. Underway at 1905 for Kwajalein for rest and recreation. Steaming for Kwajalein at time of detonation. On 31 May at 1026 anchored mooring 14, Kwajalein.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring N-14A, Bikini.

USS Badoeng Strait (CVE-116)

- FLATHEAD (Bikini, 12 June, 0626). On 11 June sortied from Bikini late in the evening (precise time unavailable). On 12 June in assigned operating area at time of detonation; at 0626 observed detonation bearing 5°, 20 nmi (37 km). At 0725 set flight quarters. Reentered lagoon at 0835; at 0852 anchored mooring N-15A'. Secured from flight quarters at 1444.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored mooring N-14A, Bikini.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring N-14A, Bikini.
- INCA (Enewetak, 22 June, 0956). At 0848 returned to Bikini from night steaming area after shot DAKOTA aborted. Anchored mooring N-14A, Bikini, at time of detonation.
- DAKOTA (Bikini, 26 June, 0606). On 25 June underway from Bikini at 1924 for assigned operating area. On 26 June in assigned operating area and at 0606 observed detonation bearing 0°, 23 nmi (43 km); at 0608 shock wave passed ship. At 0745 set flight quarters; began launching helicopters at 0815. Reentered lagoon at 0847; at 0855 anchored mooring N-15A. Secured from flight quarters at 1115.
- MOHAWK (Enewetak, 3 July, 0606). Anchored mooring N-14A, Bikini.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-14A, Bikini; at 0606 observed detonation at Enewetak.
- NAVAJO (Bikini, 11 July, 0556). On 10 July underway from Bikini at 2234 for assigned operating area. On 11 July at 0556 observed detonation in assigned operating area. Reentered lagoon at 0800; at 0830 began launching helicopters. Anchored mooring N-14A at 0843. Secured from flight quarters at 1337.
- TEWA (Bikini, 21 July, 0546). On 20 July underway at 2159 from Bikini for assigned operating area. On 21 July in assigned operating area and saw detonation bearing 2°, 26 nmi (48 km). Set flight quarters at 0732; at 0745 on station astern of USS Estes; launched helicopters at 0803. Reentered lagoon at 0830; anchored mooring N-15A at 0905. Secured from flight quarters at 0929.
- HURON (Enewetak, 22 July, 0616). Anchored mooring N-14A, Bikini. Underway for Kwajalein at 1645.

Additional Badoeng Strait source: Reference C.3.1.2.

USNS Bernalillo County (T-LST-306)

Bernalillo County, a tank landing ship with a civilian crew of 49, arrived in the PPG on 27 February and departed on 25 July. The ship operated as a surface interatoll transport for light freight and passengers as a TG 7.3 element. Operational activities for each shot are summarized below:

- LACROSSE (Enewetak, 5 May, 0625). Underway to Enewetak at 0619, 308°T, 30 nmi (56 km) off Enewetak by radar, and turned on water decontamination system. At 1230 in Enewetak Lagoon. Secured to deep water pier at 1350. Departed Enewetak at 1718 en route Bikini. Monitor reading 0.003 R/hr at 2200, turned on water decontamination system; system turned off at 2330.
- CHEROKEE (Bikini, 21 May, 0551). Underway to Bikini at time of detonation (no data on position). Engines stopped at 0604, ship lying to; at 0851 started on course 310°. Moored to Eneu pier at 1223 with bow on beach and remained there through 22 May.
- ZUNI (Bikini, 28 May, 0556). Anchored mooring C-1, Enewetak.
- YUMA (Enewetak, 28 May, 0756). Anchored mooring C-1, Enewetak. Underway to old cargo pier, Parry Island, at 1059; at 1115 moored to pier.
- ERIE (Enewetak, 31 May, 0615). No data available.
- SEMINOLE (Enewetak, 6 June, 1255). No data available.
- FLATHEAD (Bikini, 12 June, 0626). Moored to old cargo pier, Parry Island.
- BLACKFOOT (Enewetak, 12 June, 0626). Moored to old cargo pier, Parry Island. At 1431 left dock en route Bikini. On 13 June at 0200 radiometer readings 0.0025 to 0.0042 R/hr; washdown system turned on at 0303, system secured at 0353. At 0400 reading 0.0015 to 0.002 R/hr; washdown system on at 0445, system secured at 0505. Crew decontaminated areas of vessel with washdown hose at 0800; maximum reading 0.001 R/hr at 0900. Anchored mooring N-16, Bikini at 1430.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored Bikini.
- OSAGE (Enewetak, 16 June, 1314). No data available.
- INCA (Enewetak, 22 June, 0956). Moored to old cargo pier, Parry Island, until 1200; no data available for rest of day.
- DAKOTA (Bikini, 26 June, 0606). No data available.
- MOHAWK (Enewetak, 3 July, 0606). Lying to in assigned sortie area off Enewetak Atoll, between 15.8 and 6 nmi (29.3 and 11.1 km) off Parry Island. At 0856 moored to old cargo pier at Parry.
- APACHE (Enewetak, 9 July, 0606). At 0529 14.8 nmi (27.4 km) off Parry Island, Enewetak, in assigned sortie area. Between 0551 and 0752 ship steamed to Deep Entrance off Parry Island; no data available for rest of day.
- NAVAJO (Bikini, 11 July, 0556). No data available.

USNS Bernalillo County (T-LST-306)

- TEWA (Bikini, 21 July, 0546). In assigned sortie area, approximately 20.2 nmi (37.4 km) south of Eneu Island. At 1101 moored to dock, Eneu Island, Bikini.
- HURON (Enewetak, 22 July, 0616). At Bikini.

USS Caliente (AO-53)

A fleet oiler, Caliente, with a complement of 220, was probably in the PPG from 3 July through 1 August. She sortied with the task force fleet for NAVAJO and TEWA. Exposure data are in Table 46.

USS Catamount (LSD-17)

Catamount, a landing ship dock, arrived at the PPG on 2 February and departed on 23 July. It provided boat pool housekeeping facilities at Bikini, evacuated boat pool personnel during Bikini shots, and transported shot devices from Enewetak to Bikini as TE 7.3.7.1, LSD Element. Exposure data for the 275-man crew is in Table 46. Operational activities are described below.

- LACROSSE (Enewetak, 5 May, 0625). Anchored mooring N-4, Bikini.
- CHEROKEE (Bikini, 21 May, 0551). On 20 May anchored mooring N-4, Bikini; took on personnel for TG 7.1 (20), TG 7.3 (193), TG 7.4 (7), TG 7.5 (25). At 1907 completed embarking 18 LCMs and 1 AVR; at 1916 left berth for operating area BF 25-30-L. On 21 May at 0551 observed shot CHEROKEE in assigned operating area; evacuated topside spaces at 0604. At 0955 reentered lagoon. Debarked 18 LCMs at 1018. Returned and anchored to mooring N-4, Bikini, at 1025. Underway for Enewetak Atoll at 1457; at 1628 joined by USS James E. Kyes en route to Enewetak.
- ZUNI (Bikini, 28 May, 0556). On 27 May anchored mooring N-4, Bikini. Underway for operating area BH 30-35-L at 1950 with 18 LCMs, 2 AVPRs, 1 AVR embarked and 5 TG 7.1 personnel (a 2nd LT from the 1st RSSU and 4 enlisted men of TU 7), 194 TG 7.3 personnel, 6 TG 7.4 personnel, and 25 TG 7.5 personnel. On 28 May at 0556 observed shot ZUNI in assigned operating area. At 0927 reentered lagoon in formation with USS Estes. Anchored mooring N-4, Bikini, at 1020. Completed debarking boats at 1050.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). Anchored mooring N-4, Bikini.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring N-4, Bikini.
- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 2315 underway from N-4, Bikini, for operating area with 18 LCMs and 1 AVR embarked. In assigned operating area on 12 June at time of

detonation; at 0640 all hands below the main deck. At 0800 prepared to reenter lagoon; at 0926 anchored mooring N-4, all boats debarked. Underway for Enewetak at 1451 with 3 TG 7.4 enlisted men as passengers.

- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored mooring C-2, Enewetak. Ships present included USS Merapi (AF-38) and Kyes. Underway for Bikini at 1613 with Kyes and a VP-1 P2V-5 as escort.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring N-4, Bikini.
- INCA (Enewetak, 22 June, 1314). On 21 June sortied for shot DAKOTA. On 22 June reentered lagoon at 0715 after shot DAKOTA aborted; anchored mooring N-4 at 0806.
- DAKOTA (Bikini, 26 June, 0606). On 25 June underway at 2351 for assigned operating area with undetermined number of boats embarked, 9 TG 7.1 personnel, 5 TG 7.4 personnel, 23 TG 7.5 personnel. On 26 June at 0606 observed shot DAKOTA in assigned operating area. At 0713 maneuvered in formation with Estes to reenter lagoon. Anchored mooring N-4 at 0904; at 0908 all boats debarked. Underway at 1318 for Enewetak with a Marine 1st LT and a 10-man Marine detachment.
- MOHAWK (Enewetak, 3 July, 0606). Anchored mooring N-4, Bikini.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-4, Bikini.
- NAVAJO (Bikini, 11 July, 0556). At 0247 underway from N-4, Bikini, for assigned operating area; 18 LCMs, 5 TG 7.1 personnel, 6 TG 7.4 personnel, 22 TG 7.5 personnel embarked. At 0556 observed shot NAVAJO in assigned operating area. At 0600 maneuvered to reenter Bikini Lagoon. Anchored mooring N-4 at 0838; at 0911 all boats debarked. Underway for Enewetak the following morning with a Marine 1st LT, and a 10-man Marine detachment aboard.
- TEWA (Bikini, 21 July, 0546). Underway at 0211 from N-4, Bikini, en route to assigned operating area BF 30-35-L with 10 LCMs, 1 AVR, and 1 LCU, 5 TG 7.1 personnel, 6 TG 7.4 personnel, 22 TG 7.5 personnel embarked. At 0546 observed nuclear detonation in assigned operating area. At 0810 maneuvered in formation with Estes to reenter lagoon. Anchored at N-4 at 0839; at 0925 all boats debarked.
- HURON (Enewetak, 22 July, 0616). Anchored mooring N-4, Bikini. At 1354 left for Enewetak.

Additional Catamount source: Reference C.1.3.

USS Chickasaw (ATF-83)

This fleet tug participated in Bikini shots only, arriving in the PPG on 5 April and departing 26 July. Personnel from its 68-man crew participated in the decontamination of the YFNBs at Bikini after NAVAJO. Exposure data for the crew are in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). Anchored mooring N-5, Bikini.
- CHEROKEE (Bikini, 21 May, 0551). On 20 May at 1129 sortied with YC-1420 and Army barge 294 in tow for assigned operating area. In assigned operating area on 21 May at time of detonation. From 0611 to 0625 operated washdown system. Reentered lagoon at 1112; at 1258 released YC-1420 to Boat Pool LCM. Anchored mooring N-5, Bikini, at 1314; at 1327 released Army barge 294 to Boat Pool LCM.
- ZUNI (Bikini, 28 May, 0556). On 27 May at 1126 sortied with YC-1420 and Army barge 294 in tow for assigned operating area. In assigned operating area on 28 May at time of detonation. From 0620 to 0629 operated washdown system. Reentered lagoon at 1117; at 1153 released YC-1420 to Boat Pool LCM. Released Army barge 294 to Boat Pool LCM at 1207 and anchored mooring N-5, Bikini.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). Present in Bikini Lagoon in the early morning, according to USS Curtiss Deck Log (Reference C.3.1.1) for 31 May.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring N-5, Bikini. At 0758 sortied for gunnery practice. Reentered lagoon at 1321; at 1329 anchored mooring N-5, Bikini.
- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 1431 sortied with YC-1420 and Army barge 294 in tow for assigned operating area. In assigned operating area on 12 June at time of detonation. From 0652 to 0705 operated washdown system. Reentered lagoon at 0940; at 1009 released YC-1420 to Boat Pool LCM; at 1025 released Army barge 294 to Boat Pool LCM. Anchored mooring N-5, Bikini, at 1035.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored mooring N-5, Bikini.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring N-5, Bikini.
- INCA (Enewetak, 22 June, 0956). Anchored mooring N-5, Bikini.
- DAKOTA (Bikini, 26 June, 0606). On 25 June at 1838 sortied with YC-1420 and Army barge 294 in tow for assigned operating area. In assigned operating area on 26 June at time of detonation. Reentered lagoon at 0845; at 1020 anchored mooring N-5, Bikini; at 1027 released YC-1420 to Boat Pool LCM; at 1034 released Army barge 294 to Boat Pool LCM.
- MOHAWK (Enewetak, 3 July, 0606). Anchored mooring N-5, Bikini.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-5, Bikini. Underway at 1809 with YC-1420 and Army barge 294 in tow for shot

NAVAJO sortie. On 10 July returned to lagoon and anchored mooring N-5, Bikini, after postponement of shot NAVAJO.

- NAVAJO (Bikini, 11 July, 0556). On 10 July at 1924 sortied with YC-1420 and Army barge 294 in tow for assigned operating area. In assigned operating area on 11 July at time of detonation. At 0835 maneuvered to reenter lagoon. Released Army barge 294 to Boat Pool LCM at 0938; at 1006 anchored mooring N-5, Bikini; at 1116 released YC-1420 to Boat Pool LCM.
- TEWA (Bikini, 21 July, 0546). On 20 July at 0811 refueled from USS Caliente (AO-53). Sortied for assigned operating area at 1858 with POL barge 352 and Army barge 293 in tow. In assigned operating area on 21 July at time of detonation. At 0835 maneuvered to reenter lagoon; released Army barge 294 to Boat Pool LCM at 0938. Anchored mooring N-5, Bikini at 1006; at 1116 released YC-1420 to Boat Pool LCM.
- HURON (Enewetak, 22 July, 0616). Anchored mooring N-5, Bikini.

USS Crook County (LST-611)

This specially modified LST was a floating fallout collection station for Program 2 (Nuclear Radiation) as part of TU 7.3.6, Radiological Support Unit. It was modified so that it could be operated by a skeleton crew housed in heavily shielded compartments usually below decks. The remaining crew remained at Parry Island. It participated in the Bikini shots except NAVAJO, operating as the northernmost of the fallout-collecting stations; thus it was less contaminated than YAG-39 (USS George Eastman) and YAG-40 (USS Granville S. Hall), the other two manned collection stations. Exposure data for the crew are on Table 46. Exposure data for scientific personnel on Crook County during the fallout collection periods are shown in Table 10 under Project 2.63. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). On 4 May sent all hands ashore at Parry Island except a 28-man operating team; following personnel came aboard: 6 boat operations men from Project 2.63 and 2 naval officers assigned to Hq TG 7.3, Parry Island, on temporary duty. At 1408 ship got underway for Program 2 project support. On 5 May in formation with YAG-39 and YAG-40 en route to Bikini Atoll at time of detonation. At 1217 entered Bikini Lagoon. Anchored mooring N-16, Bikini at 1235.
- CHEROKEE (Bikini, 21 May, 0551) On 20 May underway from Bikini at 0945 with reduced crew, also embarked Project 2.63 boat operations party. On 21 May in assigned Program 2 operating area north of

Bikini at time of detonation; at 0551 observed shot CHEROKEE. On 22 and 23 May continued to maneuver in predicted fallout path under direction of Program 2 plot. Fallout was very light from CHEROKEE and was measured only at the stations nearer the shot than Crook County, whose operational area was about 185 nmi (345 km), bearing 325° from surface zero (Reference C.1.3.1317). Returned to Enewetak Lagoon and anchoring at 0857.

- ZUNI (Bikini, 28 May, 0551). On 27 May underway at 0925 with reduced crew of 2 officers and 14 enlisted men; also embarked 6 passengers from TG 7.1 and 2 ship's party aboard Ainsworth and Estes on temporary duty. On 28 May in operating area north of Bikini assigned by Program 2 plot aboard the Estes. At 0556 observed nuclear detonation at approximately 125° relative, 155 nmi (287 km) distant. Continued to maneuver in predicted fallout path after detonation. Position at the time of peak fallout activity was about 145 nmi (about 270 km), bearing 335° from surface zero. An unshielded film badge topside registered an exposure of less than 0.05 R for the 62-hour period the ship was in the operating area (Reference C.1.3.1317).

- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI radiological survey north of Bikini.

- ERIE (Enewetak, 31 May, 0616). On 30 May at sea with reduced crew of 2 officers and 12 enlisted men. Rendezvoused with MV Horizon at 0348 to receive Project 2.63 radsafe personnel as passenger to Enewetak. On 31 May underway in night operating area off Enewetak. Observed nuclear detonation bearing 30° relative, 15 nmi (28 km) distant. Entered Enewetak Lagoon at 0857; at 0935 anchored mooring D-3.

- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring D-3, Enewetak.

- FLATHEAD (Bikini, 12 June, 0626). On 11 June underway from Bikini at 1424 with reduced crew of 3 officers and 14 enlisted men; also embarked 5 Project 2.63 personnel and 1 ship's officer aboard Estes on temporary duty. On 12 June underway in operating area north of Bikini assigned by Program 2 plot aboard Estes. At 0626 observed nuclear detonation bearing 25° relative, approximately 40 nmi (74 km) distant. From 12 to 14 June continued to maneuver in predicted fallout path. On 12 June at 1325 encountered fallout; at various times ship was operated from remote control station. Position at the time of peak falllout activity was about 48 nmi (90 km), bearing 300° from surface zero. An unshielded film badge topside registered an exposure of about 1.7 R for the 52 hours the ship ship was operating in the fallout area (Reference C.1.3.1317). Returned to Enewetak on 14 June and anchored mooring D-1 at 1220.

- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.

- KICKAPOO (Enewetak, 14 June, 1126). At sea for FLATHEAD Program 2 project support. At time of detonation maneuvering at sea off

Enewetak to enter the lagoon; at 1126 observed detonation bearing 350° relative, approximately 25 nmi (46 km) distant. Entered lagoon at 1154; anchored mooring D-1 at 1220.

- OSAGE (Enewetak, 16 June, 1314). Anchored mooring D-1, Enewetak.
- INCA (Enewetak, 22 June, 0956). Anchored mooring D-1, Enewetak.
- DAKOTA (Bikini, 26 June, 0626). Anchored mooring D-1, Enewetak.
- MOHAWK (Enewetak, 3 July, 0606). On 2 July underway at 1910 from Enewetak for assigned operating area. On 3 July in operating area EI off Enewetak in company with USS Shelton at time of detonation. Returned to the lagoon at 0849; anchored mooring D-1 at 0915.
- APACHE (Enewetak, 9 July, 0626). Anchored mooring N-21, Bikini. At 1441 got underway for NAVAJO operating area.
- NAVAJO (Bikini, 11 July, 0556). On 10 July underway from Bikini Atoll for assigned operating area. No information on crew, but probably 2 officers and 12 enlisted men; also embarked four Project 2.63 personnel. On 11 July in assigned Program 2 operating area north of Bikini at time of detonation. At 0600 observed detonation to port, distance approximately 45 nmi (83 km). At 0603 shock wave passed ship. At 0700 began figure-eight maneuver to maintain assigned station (about 40 nmi [about 75 km] from surface zero); mission completed at 2119 and set course for Enewetak Atoll at direction of Program 2 plot aboard Estes. On 12 July at 0936 entered Enewetak Lagoon; anchored mooring D-1 at 1138. An unshielded film badge topside registered 0.8 R for the 27 hours of operation in the fallout area (Reference C.1.3.1317).
- TEWA (Bikini, 21 July, 0546). On 20 July underway at 1518 for assigned operating area; crew not participating sent aboard Ainsworth. No information on operating crew, but probably 2 officers and 12 enlisted men; also embarked 5 Project 2.63 personnel. On 21 July in assigned Program 2 operating area north of Bikini at time of detonation. On 21 and 22 July maneuvered in predicted fallout path under direction of Program 2 plot aboard Estes. Position at the time of peak fallout activity was about 48 nmi (90 km), bearing 325° from surface zero. An unshielded film badge topside registered 3.7 R for the 51-hour period the ship was in the fallout area (Reference C.1.3.1317). On 22 July at 1744 entered Enewetak Lagoon; anchored in lagoon at 1808.
- HURON (Enewetak, 22 July, 0616.) At sea on TEWA Program 2 project support. Located off Bikini Atoll at time of detonation. Entered Enewetak Lagoon at 1744; anchored in lagoon at 1808.

CVE-116. See USS Badoeng Strait

USS Curtiss (AV-4)

USS Curtiss (AV-4)

This converted seaplane tender was the major component of the Special Devices Unit (TU 7.3.8.1), arriving at the PPG on 10 April and departing 26 July. Curtiss transported nuclear components to the PPG, assisted in collection of weather data, supported scientific projects, and sortied for the six Bikini shots (served as the firing center on the ZUNI event). Curtiss ran through TEWA fallout when sailing to Enewetak for possible evacuation of the atoll on 21 July. Exposure data for the 564-man crew are in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). Anchored mooring N-10, Bikini; saw flash of light on horizon from Enewetak explosion.
- CHEROKEE (Bikini, 21 May, 0551). In operating area B 25-30-R. At 0550 all hands faced aft and donned high-density goggles, at 0551 saw blast, at 0553 shock wave passed ship. At 0908 maneuvered to take position astern of USS Estes; at 0933 recovered and launched helicopter. Reentered the lagoon at 0945; at 1050 anchored mooring N-10, Bikini. One man admitted to sick bay at 1100 with bilateral conjunctivitis caused by viewing blast directly.
- ZUNI (Bikini, 28 May, 0556). In operating area BG 20-35-L. At 0556 observed detonation, bearing 318°, Eneu tower, distance 29,600 yards (27.1 km). Between 0620 and 0635 operated washdown system; washdown system activated again between 0746 and 0752. Conducted helicopter flight operations between 0806 and 0827. Reentered lagoon at 0852; at 0948 anchored mooring N-11A, Bikini.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). On 30 May underway from Enewetak for assigned operating area; at 0010 in area EG 1525. In assigned operating area on 31 May and at 0615 saw detonation on northwest horizon -- Japtan Light bearing 300°, range 12,800 yards (11.7 km). Reentered lagoon at 0838; at 0920 anchored mooring B-1.
- SEMINOLE (Enewetak, 6 June, 1256). Anchored mooring N-10, Bikini.
- FLATHEAD (Bikini, 12 June, 0626). In operating area BF 20-25-R; at 0606 detonation, Eneu south tower bearing 317°, range 17,200 yards (15.7 km); at 0628 shock wave passed the ship. At 0731 maneuvered to take position astern of Estes; conducted flight operations between 0746 and 0759; at 0806 astern of USS Badoeng Strait. Reentered lagoon at 0832; between 0838 and 0853 conducted helicopter flight operations; anchored mooring N-10 at 0858.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.

- KICKAPOO (Enewetak, 14 June, 1126). Anchored mooring B-1, Enewetak; at 1111 called crew to view blast off the starboard. On 15 June at 1755 fifteen men returned aboard, having completed temporary duty as a decontamination team with CTG 7.3.
- OSAGE (Enewetak, 16 June, 1314). No data available. Ship was almost certainly in the vicinity of Enewetak Atoll on shot OSAGE, since it did not depart Enewetak until 17 June.
- INCA (Enewetak, 22 June, 0956). On 21 June at 1938 left berth for operating area BF 20-25-R. On 22 June at 0754 returned to mooring N-10, Bikini, following DAKOTA postponement.
- DAKOTA (Bikini, 26 June, 0606). On 26 June underway from Bikini at 2350 for assigned operating area. In assigned operating area on 26 June at time of detonation; at 0610 maneuvered to take position astern of Estes. Conducted helicopter flight operations between 0758 and 0806; at 0836 resumed helicopter flight operations. Reentered lagoon at 0840. Ended flight operations at 0852. Anchored mooring N-10 at 0900.
- MOHAWK (Enewetak, 3 July, 0606). Anchored mooring N-10, Bikini.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-10, Bikini.
- NAVAJO (Bikini, 11 July, 0556). At 0226 underway from Bikini for operating area BF 20-30-R. At 0556 saw blast bearing 304°, 35 nmi (65 km). Shock wave passed ship at 0558. At 0559 maneuvered to take position astern of Estes; began helicopter flight operations at 0812. Reentered the lagoon at 0826. At 0836 ended helicopter flight operations. Anchored mooring N-10 at 0851.
- TEWA (Bikini, 21 July, 0546). At 0142 underway for operating area BF 30-25-R. In assigned operating area at time of detonation. At 0549 the TEWA shock wave passed the ship. At 0600 maneuvered to take position astern of Estes; began helicopter flight operations at 0803. Reentered lagoon at 0830; at 0847 anchored 247°T, 240 yards (220 meters) from mooring N-10. Ended helicopter flight operations at 0853. Underway for Enewetak at 1147. At 1755 set gas-tight envelope. Activated washdown system at 1826; continued to operate washdown system every 15 minutes.
- HURON (Enewetak, 22 July, 0616). Prior to detonation operated washdown system every 15 minutes while in assigned area EH 1519, Enewetak. Experienced mild radiation contamination (average 0.022 R/hr); damage control teams decontaminated all exposed weather decks with soap and salt water. At 0616 observed detonation bearing 343°, distance 24,300 yards (22.2 km). Entered lagoon at 0651; at 0749 anchored mooring C-1.

DD-534. See USS Silverstein

DD-787. See USS Kyes

DD-790. See USS Shelton

DE-361. See USS Walton

DE-365. See USS McGinty

USS George Eastman. See YAG-39

USS Elkhorn (AOG-7)

Gasoline tanker in the PPG during May 1956.

USS Estes (AGC-12)

Estes, an amphibious force flagship, served as flagship element of the Flagship Unit, TE 7.3.0.1 and TG 7.3. Estes arrived at the PPG on 15 March and departed 25 July. Estes participated in all Bikini shots, providing communications, air control, and facilities for Program 2 and radsafe activities. Exposure data for the 577-man crew are in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). Anchored mooring N-9, Bikini.
- CHEROKEE (Bikini, 21 May, 0551). On 20 May underway from Bikini at 1830 for assigned operating area; 21 personnel from staffs of JTF 7, TG 7.3, TG 7.4 and Program 2 embarked. On 21 May in assigned operating area at time of detonation. At 0840 set flight quarters; at 0859 secured from flight quarters. Reentered lagoon at 0930; at 0955 anchored mooring N-9.
- ZUNI (Bikini, 28 May, 0556). On 27 May at 1958 underway from Bikini for assigned operating area; 19 personnel from staffs of JTF 7, TG 7.3, TG 7.4 and Program 2 embarked. On 28 May in assigned operation area at time of detonation. Reentered lagoon at 0925; at 0955 anchored mooring N-9.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). Anchored mooring N-9, Bikini.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring B-1, Enewetak.
- FLATHEAD (Bikini, 12 June, 0626). On 11 June underway from Bikini for assigned operating area at 2330; 18 personnel from staffs of JTF 7, TG 7.3, TG 7.4 and Program 2 embarked. On 12 June in assigned operating area at time of detonation. At 0828 reentered lagoon; at 0849 anchored mooring N-9.

- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored mooring N-9, Bikini.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring N-9, Bikini.
- INCA (Enewetak, 22 June, 0956). Anchored mooring N-9, Bikini.
- DAKOTA (Bikini, 26 June, 0606). Underway from Bikini for assigned operating area at 0010; 4 personnel from staffs of either JTF 7, TG 7.3, TG 7.4 or Program 2. In assigned operating area at time of detonation. Reentered lagoon at 0852; at 0848 anchored mooring N-9.
- MOHAWK (Enewetak, 3 July, 0606). Anchored mooring N-9, Bikini; commanding officer of USS Caliente (AO-53) on board from 1010 to 1017.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-9, Bikini.
- NAVAJO (Bikini, 11 July, 0556). Underway at 0301 from Bikini for assigned operating area; 16 personnel from staffs of JTF 7, TG 7.3, TG 7.4 and Program 2 embarked. In assigned operating area at time of detonation. Reentered lagoon at 0820; at 0846 anchored mooring N-9.
- TEWA (Bikini, 21 July, 0546). Underway at 0219 from Bikini for assigned operating area; 18 personnel from staffs of JTF 7, TG 7.3, TG 7.4 and Program 2 embarked. In assigned operating area at time of detonation. Reentered lagoon at 0811; at 0840 anchored mooring N-9.
- HURON (Enewetak, 22 July, 0616). Anchored mooring N-9, Bikini.

Additional Estes source: Reference C.1.3.

USNS Sgt. Archer T. Gammon (T-AK-243)

A civilian-operated naval transport, Gammon was in the PPG in May and between 7 and 11 June. No exposure data for the 16-man crew are available.

USS Granville S. Hall. See YAG-40

USS Karin (AF-33)

Karin, a refrigerated cargo ship operating out of Pearl Harbor, was used to resupply PPG and Kwajalein. No exposure data are available.

USS Kishwaukee (AOG-9)

This gasoline tanker was in PPG sometime in May, from 3 June to 1 July, and from an unknown date in July to 15 July. No exposure data are available.

USS Knudson (APD-10)

USS Knudson (APD-10)

A high-speed transport ship, Knudson arrived in the PPG on 10 April and departed 23 July. As part of the Surface Patrol and Transport Unit (TU 7.3.3), Knudson operated as surface transport between Bikini and Enewetak for light freight and passengers. She ran through TEWA fallout on late 21 July while preparing for a potential evacuation of Enewetak Atoll. Exposure data for 158-man crew are summarized in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). Anchored mooring N-3, Bikini.
- CHEROKEE (Bikini, 21 May, 0551). On 20 May at 1722 underway for operating area BH 25-30-R. On 21 May in assigned operating area and at 0551 saw detonation bearing 328°, 33 nmi (61 km). Between 0635 and 0639 operated washdown system. Reentered lagoon at 1035; at 1056 anchored mooring N-3.
- ZUNI (Bikini, 28 May, 0556). On 27 May at 1603 underway for operating area BF 30-35-L. On 28 May in assigned operating area and at 0556 observed shot ZUNI, bearing 270°, 28 nmi (52 km). Reentered the lagoon at 0958; at 1010 anchored mooring N-3.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). On 30 May at 1010 underway for Bikini Atoll. At sea on 31 May at time of detonation en route from Bikini to Bikar Atoll. At 0804 an officer and landing party of 12 men left the ship to investigate islands of Bikar Atoll; returned at 1415.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring N-3, Bikini.
- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 1654 underway for operating area BF 30-35-L. On 12 June in assigned operating area and at 0626 saw detonation bearing 302°, 33 nmi (61 km). Reentered the lagoon at 0848; at 0911 anchored mooring N-3.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). On 13 June at 1912 underway from Bikini to Enewetak. On 14 June assumed duty as search and rescue (SAR) ship at 0300. At 0856 maneuvered to maintain station 3 nmi (5.6 km) seaward of Deep Entrance, Enewetak Atoll. On station at 1126; saw shot, bearing 332°, distance about 14 nmi (26 km). Entered lagoon at 1250; at 1302 anchored mooring B-2.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring C-2, Enewetak; saw detonation bearing 0°, 8 nmi (14.8 km). Underway at 1910 for lifeguard station bearing 090°, 30 nmi (56 km) from Enewetak Island.

- INCA (Enewetak, 22 June, 0956). Anchored mooring C-2, Enewetak.
- DAKOTA (Bikini, 26 June, 0606). On 25 June at 1859 underway from Enewetak for SAR duty on lifeguard station, bearing 90°, 30 nmi (56 km) off Enewetak Island. On SAR lifeguard station on 26 June at time of detonation. Relieved of SAR duty at 1128 because of steering problem. Reentered lagoon at 1212; at 1244 went alongside YON-182, mooring L-1.
- MOHAWK (Enewetak, 3 July, 0606). Anchored mooring N-3, Bikini.
- APACHE (Enewetak, 9 July, 1806). Anchored mooring N-3, Bikini. At 1930 left for night steaming area BG-L.
- NAVAJO (Bikini, 11 July, 0556). On 10 July at 2049 underway from Bikini to assigned operating area. On 11 June in assigned operating area and at 0556 observed detonation bearing 314°, distance about 27 nmi (50 km). At 0653 maneuvered astern of USS Estes. Reentered the lagoon at 0839; at 0858 anchored mooring N-3.
- TEWA (Bikini, 21 July, 0546). On 20 July at 2050 underway for assigned operating area. On 21 July in assigned operating area and at 0546 saw detonation bearing 307°, 35 nmi (65 km) distant. At 0636 maneuvered astern of Estes. Reentered the lagoon at 0852; at 0912 anchored mooring N-3. Underway for Enewetak at 1045 for possible evacuation due to TEWA fallout. Beginning at 2000 operated washdown system for 15 minutes every hour. Entered Enewetak operating area EE 1519 at 2202.
- HURON (Enewetak, 22 July, 0616). Between 0001 and 0600 in assigned Enewetak operating area EG 1519 off Point Easy, receiving radioactive fallout and periodically activating washdown system. At 0616 saw detonation bearing 340°, 20 nmi (37 km). Entered lagoon at 0753; at 0825 anchored mooring C-2. Between 1336 and 1520 moored alongside YON-182 at L-2 to refuel. Reanchored mooring C-2 at 1550.

USS James E. Kyes (DD-787)

Kyes, a destroyer of the Surface Patrol and Transport Unit (TU 7.3.3), arrived in the PPG on 10 April and departed on 25 July. Kyes served as escort for USS Curtiss from the United States to the PPG; also served as weather-information collection ship prior to and during shots at both Enewetak and Bikini. Exposure data for 247-man crew are in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0626). On 4 May at 1208 left anchorage B-2, Enewetak for submarine patrol off Runit Island. On 5 May in area EG 30 nmi (56 km) southeast of Enewetak Atoll for weather data collection at time of detonation. At 0900 anchored mooring C-1, Enewetak.

- CHEROKEE (Bikini, 21 May, 0551). In assigned operating area BH 35-40-L; observed shot bearing 330°T 50 nmi (93 km) distant. At 1043 proceeding to enter Bikini Atoll. Anchored in mooring N-16, Bikini at 1129. Underway to Enewetak at 1445.
- ZUNI (Bikini, 28 May, 0556). Probably sortied from Enewetak on 27 May. On 28 May at 0556 observed shot ZUNI bearing 85°; at 0756 observed shot YUMA bearing 330°, 15 nmi (28 km) distant. At 0918 proceeded to Enewetak Atoll. Anchored in mooring C-2, Enewetak, at 1005.
- YUMA (Enewetak, 28 May, 0756). Probably sortied from Enewetak on 27 May. On 28 May at 0756 observed shot ZUNI bearing 85°; at 0756 observed shot YUMA bearing 330°, 15 nmi (28 km) distant. At 0918 proceeded to Enewetak Atoll. Anchored in mooring C-2, Enewetak at 1005.
- ERIE (Enewetak, 31 May, 0615). On 30 May at 1258 left anchorage C-2, Enewetak, for barrier patrol east of Runit Island; at 1701 left patrol for lifeguard station. On 31 May, steaming in area EE, east of Enewetak, at time of detonation. At 0953 anchored in mooring C-2, Enewetak.
- SEMINOLE (Enewetak, 6 June, 1255). On 5 June at 1354 lying to in Eneu Harbor to take on stores. Underway at 1438 to area EE, 30 to 40 nmi (56 to 74 km) off Enewetak. On 6 June in assigned operating area off Enewetak at time of detonation. At 1617 anchored mooring D-2, Enewetak.
- BLACKFOOT (Enewetak, 12 June, 0626). On 11 June at 1902 underway for weather station EF, 25 to 30 nmi (46 to 56 km) from Enewetak. On 12 June in assigned operating area at time of detonation. At 1140 moored to YON-182 in Enewetak Lagoon. Anchored in mooring C-1, Enewetak, at 1501.
- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 1902 underway for weather station EF, 25 to 30 nmi (46 to 56 km) from Enewetak. On 12 June in assigned operating area at time of detonation. At 1140 moored to YON-182 in Enewetak Lagoon. Anchored in mooring C-1, Enewetak, at 1501.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored mooring C-3, Enewetak. At 1603 left anchorage for Bikini in company with USS Catamount.
- OSAGE (Enewetak, 16 June, 1314). At 1014 left mooring N-12, Bikini, for weather station Dog, Enewetak. On weather station Dog at time of detonation.
- INCA (Enewetak, 22 June, 0956). On 21 June at 1824 left anchorage N-18, Bikini, for night steaming area. Returned to Bikini at 0805 on 22 June and anchored mooring N-18.

- DAKOTA (Bikini, 26 June, 0606). Between 0001 and 0600 in operating area BG, 30 to 34 nmi (56 to 63 km) from Point Baker; observed detonation at 0606, 300°T, 40 nmi (74 km) distant. At 0916 anchored mooring N-18, Bikini. Left anchorage at 1823 for Kwajalein.
- MOHAWK (Enewetak, 3 July, 0606) Anchored mooring N-12, Bikini.
- APACHE (Enewetak, 9 July, 0606). In night steaming area EE, 20 nmi (37 km) from Point Easy, Enewetak, conducting weather observations. In assigned operating area at time of detonation. At 1042 moored to YON-182 in Enewetak Lagoon. Anchored mooring C-1 at 1304.
- NAVAJO (Bikini, 11 July, 0546). On 10 July at 0728 left anchorage C-1, Enewetak, for weather station Dog; left area Dog sometime in the afternoon or evening for lifeguard station 1. On lifeguard station 1 on 11 July at time of detonation. At 0931 anchored mooring C-1, Enewetak.
- TEWA (Bikini, 21 July, 0546). On 20 July at 1951 left anchorage N-8, Bikini, for night steaming area BG-BF. On 21 July in assigned operating area BF 40-45 and BG 40-45 for weather observations at time of detonation. Reentered lagoon at 0843; at 0900 anchored mooring N-8, Bikini. Moved anchorage to mooring N-10 at 1212.
- HURON (Enewetak, 22 July, 0616). Anchored mooring N-10, Bikini. On 23 July at 0845 left for Enewetak.

USS Lipan (ATF-85)

An ocean fleet tug, Lipan participated as an element of the Utility Unit (TU 7.3.2), arriving in the PPG on 21 March and departing 21 July. Lipan participated in Bikini shots only; decontaminated YFNBs after shots ZUNI and FLATHEAD. Exposure data for the 69-man crew are in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). Anchored mooring N-6, Bikini.
- CHEROKEE (Bikini, 21 May, 0551). In assigned operating area at time of detonation with YFN-994 in tow. Reentered lagoon at 1004; at 1127 released YFN-994 to LCM-1. Assisted USS Abnaki in decontaminating YFNB-13 and YFNB-29.
- ZUNI (Bikini, 28 May, 0556). On 26 May at 1015 LCM-2 brought YFN-994 astern for towing. Underway for assigned operating area at 1140 with tow. On 28 May in assigned operating area at time of detonation. At 1010 reentered lagoon; anchored mooring N-6, Bikini at 1100. Released YFN-994 to LCM-1 at 1105. Assisted Abnaki in decontaminating YFNB-13 and YFNB-29.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.

USS Lipan (ATF-85)

- ERIE (Enewetak, 31 May, 0615). Anchored mooring N-6, Bikini. At 0900 underway with YFNB-13 secured alongside. Anchored YFNB-13 mooring N-2, Bikini, at 1425. Returned to mooring N-6 at 1624 and anchored.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring N-6, Bikini.
- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 1440 underway with YFN-994 in tow for assigned operating area. On 12 June in assigned operating area at time of detonation. At 0856 reentered lagoon; anchored mooring N-6, Bikini at 0930. Decontaminated YFNB-13 and YFNB-20.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored mooring N-6, Bikini.
- OSAGE (Enewetak, 16 June, 1314). Moored alongside YFNB-13 at mooring N-2, Bikini. At 1426 underway from mooring N-2, Bikini; anchored mooring N-6, Bikini, at 1443.
- INCA (Enewetak, 22 June, 0956). Anchored mooring N-6, Bikini.
- DAKOTA (Bikini, 26 June, 0606). On 25 June at 1855 underway with YFN-994 in tow for assigned operating area. On 26 June in assigned operating area at time of detonation. At 0909 reentered lagoon. Anchored mooring N-6, Bikini, at 0925 and released YFN-994 to LCM-1.
- MOHAWK (Enewetak, 3 July, 0606). Anchored mooring N-6, Bikini.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-6, Bikini. At 1825 underway with YFN-994 in tow for shot NAVAJO sortie; shot aborted.
- NAVAJO (Bikini, 11 July, 0556). In assigned operating area at time of detonation with Holmes & Narver POL barge 352 and YFN-994 in tow. At 0849 prepared to enter port. Anchored mooring N-6, Bikini, at 0931. At 1115 released POL barge 352 to LCM-1; released YFN-994 to LCM-1 at 1221. Underway at 1603 to go alongside <u>USS Estes</u> at mooring N-9, Bikini.
- TEWA (Bikini, 21 July, 0546). On 20 July at 2144 underway with YC-1420 and YCV-10 in tow for assigned operating area. On 21 July in assigned operating area at time of detonation. At 0922 reentered lagoon. Anchored mooring N-6, Bikini, at 1005; underway at 1621 en route to Pearl Harbor with YCV-10 and YC-1420 in tow. Had obtained a Final Radiological Safety Clearance prior to departure.
- HURON (Enewetak, 22 July, 0616). Did not sortie for shot (already departed the PPG en route to Pearl Harbor).

LSD-17. See USS Catamount

LST-306. See USNS Bernalillo County

LST-618. See T-LST-618

USNS Pvt. Joe E. Mann (T-AK-253)

Mann was a cargo ship that assisted in the shipment of Sandia Corporation experimental material from the United States to the PPG during May and July. No exposure data for the 16-man crew are available.

USS McGinty (DE-365)

McGinty, a destroyer escort and part of the Surface Patrol and Transport Unit (7.3.3) for REDWING, arrived in the PPG on 10 April and departed on 28 July. McGinty served as escort for USS Curtiss from the United States to the PPG, provided support to Project 2.62, and sortied for all Bikini shots. Exposure data for the 167-man crew are in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). Anchored mooring N-8, Bikini.
- CHEROKEE (Bikini, 21 May, 0551). On 20 May conducted search and rescue for downed pilot. At 0955 proceeded to Enewetak, arriving at 1411 to refuel. Left Enewetak for Bikini at 1749. On 21 May in assigned operating area and observed blast bearing 15°T, 35 nmi (64 km). Rendezvoused with USS Estes at 0914 for mail transfer; at 1618 transferred mail and light freight with USS Mount McKinley (AGC-7), at 1716 transferred mail to USS Kyes.
- ZUNI (Bikini, 28 May, 0556). On 27 May at 1343 left anchorage N-12, Bikini, for barrier patrol; at 2017 left barrier patrol for operating area BH 40-45; arrived at 2240. On 28 May in assigned operating area and observed blast bearing 150°T, 40 nmi (74 km) from Point Baker Tower, Bikini. At 0947 placed probe in water and conducted radiological survey. Turned on washdown system at 1206; at 1230 system turned off; at 1940 began taking radiological measurements throughout day. On 30 and 31 May continued radiological survey.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI Program 2 radiological survey.
- ERIE (Enewetak, 31 May, 0615). At sea for ZUNI Program 2 radiological survey.
- SEMINOLE (Enewetak, 6 June, 1255). Moored alongside USS Silverstein at Pier Echo, Kwajalein. At 1345 got underway for Bikini.

USS McGinty (DD-365)

- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 1536 left berth N-19, Bikini, for barrier patrol south of Eneu Island channel entrance. Ceased patrol at 2236 and steamed to operating area BG 30-35. On 12 June in assigned operating area at time of detonation. After various changes, at 1202 began taking radiological measurements. From 13 through 16 June continued radiological survey.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD Program 2 radiological survey.
- KICKAPOO (Enewetak, 14 June, 1126). Continued FLATHEAD Program 2 survey.
- OSAGE (Enewetak, 16 June, 1314). Continued FLATHEAD Program 2 radiological survey. At 1619 anchored mooring N-12, Bikini.
- INCA (Enewetak, 22 June, 0956). On 21 June at 1753 left berth N-12, Bikini, for steaming area south of Bikini bearing 135°, 30 nmi (56 km) from Point Baker Tower. On 22 June in area south of Bikini at time of detonation. At 1005 anchored mooring N-12, Bikini.
- DAKOTA (Bikini, 26 June, 0606). On 25 June at 1935 left mooring N-12, Bikini, for operating area BG 30-35-R. On 26 June in assigned operating area at time of detonation. At 0606 observed nuclear explosion. At 0928 anchored mooring N-12, Bikini.
- MOHAWK (Enewetak, 3 July, 0606). On 2 July at 1815 left mooring D-3, Enewetak for operating area EH 30-34; arrived 2005. On 3 July in assigned operating area at time of detonation. At 0906 anchored mooring D-3, Enewetak.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-11, Bikini. At 1123 left anchorage for special radiological survey north and west of Bikini; at 1303 took first measurement, continued throughout the day.
- NAVAJO (Bikini, 11 July, 0556). On 10 July at 1954 left berth N-11, Bikini, for operating area BH 35-40-L. On 11 July in assigned operating area at time of detonation. At 0715 alongside USS Caliente (AO-53) to take on fuel; ceased taking on fuel at 0840. Began radiological survey at 1450 and continued to take measurements throughout day.
- TEWA (Bikini, 21 July, 0546). On 20 July at 1929 left berth N-11, Bikini, for operating area BH 40-45. On 21 July in assigned operating area at time of detonation. At 1819 began radiological survey; continued for rest of the day. On 22 July continued radiological survey west of Bikini Atoll.
- HURON (Enewetak, 22 July, 0616). At sea for TEWA Program 2 radiological survey.

USS Merapi (AF-38)

This refrigerated cargo ship operated out of Pearl Harbor and was used to resupply the PPG and Kwajalein. No exposure data are available.

USS Mispillion (AO-105)

Mispillion served as a task group oiler. She accompanied Curtiss and escorts from Hawaii to the PPG and remained during May.

USS Mount McKinley (AGC-7)

Mount McKinley, an amphibious force flagship, served as the press and observers' ship for shots LACROSSE and CHEROKEE. She was not included in the formal task group organization. Her mission was to supply housing and communications facilities afloat to the Special Observers Group, which included members of the press, civil defense administrators, and members of the Joint Office of Test Information. Mount McKinley sortied for shot LACROSSE and subsequently reentered Enewetak Lagoon and moored at buoy N-4. On 21 May, she was in the operating area for shot CHEROKEE, later reentering Bikini Lagoon and anchoring there. Mount McKinley got underway for San Diego from Kwajalein on 22 May and was released from TG 7.3 operational control on 1 June 1956. The exposure of the crew is summarized in Table 46. The observers' exposures are in Table 51.

USS Namakagon (AOG-53)

Namakagon, a gasoline tanker, was in the PPG area in May, between 8 and 12 June, and from 16 to 21 July. No exposure data are available.

USS Natchaug (AOG-59)

This gasoline tanker was in PPG area in May and 16-19 June. No exposure data are available.

USS Navasota (AO-106)

Navasota, an oiler, was in the PPG area in May and June. The ship was assigned to an area 40 to 50 nmi (74 to 93 km) southeast of Bikini during shot FLATHEAD. For shot OSAGE the ship was anchored off Parry Island, approximately 8 nmi (15 km) south-southeast from the shot site.

USS Nemasket (AOG-10)

Nemasket, a gasoline tanker, was in the PPG during July when no shot activity took place.

USS Shelton (DD-790)

Shelton, a destroyer of the Surface Patrol and Transport Unit (TU 7.3.3), arrived at the PPG on 10 April and departed on 25 July. Shelton served as escort for USS Curtiss from the United States to the PPG; also served as weather-information collection ship prior to and during shots at both Enewetak and Bikini. Shelton was in Enewetak Lagoon during the TEWA fallout incident there. Exposure data are shown in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). At 0530 left anchorage N-11, Bikini, to patrol weather station Foxtrot; from patrol center, south tower on Bikini bearing 325°, 3.25 nmi (6.02 km), with patrol length 6.9 nmi (12.8 km). In assigned weather patrol area, vicinity of Bikini Atoll at time of detonation. On 5 and 6 May continued weather observations and released weather balloons for tracking. Reentered lagoon on 6 May at 1613; anchored mooring N-11 at 1627.
- CHEROKEE (Bikini, 21 May, 0551). On 18 and 19 May conducted search and rescue for downed pilot. On 20 May 2205 proceeded to lifeguard station 1 off Enewetak. On 21 May on assigned lifeguard station. Commenced preparations for shot at Bikini at 0520; at 0551 observed detonation bearing 81°, approximately 145 nmi (269 km) distant. At 0900 released from lifeguard station. Moored alongside YON-182 Enewetak at 1137.
- ZUNI (Bikini, 28 May, 0556). On 27 May engaged in meteorological operations, releasing and tracking weather balloons. At 1617 proceeded to lifeguard station 1, continuing to release and track weather balloons until 28 May at 0437. On lifeguard station 1 at 0556 and observed detonation, bearing 90°. At 0616 fired one WASP rocket. Released from lifeguard station 1 at 0836; departed station en route to Enewetak. Entered Deep Entrance channel at 1024; at 1052 anchored mooring D-2.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI. In assigned weather station 1 area, 30 nmi (56 km) east of Enewetak Atoll at time of detonation. At 0556 observed flash from bomb. At 0836 took departure from weather station 1 for Enewetak. Anchored in berth D-2, Enewetak, at 1052.
- ERIE (Enewetak, 31 May, 0618). Anchored in mooring N-12, Bikini.

- SEMINOLE (Enewetak, 6 June, 1255). Anchored in mooring N-12, Bikini.
- FLATHEAD (Bikini, 12 June, 0626). On 11 and 12 June on weather station Dog in vicinity of Bikini Atoll conducting weather observations using WASP rockets, 5-inch window shells, and balloons until 12 June at 0516. On assigned station BG 30-35-L at 0523. At 0626 observed detonation on port side. At 0910 proceeded toward Bikini. Anchored mooring N-11, Bikini, at 1108.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). Anchored mooring K-2, Kwajalein; other ships present included USS Sussex (AK-213) and USS Merapi (AF-38).
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring K-2, Kwajalein; other ships present included Sussex and Merapi. At 1917 left Kwajalein for Enewetak.
- INCA (Enewetak, 22 June, 0956). From 19 through 22 June on weather station Dog conducting weather observations using WASP rockets, 5-inch window shells, and balloons until 22 June. On 22 June at 0520 arrived on lifeguard station 1; continued weather observations. On lifeguard station 1 at time of detonation. At 1045 proceeded to Enewetak. Entered the lagoon at 1157 and moored alongside YON-182. At 1527 anchored mooring C-2.
- DAKOTA (Bikini, 26 June, 0606). Anchored mooring C-4, Enewetak.
- MOHAWK (Enewetak, 3 July, 0606). On 2 July anchored mooring D-4, Enewetak. At 1448 received on board a 300-pound (135-kg) drum of contaminated waste from Nuclear Application, 4926th Test Squadron, to be jettisoned at sea. Underway for lifeguard station at 1830. On 3 July between 0001 and 0606 made weather observations using weather balloons. At 0606 observed detonation, bearing 90°. At 0615 went to general quarters, at 0618 rigged washdown system, at 0636 secured from general quarters. At 0639 discharged can of contaminant over the side at 11°20'N, 162°145'E. At 0921 left area for Enewetak. Reentered lagoon at 1127; anchored D-8 at 1148.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-12, Bikini. At 1812 underway from anchorage for assigned area.
- NAVAJO (Bikini, 11 July, 0556). On 10 July underway from Bikini at 2036. In assigned area BF 35-40-L for weather observations at time of detonation. Continued weather observations until reentry to the lagoon at 0849; anchored mooring N-12 at 0906.
- TEWA (Bikini, 21 July, 0546). From 15 through 21 July on weather station Dog making weather observations using WASP rockets, 5-inch window shells, and ballons. On 21 July en route to lifeguard station 1 and continued weather observations until 0405. On lifeguard station 1 at 0546 and observed flash of detonation to the east. At

0945 entered Enewetak Lagoon. Moored alongside YON-182 at 1019; at 1255 anchored mooring B-2.

- HURON (Enewetak, 22 July, 0616). Anchored in mooring B-2, Enewetak.

USS Silverstein (DE-534)

Silverstein, a destroyer escort of the Surface Patrol and Transport Unit (TU 7.3.3), arrived in the PPG on 10 April and departed on 25 July. Silverstein served as escort for USS Curtiss from the United States to the PPG, provided support to Project 2.62, and sortied for all Bikini shots. Exposure data are in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). Anchored mooring N-12, Bikini. At 0815 set out from Bikini Atoll. Returned to mooring N-12, Bikini at 1830.
- CHEROKEE (Bikini, 21 May, 0551). On 20 May at 1239 left berth to investigate periscope sighting. Proceeded to operating area BF 25-30 at 1915. On 21 May at 0521 reported on station. At 0551 observed burst 290°T, 25 nmi (46 km); "All personnel to quarters and all safety precautions specified by TG 7.3 observed". At 0800 steaming to outline fallout area as part of Program 2; also located and checked project skiffs.
- ZUNI (Bikini, 28 May, 0556). On 27 May at 2016 left for operating area BF 30-35-R. On 28 May at 0530 all hands observed radsafe precautions for ZUNI. At 0556 observed shot ZUNI at 296°T. Maintained station until directed to conduct Program 2 radiological survey at 0935. Took water sample aboard at 1215; at 1250 placed drogue in water; at 1714 conducted bathythermograph drop. On 29 May continued survey in area north of Marshall Islands.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). On 30 May operating north of Marshall Islands on Program 2 radiological survey. Continued Program 2 radiological survey at shot time and after detonation.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring Echo, Kwajalein with USS McGinty moored alongside. At 1403 left for Bikini Atoll, Eneu Island; McGinty also underway.
- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 2242 proceeded from barrier patrol to operating area BF 30-35-R. On 12 June in assigned operating area at 0626 and observed shot FLATHEAD, 313°T, range 32.5 nmi (60.2 km). Maintained station until directed to conduct Program 2 radiological survey at 1235. At 1810 maneuvered to avoid radiation. On 13 June continued radiological survey. At 0122 made vertical cast for Scripps Institution of Oceanography.

Steaming to locate center of radiological contamination in water between 1200 and 1600. At 1400 made vertical cast. Stopped to take water sample at 1545. Conducted water sample collection between 1600 and 1924; at 1924 stopped to let Scripps personnel take water samples.

- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). In vicinity of Bikini Atoll, continuing Program 2 survey.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring N-11, Bikini.
- INCA (Enewetak, 22 June, 0956). Anchored mooring N-8, Bikini.
- DAKOTA (Bikini, 26 June, 0606). On 25 June at 1918 left berth for operating area BF 30-35-R. On 26 June on station in assigned operating area at 0537; at 0606 observed shot DAKOTA. At 0800 proceeded on course 180°T, 10 nmi (18.5 km) from Eneu to hold various drills. Reentered lagoon at 1348; at 1411 anchored mooring N-8, Bikini.
- MOHAWK (Enewetak, 3 July, 0606). On 2 July at 1750 got underway from C-2 Enewetak for assigned operating area EF 35-39. On 3 July in assigned Enewetak operating area in company of USS Shelton and other ships. At 0606 on Station George for shot MOHAWK. Reentered lagoon at 0850; at 0948 anchored mooring C-2, Enewetak.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-8, Bikini. At 1856 left berth for operating area BF 35-40-L.
- NAVAJO (Bikini, 11 July, 0556). On 10 July at 1955 underway for operating area BF 35-40-L. On 11 July reported on station at 0546; at 0556 observed shot NAVAJO at 291°, 35 nmi (65 km). At 0600 maneuvering to take position astern of USS Caliente (AO-53) while McGinty fueling; refueled between 0900 and 1000. At 1130 commenced Program 2 radiological survey. Maneuvered to avoid rain at 2036 and 2055.
- TEWA (Bikini, 21 July, 0546). On 20 July at 1929 left for operating area BF 40-45-L. On 21 July in assigned operating area and at 0546 observed shot TEWA, 280°T. Maintained station prior to commencing Program 2 radiological survey north of Bikini Atoll at 1529.
- HURON (Enewetak, 22 July, 0616). Continued Program 2 radiological survey.

USS Sioux (ATF-75)

A fleet tug of the Utility Unit (TU 7.3.2), Sioux arrived in the PPG on 2 May and departed on 24 July. Sioux participated in all Bikini shots except DAKOTA and was at Enewetak for shot INCA. Sioux supported Project 2.63

activities by mooring and tending project skiffs in vicinity of Bikini Atoll. Exposure data for the 72-man crew are in Table 46. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). At sea in vicinity of Bikini Atoll recovering and mooring Project 2.63 skiffs. At 1439 returned to lagoon; anchored mooring N-2, Bikini, at 1501.
- CHEROKEE (Bikini, 21 May, 0551). In assigned operating area. At 0551 observed detonation from port side. Reentered lagoon via Wide Entrance at 1051; at 1055 anchored mooring N-2, Bikini.
- ZUNI (Bikini, 28 May, 0556). In assigned operating area. Reentered lagoon at 0815; at 1055 anchored mooring N-3, Bikini.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI.
- ERIE (Enewetak, 31 May, 0615). At sea in vicinity of Bikini Atoll recovering and mooring Project 2.63 skiffs. Reentered lagoon via Wide Entrance at 1421; at 1425 anchored mooring N-3, Bikini.
- SEMINOLE (Enewetak, 6 June, 1255). No data available.
- FLATHEAD (Bikini, 12 June, 0626). In assigned operating area. At 0926 maneuvered to reenter lagoon via Wide Entrance. Underway at 2212 to leave lagoon for project station 12.
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). At sea in vicinity of Bikini Atoll recovering and mooring Project 2.63 skiffs. Returned to lagoon at 2307; at 2335 anchored mooring N-2, Bikini.
- OSAGE (Enewetak, 16 June, 1314). No data available.
- INCA (Enewetak, 22 June, 0956). Anchored mooring B-2, Enewetak.
- DAKOTA (Bikini, 26 June, 0606). Anchored mooring B-1, Enewetak. Underway at 1338 to shift anchorage to mooring D-4; at 1425 anchored at mooring D-4.
- MOHAWK (Enewetak, 3 July, 0606). Anchored mooring N-8, Bikini.
- APACHE (Enewetak, 9 July, 0606). At sea in vicinity of Bikini Atoll servicing Project 2.63 skiffs. Returned to lagoon at 1444; at 1500 anchored mooring N-2, Bikini. Underway at 1841 for shot NAVAJO sortie; shot aborted.
- NAVAJO (Bikini, 11 July, 0556). In assigned operating area. At 0912 maneuvered to reenter lagoon; anchored mooring N-2, Bikini, at 0959.
- TEWA (Bikini, 21 July, 0546). In assigned operating area. At 0912 maneuvered to reenter lagoon; at 0959 anchored mooring N-2, Bikini.

- HURON (Enewetak, 22 July, 0616). At sea in vicinity of Bikini Atoll recovering Project 2.63 skiffs. Returned to lagoon at 2351.

USS Sussex (AK-213)

A cargo ship with normal complement of 38, Sussex operated from Pearl Harbor for resupply of PPG and Kwajalein and was in PPG area the first week in May, from 11 to 16 June, and from 22 to 27 July. No exposure data are available.

T-AP-181.* See USNS Fred C. Ainsworth

T-AK-243.* See USNS Sgt. Archer T. Gammon

T-AK-253.* See USNS Pvt. Joe E. Mann

T-LST-306.* See USNS Bernalillo County

T-LST-618*

This tank landing ship was operated by a civilian crew of 45 as an element of the Surface Patrol and Transport Unit (TU 7.3.3) during REDWING. She arrived in the PPG on 27 February and was used for interatoll transportation of light freight and passengers. Exposure data are in Table 46.

USS Walton (DE-361)

Walton, a destroyer escort, arrived in the PPG on 5 June and departed on 23 June. Its mission was to make radiological surveys. There is no record of radiation exposure readings for the ship's crew. The ship's mission and operating area were such that there was little likelihood of any exposure. Operational activities at shot times are summarized below.

- SEMINOLE (Enewetak, 6 June, 1255). Moored at Enewetak, 20 nmi (37 km) southeast.
- FLATHEAD (Bikini, 12 June 0626). Steaming in assigned survey area, 400 nmi (741 km) northwest of shot area.

* Vessels designated T before their hull numbers are Navy vessels operated by civilian crews.

USS Walton (DE-361)

- BLACKFOOT (Enewetak, 12 June 0626). Steaming in assigned survey area, 285 nmi (530 km) northwest of shot area.
- KICKAPOO (Enewetak, 14 June, 1126). Steaming in assigned survey area, 140 nmi (260 km) northwest of shot area.
- OSAGE (Enewetak, 16 June, 1314). Moored at Enewetak, 10 nmi (18.5 km) south.
- INCA (Enewetak, 22 June, 0956). Anchored at Enewetak, 13 nmi (24 km) southeast.

YAG-39 (USS George Eastman)

YAG-39, a converted Liberty ship, was used as floating fallout-collection station by Project 2.63 and other projects in the TG 7.1 Program 2 as part of TU 7.3.6, Radiological Support Unit. YAG-39 arrived in the PPG on 28 March and departed 28 July. YAG-39 was equipped with heavily shielded control and laboratory facilities that were manned by a skeleton crew from the ship's company and personnel from the TG 7.1 projects. Unlike the remainder of the fleet, YAG-39, YAG-40, and USS Crook County were based at Enewetak, and the crews lived on Parry when not on duty. Exposure data for the crew as a whole are shown in Table 46. Exposure data for its scientific passengers are shown in Table 10 under Project 2.63. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). On 4 May at 1303 left Enewetak. On 4 May steaming toward Bikini in company with YAG-40 and Crook County at time of detonation. At 1315 anchored mooring N-19, Bikini.
- CHEROKEE (Bikini, 21 May, 0551). On 20 May left Bikini Lagoon with skeleton crew aboard for operating area north of Bikini Atoll to conduct Program 2 radiological survey. On 21 May in assigned operating area and at 0551 observed shot. Steamed for rest of day in operating area on Program 2 radiological survey. Fallout was very light. Operating area was about 130 nmi (240 km), bearing 315° from surface zero (Reference C.1.3.1317).
- ZUNI (Bikini, 28 May, 0556). On 27 May at 1245 left Bikini Lagoon for operating area north of Bikini Atoll with skeleton crew aboard to conduct Program 2 radiological survey. On 28 May in assigned operating area and observed shot ZUNI. At 1800 began receiving fallout at 13°0'N, 165°1.5'E; placed drogues over sides; at 1810 secured all hatches and ports; at 1848 turned on washdown system. An unshielded film badge topside recorded an exposure of 0.2 R for the 35-hour period YAG-39 was in the fallout area (Reference C.1.3.1317).

- YUMA (Enewetak, 28 May, 0776). Continued ZUNI radiological survey north of Bikini. Ship remained at sea until 0815 on 30 May when anchored at D-2, Enewetak.
- ERIE (Enewetak, 31 May, 0615). Anchored mooring D-2, Enewetak.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring E-5, Enewetak.
- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 1225 left berth N-20, Bikini, for operating area north of Bikini Atoll with skeleton crew aboard for Program 2 radiological survey. On 12 June in assigned operating area and at 0626 observed shot FLATHEAD. At 1100 began receiving fallout at 12°4'N, 165°22'E; placed drogue over side; at 1810 secured all ports and hatches, turned on washdown system; at 2128 launched second drogue. On 13 June at 0615 relieved on station by MV Horizon, turned off washdown system, opened hatches and ports. An unshielded film badge topside recorded an exposure of 0.05 R for the 26-hour period YAG-39 was in the fallout area (Reference C.1.3.1315).
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (14 June, 1126). At 0845 arrived Enewetak from fallout operating area near Bikini. Anchored mooring C-1, Enewetak.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring C-1, Enewetak.
- INCA (Enewetak, 22 June, 0959). Anchored mooring C-1, Enewetak.
- DAKOTA (Bikini, 26 June, 0606). Anchored mooring C-1, Enewetak.
- MOHAWK (Enewetak, 3 July, 0606). On 2 July at 1855 left mooring C-1, Enewetak, for operating area IG. On 3 July in assigned operating area about 25 nmi (46 km) southeast of Enewetak at time of detonation; at 0606 observed shot MOHAWK. En route to Enewetak at 0659; 0921 anchored mooring C-1, Enewetak.
- APACHE (Enewetak, 9 July, 0606). On 8 July anchored mooring N-21, Bikini, until 1503 when underway for operating area. At 1945 shot aborted, returned to anchorage. On 8 July anchored mooring N-21, Bikini. At 1521 left for operating area; at 2200 shot aborted, set course to return to Bikini. On 10 July at 0720 anchored in mooring N-21, Bikini Lagoon.
- NAVAJO (Bikini, 11 July, 0556). On 10 July at 1815 left mooring N-21 for operating area north of Bikini Atoll. On 11 July at 0518 arrived assigned operating area and maneuvered in figure-eights. At 0556 observed shot NAVAJO. At 0602 maneuvered for fallout area and steamed for the rest of the day in assigned operating area conducting Program 2 radiological survey. Operating area was about 20 nmi (37 km) north of surface zero. An unshielded film badge topside recorded an exposure of 10 R for the 50-hour period the ship was in the fallout area (Reference C.1.3.1317).

YAG-39 (USS George Eastman)

- TEWA (Bikini, 21 July, 0546). On 20 July at 1546 left berth N-21, Bikini, for operating area north of Bikini Atoll. In assigned operating area on 21 July and at 0546 observed shot TEWA. At 0748 received fallout for Program 2 radiological survey. At 1030 steamed in figure-eights in the fallout area about 20 nmi (37 km), bearing 350° from surface zero. On 22 July at 0204 relieved by MV Horizon. At 0815 transferred water samples in Bikini Lagoon. Left Bikini at 0830 for operating area to collect water samples. At 1500 compared readings with MV Horizon. Completed sampling at 2113.
- HURON (Enewetak, 22 July, 0616). In assigned fallout operating area for Program 2 radiological survey. At 2113 left operating area north of Bikini Atoll for Enewetak.

YAG-40 (USS Granville S. Hall)

Converted Liberty ship used like YAG-39 (USS George Eastman) above and part of the same TU 7.3.6, Radiological Support Unit. Operational activities are summarized below.

- LACROSSE (Enewetak, 5 May, 0625). On 4 May at 0747 anchored mooring, C-1 Enewetak. Left mooring at 1340 en route to Bikini in company with YAG-39 and USS Crook County. On 5 May steaming en route to Bikini at time of detonation. At 1251 anchored mooring N-18, Bikini.
- CHEROKEE (Bikini, 21 May, 0551). On 20 May at 1253 left berth N-18, Bikini, for operating area. On 21 May in assigned operating area and at 0551 observed shot CHEROKEE bearing 153°, 61 nmi (113 km). Steamed for rest of day in operating area conducting Program 2 radiological survey. Light fallout, 0.00025 R/hr encountered with peak at H+9. YAG-40 was about 70 nmi (130 km), bearing 325° from surface zero (Reference C.1.3.1317).
- ZUNI (Bikini, 28 May, 0556). On 27 May at 1230 left berth N-18, Bikini, for operating area to conduct Program 2 radiological survey. On 28 May in assigned operating area and at 0556 observed shot ZUNI 60 nmi (111 km) distant. At 0920 began receiving fallout, ship experienced rain squalls during washdown, which washed deposited material from control area. Operating area was about 50 nmi (83 km), bearing 350° from surface zero.
- YUMA (Enewetak, 28 May, 0756). At sea for ZUNI, continuing ZUNI radiological survey north of Bikini. On 30 May at 0703 anchored in mooring C-1, Enewetak.
- ERIE (Enewetak, 31 May, 0615). Anchored mooring C-1, Enewetak.
- SEMINOLE (Enewetak, 6 June, 1255). Anchored mooring C-1, Enewetak.

- FLATHEAD (Bikini, 12 June, 0626). On 11 June at 1503 left berth N-21, Bikini, for operating area for Program 2 radiological surveys. On 12 June in assigned operating area about 50 nmi (83 km), bearing 20° from surface zero. At 1438 received fallout. At 1600 turned north of Bikini with aft washdown system on. On 13 June at 0600 turned aft washdown system off. Unshielded film badge topside recorded 2.5 R exposure for the 33-hour period YAG-40 was in the fallout area (Reference C.1.3.1317).
- BLACKFOOT (Enewetak, 12 June, 0626). At sea for FLATHEAD.
- KICKAPOO (Enewetak, 14 June, 1126). At 0900 returned to Enewetak from operating area and anchored mooring D-2, Enewetak.
- OSAGE (Enewetak, 16 June, 1314). Anchored mooring D-2, Enewetak.
- INCA (Enewetak, 22 June, 0956). Anchored mooring D-2, Enewetak.
- DAKOTA (Bikini, 26 June, 0606). Anchored mooring D-2, Enewetak.
- MOHAWK (Enewetak, 3 July, 0606). On 2 July at 1844 left mooring D-2, Enewetak, for operating area near Enewetak. On 3 July in assigned operating area 23 nmi (43 km) from Enewetak beacon at time of detonation, bearing 1°. At 0931 anchored mooring D-2, Enewetak.
- APACHE (Enewetak, 9 July, 0606). Anchored mooring N-20, Bikini. Left for operating area at 1453; shot aborted, returned to Bikini.
- NAVAJO (Bikini, 11 July, 0556). On 10 July at 1811 left berth N-20 for operating area. On 11 July at 0130 arrived in assigned operating area about 35 nmi (65 km), bearing 350° from surface zero. At 1347 turned on after section of washdown system and shifted to remote control as fallout was received. At 2055 secured after section of washdown system. An unshielded film badge topside recorded 1.8 R for the 33-hour period the ship was in the fallout area (Reference C.1.3.1317).
- TEWA (Bikini, 21 July, 0546). On 20 July at 1553 left berth N-20, Bikini, for operating area. On 21 July in assigned operating area about 35 nmi (65 km), bearing 300° from surface zero. Closed up ship at 1030 and at 1049 turned on washdown system as fallout was recieved. An unshielded film badge topside recorded an exposure of 41.6 R for the 33-hour period YAG-40 was in the area (Reference C.1.3.1317).
- HURON (Enewetak, 22 July, 0616). At sea for TEWA. Steaming from operating area toward Bikini at shot time. At 0715 offloaded samples at Bikini.

YC-1420

A large, unmanned covered lighter used at Bikini and towed to sea during fleet sorties.

YCV-10

An unmanned aircraft lighter used at Bikini and towed to sea during fleet sorties.

YFNB-13 and YFNB-29

These unmanned fuel barges were moored in Bikini Lagoon and were not towed to sea during sorties. They were used as Program 2 fallout collection stations and required decontamination.

YON-182

An unmanned fuel-oil barge moored at L-4 in Enewetak and used for refueling small units.

OTHER NAVAL UNITS

The following organizations had personnel who participated in REDWING. Most of these men participated as part of TG 7.1 or TG 7.4 or other non-TG 7.3 organizations. Summary of exposure information from the Consolidated List is shown in Table 46.

Amphibious Base -- Coronado, California. Home station for the personnel of the Bikini Boat Pool. A single enlisted man on the TG 7.1 roster was listed with this affiliation, and his exposure data have been arbitrarily added to the Bikini Boat Pool exposure data in Table 46.

Boat Pool, Bikini. This 203-man organization with home station at the Amphibious Base in Coronado provided intra-atoll transportation and assisted with postshot scientific data-recovery operations. It arrived in the PPG on 27 February and operated as an element of the Boat Pool Unit (TE 7.3.7.2) based on USS Catamount, departing on 23 July.

Reference to the 5x8-card dosimetry records (Reference C.1.7.4) indicates that this group was often issued mission badges, indicating that they were required to enter radiological exclusion (radex) areas, probably providing transportation for data recovery parties. Some individuals had many such badges issued (27 in one case); some had none. The average number of such badges issued to individuals was six. Frequently, individuals were given two, and sometimes three, mission badges in a single day.

Boat Pool, Enewetak. This 39-man contingent had been stationed at Enewetak since the 1954 CASTLE test series. In REDWING it was designated TU 7.3.7.3 and was used for intra-atoll transportation, primarily on the lower islands; at least the detailed exposure records (Reference C.1.7.4) show that no mission badges were issued, indicating that no radex areas were entered. The detailed exposure data also indicate that the last permanent badge issued to 29 of the 35 men was read on 30 June, and there is no indication that any personnel badges for these 29 were issued after that date.

Bureau of Aeronautics, Washington, D.C. This organization sponsored and personnel from it participated as part of Projects 5.8, 8.4, and 8.5. Exposure data are in Table 46.

Bureau of Medicine and Surgery, Washington, D.C. Personnel participated in Project 2.63. Exposure data are in Table 46.

Bureau of Ships, Washington, D.C. Personnel participated in Projects 2.9 and 2.63. One of the military participants was the Commander, TU 7.3.6. Exposure data are in Table 46.

Chief of Naval Operations (CNO), Washington, D.C. CNO was the person through whom the Commander JTF 7 (CJTF 7) reported to the Joint Chiefs of Staff (JCS). A representative of this office was badged with Hq JTF 7 and is included in the Hq JTF 7 exposure data in Table 46 under Misc Navy.

Cloth[ing] Supply Office. An individual with this affiliation was listed on the TG 7.1 Consolidated List, but no other information is available about this naval organization or its function in REDWING. Exposure data are included under Misc Navy in Table 46.

Fleet Weather Centers. Representatives of these organizations from North Island, California; Pearl Harbor, Hawaii; and Sangley Point, Philippine Islands, were badged with the Hq JTF 7. The functions of these groups are not identified. Exposure data are in Table 46.

Hydrographic Office, Washington, D.C. A representative of the organization was badged with Hq JTF 7. Exposure data are included in Table 46 under Misc Navy.

Naval Air Special Weapons Facility (NASWF), Albuquerque, New Mexico. The probable function of this group was the provision of the aircraft and crew for TG 7.1, Project 5.8. This group also participated in Projects 8.4 and 8.5. Exposure data for this organization are presented in Table 46.

Naval Air Station, Kwajalein. The support unit for VP-1. Was designated a part of the Patrol Plane Unit (TU 7.3.4). Exposure data for eight men from this station are in Table 46. These men may have been badged as they handled aircraft that could have come into contact with radioactive material.

Naval Air Station, Miramar, California. A representative of this station was badged as part of Hq JTF 7. Exposure data are in Table 46 under Misc Navy. No task force function has been identified for this man.

Naval Air Station, Moffett, California. This is the base for Transport Squadron Three (VR-3), which was represented in strength. However, there were two persons badged in TG 7.1 or TG 7.4 who were identified as simply "NAS Moffett" or "Moffett" and who may represent VR-3 personnel incompletely identified, or who may represent other organizations. Their exposure data are listed with VR-3, Moffett NAS, in Table 46.

Naval Air Station, Point Mugu, California. No function for the individual listed from this station and badged in TG 7.1 has been identified. His exposure data are included in Misc Navy in Table 46.

Naval Medical Research Institute, Bethesda, Maryland. Participation of this group was on Project 2.72. Onsite participation is not confirmed by the exposure data.

Naval Ordnance Laboratory (NOL), White Oak, Silver Springs, Maryland. Fifteen men from this organization (twelve civilians and three military) manned two projects in the airblast program, Projects 1.3 and 1.6. Exposures were low, reflecting the low potential for exposure of the projects and the fact that NOL personnel were probably not at Enewetak when the TEWA incident occurred, as their last event was MOHAWK.

Naval Radiological Defense Laboratory (NRDL), San Francisco, California. This organization participated in TG 7.1, TU 3. NRDL staffed Projects 2.61, 2.63, 2.71, and 2.8, in the area of nuclear radiation, fallout collection, and decontamination. NRDL assisted in the same areas with Projects 2.9 and 2.10. Projects 8.1a, 8.1b, 8.1c, and 8.2, involving thermal radiation measurements, were also staffed by NRDL. In addition, NRDL provided thermal instrumentation for Projects 5.5 and 5.7. Exposure data are available for 37 uniformed NRDL personnel and for 107 civilians (Reference C.1.7.3) and are presented in Table 46.

Naval Research Laboratory (NRL), Washington, D.C. Participated in Project 6.6, and staffed an experimental project for Los Alamos Scientific Laboratory (LASL) in TU 1 of TG 7.1. Exposure data are in Table 46.

Naval Shipyards. Thirty-seven individuals from naval shipyards in Boston, Charleston, Mare Island, Norfolk, New York, Pearl Harbor, Philadelphia, Portsmouth, Puget Sound, and San Francisco participated in REDWING. They served as radsafe monitors in TG 7.1 TU 7, but a few were monitors for projects in TU 3 of TG 7.1. A summary of the exposure data are shown in Table 46.

Patrol Squadron One (VP-1). VP-1 was based at Kwajalein and, supported by the Naval Air Station personnel there, flew radiological reconnaissance missions for TG 7.1 Program 2 as well as surveillance missions for the task force. Exposure data for the squadron is included in Table 46 under TU 7.3.4.

Patrol Squadron-22 (VP-22). Based in Hawaii and participated in off-site radiological reconnaissance.

Transport Squadron Three (VR-3), Moffett NAS, California. A large contingent (181 men) from this squadron was badged with TG 7.4. This squadron probably flew radioactive samples back to the United States for analysis by the weapon laboratories. It may have also flown supply missions into the PPG.

Transport Squadron Eight (VR-8). A 10-man contingent of personnel from this air transport squadron, based on the eastern U.S. coast, were badged with TG 7.4. No function has been identified. Exposure data are in Table 46.

Transport Squadron 21 (VR-21), NAS Barbers Point, Hawaii. A single person from this squadron was badged in TG 7.4. His exposure data are included in Table 46 under Misc Navy.

CHAPTER 8

AIR FORCE PARTICIPATION IN OPERATION REDWING

Almost 2,800 Air Force personnel participated in the REDWING series, 91 in Hq, Joint Task Force 7 (JTF 7), 216 in Task Group (TG) 7.1, and the remainder in TG 7.4. Air Force personnel were stationed on Parry and Enewetak islands on Enewetak Atoll, Eneu Island on Bikini Atoll, and at four remote islands used as weather stations -- Tarawa, Rongerik, Kusaie, and Kapingamarangi. Over 90 percent of Air Force personnel were stationed on Enewetak Island. TG 7.4 manned, operated, and maintained 84 Air Force aircraft and maintained two Navy aircraft during REDWING. Responsibilities for TG 7.4 included cloud sampling, measuring blast and thermal effects on aircraft, photography, weather reconnaissance and reporting, communications, search and rescue, and operations of the airbases at Enewetak and Eneu islands. They also manned JTF 7 Weather Central office.

Exposure information on Air Force personnel is complete. The newly instituted concept at REDWING of providing everyone with a permanent badge to be worn at all times for the duration of the series worked very well. In addition to permanent badges, mission badges were used extensively for persons entering contaminated areas. These were normally 1-day badges and were used to keep an accurate and up-to-date record of exposure, so that maximum permissible exposures (MPEs) were not exceeded. Within the Air Force, mission badges were used by most pilots and crews, sample-removal personnel, and aircraft decontamination personnel. TEWA shot at Bikini caused measurable fallout at Enewetak; however, it is reasonable to assume that an accurate record of accumulated exposures for everyone is available since everyone was wearing a permanent badge.

Over 100 Air Force units with personnel listed in the Consolidated List of Exposures (Reference C.1.7.3) participated in the REDWING operation. These units and the number of men provided by each are shown in Table 47. This table also shows the task force functional organization or element into which the participants fit. For some participants, home organization and station were not given in the Consolidated List; rather the TG 7.4 element, such as the

Table 47. Air Force units badged for REDWING.

Unit Designation	No. of Persons Badged
Headquarters, Task Group 7.4	
Air Force Special Weapons Center, Kirtland AFB, New Mexico	106
Task Group 7.4[a]	6
4929th Test Squadron, Kirtland AFB, New Mexico	2
26th District OSI, Hickam AFB, Hawaii	5
1009th Special Weapons Squadron, McClellan AFB, California	4
4925th Test Group, Kirtland AFB, New Mexico	1
Headquarters, Test Base Unit (TBU)	
4930th Support Group, Enewetak	60
TBU-5, Enewetak[a]	33
4931st Operations Squadron (TBU)	
TBU-2, Enewetak	204
1401st Air Base Wing, Andrews AFB, Washington, D.C.	6
4931st Operations Squadron, Enewetak[a]	3
747th Aircraft Control and Warning Squadron, Ellington AFB, Texas	1
6486th Air Base Wing, Hickam AFB, Hawaii	2
1611th Air Base Group, McGuire AFB, New Jersey	3
4900th Air Base Group, Kirtland AFB, New Mexico	3
4932nd Maintenance Squadron (TBU)	
4932nd Maintenance Squadron, Enewetak[a]	324
TBU-3, Enewetak	22
4924th Maintenance Squadron, Kirtland AFB, New Mexico	13
Warner-Robins Air Materiel Area, Warner-Robins AFB, Georgia	12
Sacramento Air Materiel Area, McClellan AFB, California	2
3525th Preventive Maintenance Squadron, Williams AFB, Arizona	1
6486th Maintenance and Supply Group, Hickam AFB, Hawaii	1

Note:
[a]No actual home unit was given for these men in the source document.

(continued)

Table 47. Air Force units badged for REDWING (continued).

Unit Designation	No. of Persons Badged
Helicopter Element (TBU)	
310th Troop Carrier Squadron, Pope AFB, North Carolina	50
Sampling and Decontamination Element (Test Aircraft Unit TAU)	
4926th Test Squadron (Sampling), Enewetak	207
Early Penetration Element (TAU)	
461st Bombardment Wing, Blytheville AFB, Arkansas	21
759th Bombardment Squadron, Blytheville AFB, Arkansas	1
764th Bombardment Squadron, Blytheville AFB, Arkansas	4
765th Bombardment Squadron, Blytheville AFB, Arkansas	7
766th Bombardment Squadron, Blytheville AFB, Arkansas	6
Early Penetration Element, Enewetak[a]	4
345th Bombardment Group, Langley AFB, Virginia	10
498th Bombardment Squadron, Langley AFB, Virginia	3
499th Bombardment Squadron, Langley AFB, Virginia	8
500th Bombardment Squadron, Langley AFB, Virginia	2
Strategic Air Command (SAC) Indirect Bomb Damage Assessment Element (TAU)	
301st Bombardment Wing, Barksdale, AFB, Louisiana	46
Hq SAC, Offutt AFB, Nebraska	16
Wright Air Development Center Element (TAU)	
Wright Air Development Center, Wright-Patterson AFB, Ohio	82
Tech Photo Element, Enewetak (TAU)	52
Ionosphere Element (TAU)	
Air Force Cambridge Research Center, Massachusetts	21
Drop and Canister Element (TAU)	
4928th Test Squadron, Kirtland AFB, New Mexico	51

Note:

[a]No actual home unit was given for these men in the source document.

(continued)

Table 47. Air Force units badged for REDWING (continued).

Unit Designation	No. of Persons Badged
Headquarters USAF, Element (TAU)	
Hq USAF, Washington, D.C.	9
Headquarters Test Services Unit (TSU), Enewetak	17
Weather Central and Weather Reporting Elements, Enewetak (TSU)	
6th Weather Squadron, Tinker AFB, Oklahoma	59
Weather Reporting Element, Enewetak[a]	299
Weather Reconnaissance Element (TSU)	
55th Weather Squadron, McClellan AFB, California	6
57th Weather Squadron, Hickam AFB, Hawaii	35
Weather Reconnaissance Element, Enewetak[a]	25
4th Weather Group (Detachment 33), Kirtland AFB, New Mexico	1
Documentary Photo Element 9TSU)	
1352nd Motion Picture Squadron, Hollywood, California	26
Documentary Photo Element, Enewetak[a]	4
C-54 Support Element (TSU)	
1370th Mapping and Charting Squadron, Palm Beach AFB, Florida	2
1371st Mapping and Charting Squadron, Palm Beach AFB, Florida	36
Air Photo and Charting Service, Scott AFB, Illinois	1
Communications Element (TSU)	
Airways and Air Communications Services squadrons (38 each)	198
Airways and Air Communications groups (3 each)	12
Commmunications Element[a]	3
1800th Airways and Air Communications Services Wing, Tinker AFB, Oklahoma	1
Hq USAF Security Service, Kelly AFB, Texas	1

Note:

[a]No actual home unit was given for these men in the source document.

(continued)

Table 47. Air Force units badged for REDWING (continued).

Unit Designation	No. of Persons Badged
Search and Rescue Element (TSU)	
49th Air Rescue Squadron, Selfridge AFB, Michigan	140
Search and Rescue Element, Enewetak[a]	1
Military Air Transport Services (MATS) Terminal Element (TSU)	
MATS Terminal Element, Enewetak[a]	53
Hq Pacific Division, MATS, Hickam AFB, Hawaii	7
Air Transport Units (USAF)	
47th Air Transport Squadron, Hickam AFB, Hawaii	48
1254th Air Transport Group, Washington, D.C.	19
48th Air Transport Squadron, Hickam AFB, Hawaii	10
50th Air Transport Squadron, Hickam AFB, Hawaii	8
1707th Air Transport Wing, Patrick AFB, Florida	5
1737th Ferry Squadron, 1502nd Air Transport Wing, 1703rd Air Transport Group, 1608th Air Transport Wing, 1734th Air Transport Squadron	8
Miscellaneous (USAF)	
503rd Air Defense Group, Portland, Oregon	1
Hq Air Materiel Command, Wright-Patterson AFB, Ohio	1
Hq Far Eastern Air Forces, Yokota AFB, Japan	8
Hq Air Defense command, Ent AFB, Colorado	7
Air University, Maxwell AFB, Alabama	1
3331st Technical Training Squadron, Scott AFB, Illinois	1
Hq USAF Communications Service, Scott AFB, Illinois	1
Hq USAF Deputy Chief of Staff for Operations, Washington, D.C.	4
Hq 8th Air Force, Westover AFB, Massachusetts	1
Hq Air Research and Development Command, Eglin AFB, Florida	2
Hq 15th Air Force, March AFB, California	1
Unknown	1

Note:
[a]No actual home unit was given for these men in the source document.

Early Penetration Element, was given. Such participants are listed under the name of the element itself.

In Table 47, Hq, Strategic Air Command (SAC) personnel have been included with the SAC Indirect Bomb Damage Assessment (IBDA) element because, although a few were visitors, most spent considerable time in the test area. Weather Central and Weather Reporting elements have been combined because the 6th Weather Squadron manned both organizations. Note that most men here listed only "Weather Reporting Element" on their 5x8 cards (Reference C.1.7.4). The 38 individual Airways and Air Communications Services (AACS) squadrons have not been listed because most provided only a few men. The 1253rd AACS Squadron, APO 187, provided most Communications Element personnel. Air transport units are listed separately near the end of the table because they were not permanently based at the test area. They were transporting equipment, supplies, and personnel to and from the test site. The miscellaneous category includes those units that had very few participants, most of whom were probably observers.

Table 48 provides exposure information for Air Force personnel. It follows the format of Table 47, with the addition of Hq JTF 7 and TG 7.1.

HEADQUARTERS, JOINT TASK FORCE 7

Research has identified 91 Air Force men who were assigned to this headquarters. Duties were primarily office staff in nature, although 15 men received more than 3.9 R (see Table 48).

TASK GROUP 7.1

Altogether, there were 216 Air Force personnel badged who indicated that they worked in this task group. Most were in Task Unit (TU) 3, which conducted the Department of Defense (DOD) experimental programs (see Chapters 1 and 3). Of the 216 persons, 86 were from the Wright Air Development Center (WADC) at Wright-Patterson AFB, Ohio. All 86 were in TU 7.1.3. There were also 82 WADC personnel in the WADC element in TG 7.4 (see below). Personnel in TG 7.1 with the highest badge readings were participants in Project 2.66, the early penetration of the clouds by B-57 aircraft.

Table 48. REDWING personnel exposure, U.S. Air Force organizations.

Organization	No. of Persons Badged	Exposure Ranges (roentgens) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	10-15	Over 15	Over 3.9[a]	Collective Exposure (man-R)	Mean Exposure (R)
Hq Joint Task Force 7	91	3	20	14	2	3	6	11	21	11				15	190	2.088
Task Group 7.1	216	18	55	15	17	26	26	12	25	13	7		2	24	413.4	1.914
Task Group 7.4																
Hq, Task Group 7.4	123	22	15	10	6	9	19	19	19	4				5	214.2	1.741
Test Base Unit (TBU)																
Hq TBU	93	4	16	3	5	5	29	15	16						183.8	1.976
4931st Operations Sq	221	6	35	23	4	6	15	47	72	12	1			16	518	2.344
4932nd Maintenance Sq	375	14	50	26	5	9	52	79	120	15	4	1		23	918.3	2.449
Helicopter Element	50		4	4	4	7	6	11	4	4	6			10	142	2.84
Test Aircraft Unit (TAU)																
Sampling & Decon	207	3	15	15	8	12	9	22	34	34	49	6		90	839.3	4.054
Early Penetration	66	1	21	19	10	2	3		4	1	2	1	2	6	121.1	1.834
Indirect Bomb Damage Assessment	62	10	41	7	3	1									21	0.339
Wright Air Development Center	82	2	11	19	5	7	9	18	3	6	2			8	157.8	1.924
Tech Photo	52	3	3	1	1	2	10	20	12						125.8	2.418
Ionosphere	21	4				8	7	1	1						36	1.714
Drop and Canister	51	6	44	1											11.75	0.230
Hq USAF	9	4	3						1		1			1	11.75	1.306
Test Services Unit																
Hq Element	17		2	1			3	5	4	2				2	44.75	2.632
Weather Central and Weather Reporting	359	4	39	95	48	26	43	43	44	15	2			18	638.1	1.777
Weather Reconnaissance	67	4	25	12	5	8	3	5	4	1				1	74.5	1.112
Documentary Photo	30	1	9	2	7		6	1	4						42.75	1.425
C-54 Support	39	1	3	6	1	2	3	10	12	1				1	90.75	2.327
Communications	215	16	64	16	13	6	28	37	32	2	1			5	348	1.619
Search and Rescue	141	2	8	4	4	10	19	33	53	6	2			10	338.5	2.755
MATS Terminal	60	7	10	3	1	1		12	20	6				6	137.8	2.296
Air Transport Units	98	71	11	4	11		1								21.75	0.222
Miscellaneous	35	14	19		1	1									7.75	0.221
Totals	2,780	220	523	300	161	151	297	401	505	133	77	8	4	241	5,700	2.050

Note:

[a]Basic Maximum Permissible Exposure (MPE) was 3.9 R (gamma) per 13-week period; a special MPE of 20 R (gamma) per 13-week period was established for cloud samplers.

Source: Reference C.1.7.3.

TASK GROUP 7.4

Headquarters, Task Group 7.4

There were 124 personnel who were badged working in this headquarters (see Table 48). Some of the personnel identified as being the Task Group Headquarters may have had other nonadministrative duties as there were five who exceeded the MPE of 3.9 R.

Headquarters, Test Base Unit

This headquarters unit had 93 badged personnel with exposures as shown in Table 48. No one exceeded the 3.9 R MPE.

4931st OPERATIONS SQUADRON. This squadron ran the airbases at Enewetak and Eneu islands. It also operated interisland and interatoll airlifts using three C-54s, four C-47s, and eight L-20s. The persons with high badge readings over 5 R were possibly probably associated with aircraft decontamination.

4932nd MAINTENANCE SQUADRON. This squadron provided maintenance and supply support to the airbases and to TG 7.4 in general. Again, persons with high badge readings were probably involved with aircraft decontamination.

HELICOPTER ELEMENT. This element was formed by the 310th Troop Carrier Squadron from Pope AFB, North Carolina. It operated ten H-19 helicopters for transportation between the various islands at Enewetak Atoll. These aircraft were routinely used for experiment recovery, which may account for the 10 badge readings over 3.9 R.

Test Aircraft Unit

SAMPLING AND DECONTAMINATION ELEMENT. This element operated six B-57B and ten F-84G sampler aircraft that were used to collect particulate and gaseous samples from the radioactive clouds. Exposure limits for these persons were set at 20 R rather than 3.9 R because of their mission. As can be seen from Table 48, there were 90 men who exceeded the lower MPE of 3.9 R, but none who exceeded 20 R.

EARLY PENETRATION ELEMENT. This element operated five B-57B aircraft in support of a Hq USAF experimental project, Project 2.66 (see Chapter 3). The purpose of this project was to measure exposures one would receive by penetrating the radioactive cloud shortly after detonation and to determine factors affecting crew safety. This element did not perform any sampling missions. As could be expected, there were some high exposures in this element, one being the highest recorded in the entire task force -- 16.360 R. This organization came under the 20 R MPE waiver.

INDIRECT BOMB DAMAGE ASSESSMENT (IBDA) ELEMENT. This element operated three B-47 aircraft equipped with radar scopes and cameras to photograph the scope image of the detonations. A SAC unit, the 301st Bomb Wing from Barksdale AFB, Louisiana, formed this element. Since the aircraft did not approach the radioactive cloud, exposures for personnel in this element were comparatively low.

WADC EFFECTS ELEMENT. This element operated one B-47, one B-52, one B-66, one B-57B, two F-84F, and one F-101A aircraft. These aircraft were subjected to various blast and thermal loads by positioning them at known distances from the detonations. The F-101A pilot received small amounts of initial gamma radiation on at least one occasion, when he was positioned at high altitude almost directly over the burst. Exposures to men in this element were about average compared to others in TG 7.4.

TECHNICAL PHOTO ELEMENT. This element operated three B-50E aircraft equipped with high-speed cameras to photograph nuclear cloud growth. Planning documents showed that the 6091st Reconnaissance Squadron was to man this element; however, no one declared this unit on his 5x8 card so there is no certainty that the 6091st was actually the unit that participated. Fifty-two men indicated "Tech Photo El" on their 5x8 card (see Table 47). No one in this element exceeded the 3.9 R MPE.

IONOSPHERE ELEMENT. This element operated one C-97 aircraft to study electromagnetic changes in the ionosphere due to the nuclear detonations. Air Force Cambridge Research Center (AFCRC) staffed this element. No one exceeded the 3.9 R MPE.

DROP AND CANISTER ELEMENT. This element operated two B-52 and one B-36 aircraft to airdrop the nuclear devices for shots CHEROKEE and OSAGE. These aircraft were also used to drop parachute-suspended canisters on several other shots to record various measurements (pressure, temperature, etc.) at several different altitudes just before and just after detonations. Exposures were quite low for these personnel.

HQ USAF ELEMENT. This element, manned by personnel from Hq USAF, managed Project 2.66 (Early Penetrators). These men did not fly the B-57B aircraft but recorded and reported results from the flights and subsequent aircraft contamination studies (see Chapter 3). The two men shown in Table 48 who received more than 3 R were enlisted personnel -- probably involved in taking contamination readings on returning aircraft. Except for these two, readings were relatively low for persons in this element.

Test Services Unit

HEADQUARTERS, TEST SERVICES UNIT. Seventeen persons listed this unit as their organization on the 5x8 cards. Test Services Unit (TSU) was manned by Military Air Transport Service (MATS), and dozens of U.S.-based units furnished needed manpower. Both persons who exceeded the 3.9 R MPE were enlisted; however, their specific duties are unknown.

WEATHER CENTRAL AND WEATHER REPORTING ELEMENTS. These two elements have been combined because the 6th Weather Squadron manned both elements and it is not possible to determine who worked where. The Weather Central was located on Parry Island and, except for TEWA fallout, these persons received very little exposure. Weather reporting personnel were on Enewetak and Eneu islands and the four remote weather islands. The relatively high exposures for these men evidently came from several sources. Eighteen persons exceeded the 3.9 R MPE and sixty-one received more than 3 R. The 18 weather personnel on Rongerik received between 2 and 3 R from light fallout from several shots. Also personnel on Enewetak received fallout from the TEWA shot, which, depending on length of stay, could have contributed as much as 3 R. Some of the weather personnel on Enewetak were possibly used to help decontaminate "hot" aircraft as well. All three TG 7.4 units (TAU, TSU, and TBU) provided men for decontamination. Both men in this group who received more than 5 R were enlisted.

WEATHER RECONNAISSANCE ELEMENT. Personnel in this element operated and maintained ten WB-50 aircraft used for weather reconnaissance for postshot tracking of the nuclear clouds. The majority of personnel were from the 57th Weather Reconnaissance Squadron at Hickam Field, Hawaii. They were based at Enewetak Island for the duration of the REDWING series. Only one person, a staff sergeant, received an exposure in excess of 3.9 R. His specific duties are not known.

DOCUMENTARY PHOTO ELEMENT. Personnel from the 1352nd Motion Picture Squadron, Lookout Mountain AFS, Hollywood, California, staffed this element. They performed documentary photography for Hq JTF 7 during REDWING. No one in this element exceeded the 3.9 R MPE.

C-54 SUPPORT ELEMENT. Most persons in this element were from the 1371st Mapping and Charting Squadron. They operated three C-54 aircraft from Enewetak for radio-telephone relay. The aircraft were also used to augment airlift missions to Tarawa, Wake, Majuro, Truk, Bikini, Guam, and Hawaii. The one person who exceeded the 3.9 R MPE may have been detailed to decontaminate the sampler and early-penetration aircraft.

COMMUNICATIONS ELEMENT. This element was staffed by personnel from 38 different Airways and Air Communications Services (AACS) squadrons, 3 AACS groups and one AACS wing. The 1253rd AACS Squadron, which was a permanent organization on Enewetak, prcvided most of the personnel. All five persons who exceeded the 3.9 R MPE were enlisted and all were from different AACS squadrons except two who were from the 2049th AACS Squadron. Most of the men in this element were on Enewetak; however, there were a few on the weather islands and on Eneu at Bikini. High exposures are probably from TEWA fallout and aircraft decontamination duties.

SEARCH AND RESCUE ELEMENT. Persons in this element were from the 49th Air Rescue Squadron. They operated seven SA-16 aircraft for rescue operations. The aircraft were also used to resupply the remote weather islands. These men were stationed on Enewetak Island and exposed to TEWA fallout, which partly explains the high exposures shown in Table 48. Although there is no indicative historical data, perhaps the unusually high exposures -- 10 enlisted men exceeded the 3.9 R MPE -- were the result of aircraft decontamination operations.

MATS TERMINAL ELEMENT. Some men from this element were probably permanently based at Enewetak Island since air terminal operations were needed at all times, not just during test series such as REDWING. The six persons who exceeded the 3.9 R MPE were probably exposed to TEWA fallout and, in addition, were probably associated with aircraft decontamination.

Air Transport Units

As mentioned earlier, air transport units have been separated from the rest of TG 7.4 for exposure presentation purposes. For the most part, personnel in these units were in the test area for very short periods. They flew cargo and personnel in and out of the test area. As can be seen from Table 48, their exposures reflect this, being much lower than other Air Force elements. Some of the individual air transport units (shown in Table 47), such as the 48th Air Transport Squadron, reflected zero exposure for all their personnel. Others, such as the 1707th Air Transport Wing, indicate that everyone in the unit recived some exposure. In the latter example, the men may have been in the test area permanently rather than transients, since three of the five had exposures between 1 and 1.5 R.

Miscellaneous

This is a grouping of 35 men from 13 different units as shown in Table 47. Units were generally major command headquarters and personnel were mostly visitors to the test area. Table 48 shows that exposures for these personnel were very low except for four who had exposures between 1 and 3 R. One person listed his home station as Hickam AFB, Hawaii, but no unit was indicated.

CHAPTER 9

U.S. MARINE CORPS PARTICIPATION IN OPERATION REDWING

U.S. Marine Corps personnel participated in support of the operation by providing helicopter airlift for the scientific projects. Marines from ships companies also provided physical security for nuclear devices and may have assisted in ship decontamination. Marine Corps units providing personnel for REDWING operations included the following.

Marine Helicopter Transport Squadron 363 (HMR-363), Santa Ana, California. HMR-363 operated as TE 7.3.1.2 of the naval task group (TG 7.3). Personnel were based on the carrier, USS Badoeng Strait, as were flight operations during shot periods. At other times, flight operations were based on the Eneu airstrip at Bikini. The unit arrived at the Pacific Proving Ground (PPG) in early spring of 1956 and was in place in March. The squadron had difficulty with their HRS-1 helicopters and did not fly from 26 March until HRS-3 replacements arrived on 26 April.

The primary responsibility of this unit was the operation of ship-to-shore and interisland airlift at Bikini. The squadron provided air service for radiological surveys and for Project 2.65 surveys. HMR-363 provided facilities and assistance for limited primary gross decontamination of all aircraft ashore at Bikini, as well as decontamination crews for their own helicopters aboard Badoeng Strait. A summary of HMR-363 operations is shown in Table 49.

Personnel dosimetry for the squadron based on the Consolidated List is shown in Table 50, and a summary of the exposures and decontamination efforts reported in the squadron history (Reference C.1.3.4) is as follows:

Average Pilot Exposure:	1.813 R (about 36 pilots)
Average Intensities of Helicopters Returning on Shot Days:	0.150 R/hr
Hottest Helicopter:	4 R/hr following ZUNI

Table 49. Marine Helicopter Transport Squadron 363 (HMR-363) operational statistical summary, REDWING.

Month	No. of Aircraft Assigned	Aircraft in Commission (percent)	(1) Scientific Data Recoveries Trips[a]	(2) Scientific Data Recoveries Hours[b]	(3) Operational Flights Trips[c]	(4) Operational Flights Hours[d]	(5) Misc. Hours[e]	(6) Total Trips[f]	(7) Total Hours[g]
May	14	80	49	78	909	896	128	958	1,102
June	15	80	72	100	728	718	57	800	875
July	14	80	61	94	801	720	38	862	852

Notes:

[a]Scientific data recovery flights exclude columns 3 and 5.

[b]Scienfific data recovery hours exclude columns 4 and 5.

[c]Operational flights exclude column 1.

[d]Operational hours exclude columns 2 and 5

[e]Pilot training, tests, SAR, etc., where passenger/cargo not involved.

[f]Total trips include columns 1 and 3.

[g]Total flight hours include columns 2, 4, and 5.

Table 50. REDWING personnel exposure, U.S. Marine Corps organizations.

Element	No. of Persons Badged	No Reading	Exposure Ranges (R) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	Over 3.9[b]	High (R)
HMR-363[c]	164			29	56	35	13	16	9	6	0	3.6
USS Curtiss (AV-4)	66	10		6	15	22	9	3	1		0	2.6
USS Estes (AG-12)	17	7		10							0	0.3
Air Fleet Marine Force Pacific	1		1								0	
3rd Marine Air Wing	1		1								0	
Totals	249	17	2	45	71	57	22	19	10	6	0	3.6

Notes:

[a]Collective Marine Corps exposure was 265.5 man-R; mean exposure was 1.07 R.

[b]Basic Maximum Permissible Exposure (MPE) was 3.9 R (gamma) per 13-week period.

[c]Ten did not return all badges.

Source: Reference C.1.7.3.

Average Intensities of Helicopters Returning on Non-Shot Days:	0.030 to 0.050 R/hr
Number of Decontaminations:	368
Hours Expended in Decontamination:	1,680 manhours
Highest Intensity of All Helicopters at End of Operation (TEWA + 4 days):	0.0005 R/hr

HMR-361 (L). This squadron provided 14 pilots to supplement HMR-363 pilots. Exposures are included in HMR-363 totals in Table 50.

Marine Detachment, USS Curtiss. A Marine contingent of 66 was aboard this ship. Curtiss was used to transport device components from the United States to the PPG and was equipped for device assembly work. The Marines aboard Curtiss were undoubtedly involved primarily in providing physical security but may have also provided decontamination workers. Curtiss provided such crews for decontamination of the ships of Program 2, but whether the Marine company was involved is not clear. Shot-by-shot activities of Curtiss are described in Chapter 7. Table 46 presents summary exposure data for the total ships' company, while Table 50 shows the Marine component.

Marine Detachment, USS Estes. This ship had 17 Marines aboard. Estes, like Curtiss, provided crews for decontamination of Program 2 ships and the Marines aboard could have been involved. Shot-by-shot activities for Estes, as well as summary exposure data, are presented in Chapter 7. A summary of exposures for the Marine component is shown in Table 50.

Air Fleet Marine Force Pacific. One man was badged in TG 7.4. What function he performed is not known. His badge reading was zero.

3rd Marine Air Wing (El Toro, California). This parent organization for both the helicopter squadrons having personnel at REDWING had a single individual badged as part of TG 7.4. His badge reading was zero.

Naval Air Station, Kwajalein. In addition to Marines in the proving ground proper, there were 61 Marines on Kwajalein. These men were not badged.

CHAPTER 10

JOINT DEFENSE AGENCIES, OTHER GOVERNMENTAL AGENCIES, ATOMIC ENERGY COMMISSION ORGANIZATIONS, CONTRACTOR, AND OBSERVER AND VIP PARTICIPATION IN OPERATION REDWING

Joint defense agencies provided several important elements in REDWING, especially the experimental coordination, through the Armed Forces Special Weapons Project (AFSWP). The Atomic Energy Commission (AEC), through its contractors, provided the devices themselves and, through its base-support contractor, provided the physical plant for the tests.

JOINT DOD ORGANIZATIONS

Armed Forces Special Weapons Project (AFSWP). This agency represented the DOD in the nuclear test operations. AFSWP coordinated Task Unit 3 (TU 3), the DOD Effects Program. Its headquarters at Arlington Hall Station near Washington, D.C., was active in integrating service requirements for nuclear weapons effects information in the Effects Program, and its Field Command at Sandia Base, New Mexico, was responsible for coordinating the practical detail of the effects experiments.

It appears from the after-action project reports that some AFSWP personnel directly participated in several projects, and, where this is clear, their exposures have been noted with that project in Table 10. However, exposures for AFSWP as a whole are represented in Table 51.

Because the organizational affiliation of participants on the Consolidated List (Reference C.1.7.3) was not always complete, some interpretations were made in assembling the AFSWP entry in Table 51. Personnel from "AFSWP," "FCWET," DWET," "WETD," and "Arlington Hall Sta." have been lumped together under AFSWP. There is also a group identified simply as "Sandia Base," presumably AFSWP, but they have been kept as a separate grouping in Table 51.

Joint Office of Test Information (JOTI). See Observers below.

Joint Task Force Seven. This was itself a joint-DOD command and had a small group of permanently assigned personnel at headquarters levels.

Table 51. REDWING personnel exposures, joint defense and other government agencies, Atomic Energy Commission organizations, contractors, observers, and visitors.

Element	No. of Persons Badged	No Reading	Exposure Ranges (roentgens) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	Over 3.9[a]	High (R)	Collective Exposure (man-R)	Mean Exposure (R)
JOINT DOD ORGANIZATIONS																
Joint Task Force 7	135	1	2	24	23	5	17	25	18	19	1			4.4	236	1.748
AFSWP																
Military Personnel[b]	67		8	10	9	6	6	10	4	9	4	1	6	5.2	117.8	1.757
Civilian personnel	7			3			1	2	1					2.6	9.75	1.393
Total AFSWP	74		8	13	9	6	7	12	5	9	4	1	6	5.2	127.5	1.723
"Sandia Base" Military[c]	34		2	3	3	5	1	2	3	7	5	3	8	7.4		
Total Joint DOD Organizations	243	1	12	40	35	16	25	39	26	35	10	4	14	7.4	456.8	1.880
ATOMIC ENERGY COMMISSION ORGANIZATIONS																
Hq & Fld Offices (except DMA)	37		9	28											7	1.892
DMA	12		3	7	1		1								4.25	0.354
Health & Safety Lab (NYKOPO)	19	1	1	8	3	3		1	1	1					16.5	0.868
Hanford Atomic Power Oprns	6				1	1	1		3						12	2
LASL																
Military[d]	83	1	1	9	12	8	5	2	11	18	9	7	16		220.8	2.660
Civilian[e]	209		14	62	38	26	12	16	14	19	4	4	8		286.5	1.371
Total LASL	292	1	15	71	50	34	17	18	25	37	13	11	24		207.3	1.737
Oak Ridge Nat'l Laboratory	3			1				1	1						5.25	1.75
Sandia Corporation [e]	145	1	11	51	29	21	8	5	10	9					145	1
UCRL																
Military	8			4		1			1		2		2		14	1.75
Civilian[f]	360		54	190	40	28	14	13	3	10	6	2	8		251.5	0.699
Total UCRL	368		54	194	40	29	14	13	4	10	8	2	10		265.5	0.722
Total AEC Organizations	882	3	93	360	124	88	41	38	44	57	21	13	34		962.8	1.092

Notes:

[a]Basic Maximum Permissible Exposure (MPE) was 3.9 R (gamma) per 13-week period.

[b]Three did not return all badges.

[c]Two did not return all badges.

[d]Seven did not return all badges.

[e]Eight did not return all badges.

[f]Thirteen did not return all badges.

Source: Reference C.1.7.3.

(continued)

Table 51. REDWING personnel exposures, joint defense and other government agencies, Atomic Energy Commission organizations, contractors, observers, and visitors (continued).

Element	No. of Persons Badged	No Reading	Exposure Ranges (roentgens) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	Over 3.9[a]	High (R)	Collective Exposure (man-R)	Mean Exposure (R)
OTHER GOVERNMENT AGENCIES																
Coast Guard Loran Detachment	15			3				4	4	4				3.8	34.75	2.317
Federal Civil Defense Agency	4			3	1										1.5	0.375
Forest Prod Lab USDA	1			1											0.25	0.25
Nat'l Bur Stds	1			1											0.25	0.25
Public Health Service	9		1	1	3	1	2	1							9.5	2.375
Weather Bureau	4				1		1			2					9.5	2.375
Total Other Gov't Agencies	34		1	9	5	1	3	5	4	6				3.8	55.75	1.640
CONTRACTORS AND CIVILIAN ORGANIZATIONS																
ACF Industries Inc	29	12	7	9		1									3.5	0.121
Advance Industries	4		1	1			1	1						2.4	4.25	1.063
Allied Res Assoc	4			2	2									0.7	2	0.5
Allison Div GM	1			1											0.25	0.25
American Red Cross	1									1				3.0	3.0	3.0
Boeing Co	5				2			3						2.2	8.25	1.65
Calif Forst&Rng Exp St (CFRES)	2			1	1									0.5	1	0.5
Cambridge Corp	52	42	8	2											0.5	0.10
Cook Research Laboratories	4			2	1			1						2.3	3.5	0.875
Douglas Aircraft[b]	14		1	2	1	1	1	4	4					2.9	24.25	1.732
EG&G (AEC)	153	9	16	35	23	16	9	18	8	16	2	1	3		196.8	1.286
Gilfillan Bros	1									1				3.0	3.0	3.0
Hazeltine	1			1										0.1	0.1	0.1
Holmes & Narver	2,628		265	411	201	125	143	132	175	563	397	216	613	6.8	6,815	2.593
Horning-Cooper	1						1							1.6	1.6	1.6
Herrick L. Johnson	40	13	15	12											3	0.75
Kaiser Electric	1				1									0.8	0.8	0.8
Martin Co	2					1	1							1.9	3	1.5
McDonnell Aircraft	3			3										0.3	0.75	0.25
Philco Corp	1						1							1.9	1.9	1.9
Pratt & Whitney	1			1										0.2	0.2	0.2
Radiation Inc	4			3				1						2.3	3	0.75
Raydist Navigation	9			2				2	3	2				3.4	20.25	2.25

Notes:

[a]Basic Maximum Permissible Exposure (MPE) was 3.9 R (gamma) per 13-week period.

[b] Three did not return all badges.

Source: Reference C.1.7.3.

(continued)

Table 51. REDWING personnel exposures, joint defense and other government agencies, Atomic Energy Commission organizations, contractors, observers, and visitors (continued).

Element	No. of Persons Badged	No Reading	Exposure Ranges (roentgens) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	Over 3.9[a]	High (R)	Collective Exposure (man-R)	Mean Exposure (R)
CONTRACTORS (continued)																
Reeves Instruments	1			1											0.25	0.25
Republic Aviation	2			2											0.5	0.25
Scripps Institution[b]	60	1	2	8	14	14	11	4	2	3	1		2	4.7	78.75	1.313
Sperry Rand	1							1						2.3	2.3	2.3
United Aircraft	1				1									0.5	0.5	0.5
University of Calif	2			1						1				3.1	3.75	1.875
University of Dayton	10				3	2	2	2	1					2.8	15.5	1.55
University of Illinois	1			1										0.1	0.1	0.1
University of Texas	4			4										0.5	1	0.25
Univ of Wash App Fish Lab	9		1	5				1	1	1			1		9.75	1.083
Western Electric	1						1							1.6	1.6	1.6
Total Contractors	3,053	77	316	510	250	160	171	170	194	588	400	217	619	6.8	7,213.9	2.363
OBSERVERS																
USS Mount McKinley (AGC-7)																
Media reps	16		6	9					1						5	0.313
Civilian (non-gov't)	21		4	16	1										4.75	0.226
Military	4		1	3											0.75	0.188
Gov't civilians	8		2	6											1.5	0.188
Total Mt. McKinley Observers	49		13	34	1				1						12	0.245
VIP Observers and Escorts																
Civilian	37		7	27		3									10.5	0.284
Military	29		6	15		8									13.75	0.474
Foreign	14				1	12	1								17.5	1.25
C-121 crew	5			5											1.25	0.25
Total VIP Observer Group	85		13	47	1	23	1								43	0.506
Total All Observers	134		26	81	2	23	1		1						55	0.410
UNIDENTIFIED AFFILIATION[c]	18		5	4	1		2	1		3	1	1	2	6.7	30	1.667

Note:

[a]Basic Maximum Permissible Exposure (MPE) was 3.9 R (gamma) per 13-week period.

[b]Two did not return all badges.

[c]One did not return all badges.

Source: Reference C.1.7.3.

ATOMIC ENERGY COMMISSION ORGANIZATIONS

AEC Headquarters and Field Offices (except DMA). Thirty-six persons, almost entirely civilian, were badged with these affiliations in Hq JTF 7 and TG 7.1. Exposure summary is in Table 51.

Division of Military Applications (DMA). Twelve military personnel from this division of AEC.

Hanford Atomic Power Operation. Six from this GE-operated AEC facility participated as radsafe monitors for Project 2.63. Their exposures are shown in Table 51 as well as in the project summary in Table 10.

Health and Safety Laboratory (HASL), New York. Participated in Project 2.64, aerial determination of fallout. Exposures are in Table 51.

Los Alamos Scientific Laboratory (LASL). Primary participation was in TU 1, TU 8, and TU 10 of TG 7.1. Exposures for LASL personnel are shown in Table 51, divided into military and civilians. These latter were employees of the University of California who operated the laboratory for the AEC.

Oak Ridge National Laboratory (ORNL). Three men from ORNL were badged at REDWING, two of whom acted as radsafe monitors for Project 2.63. The duties of the third are not known.

Sandia Corporation, Albuquerque, New Mexico. Personnel from this Western Electric subsidiary operated the Sandia Laboratory for AEC and participated in REDWING with several projects in the weapon technology area and two in the TU 3, DOD effects program. Exposures are in Table 51.

University of California Radiation Laboratory (UCRL), Livermore, California. Like LASL, operated by University of California for the AEC. Participated primarily as TU 2, TU 9, TU 11, and TU 12 of TG 7.1. Exposures are presented in Table 51, divided into military and civilian.

OTHER GOVERNMENT ORGANIZATIONS

U.S. Coast Guard Loran Station, Enewetak. This Loran station was part of a system of navigation aids in the Pacific and its function had no specific connection with REDWING. It was located on the north end of Enewetak Island. It was administratively integrated into TG 7.2 in the pre-REDWING and REDWING testing phase. This group, with a normal complement of one officer and nine enlisted men, was badged with TG 7.2, and exposures are shown in Table 51. The number of men on the Consolidated List is slightly greater than ten, presumably because of rotations. The Commander, 14th Coast Guard District, also was at REDWING, but his exposure is included in the VIP Observer group below.

Federal Civil Defense Agency (FCDA). Personnel from this agency were with JOTI, which acted as a source of information for visitors. Two were badged with TG 7.1 and two with USS Mount McKinley (AGC-7) observer group. Exposures are in Table 51.

Forest Products Lab, U.S. Forest Service. Participated in Project 8.2. One person identified, and his exposure is shown in Table 51.

National Bureau of Standards, Boulder, Colorado, and Washington, D.C. One man participated in the Hq USAF element of TG 7.4. Exposures are in Table 51.

U.S. Public Health Service (USPHS). Nine persons from USPHS offices in the United States were badged with Hq JTF 7. USPHS was interested in off-site fallout monitoring. Exposures are in Table 51.

U.S. Weather Bureau. Four persons badged, two each with Hq JTF 7 and TG 7.1. Weather Bureau interest was in fallout prediction, at least in part. Exposures are in Table 51.

CONTRACTORS AND CIVILIAN ORGANIZATIONS

ACF Industries, Albuquerque New Mexico. This contractor was probably working for LASL supporting device assembly work in TU 1 of TG 7.1. Exposures are shown in Table 51.

Advance Industries, Cambridge, Massachusetts (formerly Ultrasonic Corp.). Four men supported the Air Force Cambridge Research Center (AFCRC) in Project 6.4, TG 7.1.

Allied Research Associates, Boston, Massachusetts. Four men from this organization provided support to the Air Force Wright Air Development Center (WADC) in Projects 5.5 and 5.9 in TG 7.1.

Allison Division of General Motors, Detroit Michigan. One man from this organization support Program 5, TG 7.1.

American Red Cross. This organization had a representative on Enewetak. He received 3.02 R exposure.

Applied Fisheries Laboratory. See University of Washington.

Boeing Aircraft, Witchita, Kansas. Five men from this organization worked on Projects 5.1 and 5.2 of TG 7.1.

Bendix Aviation. The project report for Project 1.4 credits this contractor as participating, but onsite participation is not confirmed by the Consolidated List.

California Forest and Ranges Experiment Station (CFRES). Two men conducted Project 8.2 in TG 7.1.

Cambridge Corporation, Boulder, Colorado. In prior Pacific tests this contractor had provided specialized services for the AEC in device assembly work, and presumably this may have been its function in REDWING.

Convair Division, General Dynamics. The project report credits this organization with participation in Project 6.4, but onsite participation is not confirmed by the Consolidated List.

Cook Research Laboratories, Chicago, Illinois. Four men supported the aircraft effects and thermal Projects 5.1, 5.5, and 8.4.

Cooper Development. See Horning Cooper.

Douglas Aircraft Company, Long Beach and El Segundo, California. Fourteen men supported the effects aircraft Projects 5.3 and 5.8, which involved Douglas aircraft.

EG&G Inc., Boston, Massachusetts. As an AEC contractor in TG 7.1, TU 3, TU 5, and Project 9.1.

General Electric Company, Schenectady, New York. The Project 5.9 report indicates General Electric was involved, but onsite participation is not confirmed by the Consolidated List.

General Electric Company. See Hanford Atomic Power Operation.

Gilfillan Bros. Inc., Los Angeles, California. One man worked on Program 5 support activities.

Hastings (and Hastings Raydist). See Raydist Navigation Corporation.

Hazeltine Corporation. This contractor provided Air Operations Center equipment for TG 7.4; one man was badged as an onsite participant.

Holmes & Narver, Los Angeles, California. This large organization was the AEC base support contractor; over 2,600 men were on site.

Horning-Cooper, Monrovia, California. This contractor provided small rocket support for the Naval Radiological Defense Laboratory (NRDL) in Project 2.61. One man was on site and badged.

Herrick L. Johnson, Inc., Columbus, Ohio. In prior tests, this contractor had provided special services to the AEC on Parry. Presumably this organization provided the same services for REDWING.

Kaiser Electric. This organization had one man badged, but what his duties were is not known.

Martin Aircraft Company, Baltimore, Maryland. Two men supported WADC in Project 5.4, which tested effects on the B-57 manufactured by Martin.

McDonnell Aircraft, St. Louis, Missouri. Three men supported WADC on Project 5.6 testing the F-101, a McDonnell plane.

Philco Corporation. One man, whose function was probably as a representative for his firm's electronic products, was badged and his exposure is in Table 51.

Pratt and Whitney. One man, probably a technical representative of this aircraft engine manufacturer, was badged as part of TG 7.4.

Radiation, Inc. Four men, whose functions are unknown, were badged with TG 7.4.

Raydist Navigation Corporation, Norfolk, Virginia. This firm provided special tracking and navigation for Program 5 and Project 1.8 from a station on USS Badoeng Strait. Nine men were badged.

Reeves Instrument Corp. One man was badged; his function is undetermined.

Republic Aviation Corporation, Farmingdale, New York. This firm manufactured the F-84s used in cloud sampling and on Project 5.5. Two men were badged.

Scripps Institution of Oceanography (SIO), La Jolla, California. SIO provided 60 men and the ship, MV Horizon, for TG 7.1, Projects 1.9a, 1.9b, and 2.62a.

Sperry Gyroscope Co. One man from Sperry Gyroscope supported AFCRC in Project 6.1b.

United Aircraft Service Corporation. One man from this organization was badged as TU 3 of TG 7.1; his exposure was 2.3 R.

University of California. This organization operated the two weapon design laboratories, LASL and the University of California Radiation Laboratory (UCRL), for the AEC. Also several of the Regents were badged as VIPs, and there may have been other TG 7.1 interests unconnected with weapon development experiments. Exposures are listed under LASL, UCRL, Observers, and University of California in Table 51.

University of Dayton and UD Research Institute, Dayton, Ohio. Ten from this organization assisted WADC on Projects 5.5 and 5.9.

University of Illinois. One man participated for WADC in the structures experiment, Project 3.1.

University of Texas. Four from the University of Texas "EMEL" were badged with TG 7.5, the base support group. Their role has not been discovered. Their exposures were low.

University of Washington, Applied Fisheries Lab. This AEC contractor operated the Enewetak Marine Biology Laboratory. Nine persons were badged.

Western Electric. This organization is the corporate parent of the Sandia Corporation, but one person from Western Electric was badged with TG 7.4

OBSERVERS AND VIP VISITORS

USS Mount McKinley Observers. Press and radio-TV representatives viewed LACROSSE and CHEROKEE from the Mount McKinley. Observing also were a group of State and Federal civil defense administrators and a group known as the Joint Office of Test Information (JOTI), which acted as host for these groups of observers. These observer groups' exposures are presented in Table 51 under "Mount McKinley Observers."

VIP Observers. An official observers' program was instituted, and six groups of observers attended. All were transported in special air mission flights. "The last group which consisted of some British and Canadian Observers departed on 22 July 1956" (Reference C.2.1, p. 122).

These visitors were apparently badged with the Hq JTF 7 group, and there are a number of high government officials and important civilians who were either labeled VIP on the lists or would probably qualify. There were also high-ranking military officers who may have been such observers. If a major operational element of such an officer's command was actively involved in REDWING, then the officer's badge exposure was placed with the appropriate service group. Otherwise, the exposure went into the VIP Observer category in Table 51. The foreign visitors were easily identified. Escort officers also were identified and have been grouped with these VIP Observers in Table 51.

An aircraft crew was also badged with Hq JTF 7. They were listed by name with no rank, and their affiliation was given as "C-121 Crew." These were perhaps the crew for the C-121 "Viking" call-sign aircraft, which provided the VIPs with an aerial view of the detonations. Their dosimetry is also listed with this group in Table 51.

UNIDENTIFIED AFFILIATION

There were 18 men whose affiliation was not clear or complete in the Consolidated List. One of these, probably an Army Private, had an exposure of 6.7 R.

CHAPTER 11
PERSONNEL EXPOSURES

REDWING was the first atmospheric nuclear weapon test at the Pacific Proving Ground in which film badges were provided for all personnel to record their exposures to ionizing radiation. In earlier test series, only personnel actually involved in data recovery or other operations involving entrance to radiological exclusion (radex) areas had been badged. Support personnel at the base islands and on ships in those earlier tests were either not badged or only selectively badged. The proportion of participants badged had grown during the tests of the 1950s so that in the 1954 series at the PPG only the service support personnel at Enewetak Atoll were not completely badged.

For the purposes of understanding how the REDWING collective exposure was shared among the participants this universal badging is helpful, especially as there was one incident in which the support personnel were more heavily exposed than experimental groups conducting the tests. This was the last Bikini shot, TEWA, whose cloud drifted west and deposited fallout on the base islands at Enewetak Atoll. This one incident contributed about 40 percent of the collective exposure experienced by the task force during REDWING.

Transient naval ships were an exception to the universal badging, and because of the following instance, complete exposure assessment based on badge readings is impossible.

USS Agawam (AOG-6) arrived at Enewetak from Guam just after the fallout from the shot TEWA had begun to wane. Agawam arrived from the west and her track shows that this involved a rhumb-line course south of Enewetak with a sharp left turn and a northerly run of 165 km into the lagoon. The area affected by fallout from the TEWA cloud has not been well defined. Enewetak appears to have been covered by the southern edge of the cloud, so that Agawam was coming from the best side for minimum exposure; however, the cloud could have continued to the west with a southerly component and crossed the track of the incoming Agawam. The offsite fallout record from Ujelang could have provided some information on this, but the published tabulation stops many hours before the TEWA cloud could have arrived. Agawam represents a special problem because her crew was not badged, or at least the badge readings were not recorded with the rest of the task force. Agawam probably did not have a washdown capability. Its deck log makes no mention of any radiological incident.

The Enewetak Boat Pool personnel apparently did not receive film badges, with a few exceptions, after 1 July. Both of the test events (MOHAWK and TEWA) that brought fallout to the base island area at Enewetak occurred after this date, and thus the exposure assessment based on film badge readings is incomplete with regard to the Enewetak Boat Pool.

The summary of Joint Task Force 7 (JTF 7) personnel exposures as recorded in the Consolidated List of Exposures (Reference C.1.7.3) is presented in Table 52 by task group and, as appropriate, by task units and elements.

The contribution of each task group toward the total radiation exposure is summarized in Table 53, and a mean exposure for each individual in each task group calculated. The disproportionate contributions of TG 5, TG 4 and TG 2 are evident.

The contribution within each task force component may vary considerably, as shown in Table 52. For example, the removal of the Radiological Support Unit 7.3.6 from the TG 7.3 contribution drops the TG 7.3 mean exposure from 0.9 to 0.8. The mean for this unit itself is 2.3 R. The separate consideration of this group is reasonable not only because of the higher potential exposures incidental to the TU 7.3.6 activities, but also because this unit was based on Enewetak and not Bikini where the majority of TG 7.3 was based.

Other groups show different levels of exposure due to their activities. The Test Aircraft Unit of TG 7.4, containing both the sampler crews and early cloud penetration crews, has an expectedly higher exposure than other TG 7.4 elements.

Table 52. REDWING Joint Task Force 7 personnel exposure summary by task force organization.

Element	No. of Persons Badged	No Reading	Number of Exposures (R) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	10-15	Over 15	Over 3.9[a]	High (R)	Collective Exposure (man-R)	Mean Exposure (R)
Hq JTF 7	135	1	2	24	23	5	17	25	18	19	1				1	4.6	236	1.748
TASK GROUP 7.1 (SCIENTIFIC)																		
Military	608	4	33	98	67	51	55	50	54	98	65	31		2	98	15.8	1,395	2.294
Civilian	1,439	11	140	507	187	155	120	110	79	90	24	16			40	6.3	1,679	1.166
Total Task Group 7.1	2,047	15	173	605	254	206	175	160	133	188	89	47		2	138	15.8	3,074	1.503
TASK GROUP 7.2 (ARMY)	1,341		9	73	258	39	49	125	196	414	157	21			203	6.9	3,480	2.595
TASK GROUP 7.3 (NAVY)																		
Flagship Unit	577	1	11	285	182	73	17	3	4	1						3.1	350	0.607
Carrier Unit	931	4	40	430	261	104	48	24	13	6		1			1	5.6	635.5	0.683
Utility Unit	282	1	1	64	124	67	22	2	1							2.9	238.5	0.846
Surface Patrol&Trans Unit	1,075	6	2	181	479	267	98	30	11		1				1	4.7	1,012	0.941
Patrol Squadron Unit	354	3	1	5	158	141	43	2		1						3.5	379.3	1.071
NAS Kwajalein Unit	8		2	6												0.1	1.5	0.188
Radiological Support Unit	187	1		2	11	21	28	36	63	22	3				30	6.2	428.8	2.293
Boat Pool Unit	517	4		188	211	53	19	18	13	8	3				4	4.7	422.5	0.817
Special Devices Unit	564	9	2	81	233	159	61	14	5							2.8	545.8	0.968
Accommodations Ship Unit	188			91	79	13	4	1								2.1	107.5	0.572
Total Task Group 7.3	4,683	29	59	1,333	1,738	898	340	130	110	38	7	1			36	6.2	4,121	0.880
TASK GROUP 7.4 (AIR FORCE)																		
Headquarters	124		22	15	10	6	9	19	19	19	4	1			6		221	1.780
Test Aircraft Unit	549		33	138	62	27	32	38	61	55	41	53	7	2	101		1,318	2.400
Test Services Unit	928		35	160	139	79	53	105	146	173	33	5			40		1,765	1.901
Test Base Unit	739		24	105	56	18	27	102	152	212	31	11	1		45		1,763	2.382
Task Group 7.4 Total	2,340		114	418	267	130	121	264	378	459	109	70	8	2	192		5,067	2.164
TASK GROUP 7.5 (BASE SUPPORT)	2,677		271	422	206	127	158	132	178	566	401	216			617		6,887	2.573

Note:

[a]Basic Maximum Permissible Exposure (MPE) was 3.9 (gamma) per 13-week period; a special MPE of 20 R (gamma) was established for cloud samplers.

Source: Reference C.1.7.3.

Table 53. Summary of task force exposure, REDWING.

	Hq	TG 7.1	TG 7.2	TG 7.3	TG 7.4	TG 7.5
JTF 7 personnel (percent)	1	15.8	10.5	36.1	15.9	20.6
Total radiation (percent)	1	13.6	13.6	18.9	21.6	31.1
Mean[a] (R)	1.7	1.5	2.2	0.9	2.3	2.6

Note:

[a]Overall Joint Task Force 7 mean was 1.7 R.

A group that can be identified as radsafe personnel, made up of the 1st Radiological Safety Support Unit and selected personnel from other organizations, has a mean exposure of 2.8 R, considerably higher than the task force as a whole. The Bikini Boat Pool personnel show a higher average than TG 7.3, which should be expected because of their work in supporting data-recovery activities.

The Boat Pool mean is, however, lower than the overall task force mean of 1.7 R and considerably lower than the 2.2 R mean of TG 7.2, whose activities primarily centered around the base camp. This reversal is due to the heavy contribution from TEWA. The fallout from TEWA contributed considerably to the total exposure experienced by the Enewetak-based elements of the task force and masks most distinctions that would be expected in their contributions, based on operational considerations.

The actual exposure from TEWA would have varied with an individual's location and activities. There were showers during the day of 22 July, and the washed-down fallout materials were concentrated or diluted depending on the detail of the drainage patterns (Reference C.1.7.1). The contribution of TEWA may be estimated by considering several groups. The USCG Loran station crew is a simple example. This group was badged on 9 July, and then again toward the end of the month. The mean increment of exposure from these badges was 1.7 R.

Another small group was the contingent of United Kingdom and Canadian observers who were flown out of the Pacific Proving Ground on 22 July, according to the TG 7.2 final report (Reference C.2.2). This group was one of six observer groups brought in, presumably for short periods, to view bursts from the VIP aircraft. This group probably came to view TEWA or perhaps HURON. The recorded exposures of this group are distributed uniformly around 1.25 R, and perhaps this value should be considered a lower boundary for the TEWA contribution. If a mean value of about 1.5 R is assumed for the TEWA contribution and extended over the Enewetak-based personnel, then the TEWA contribution can be assumed to be about 40 percent of all that experienced in REDWING.

BIBLIOGRAPHY AND REFERENCES

The sources consulted for this report are listed below. They are organized into sections based upon their relationship to the body of nuclear testing information.

The first section (A) contains basic references pertinent to nuclear weapons development and effects and to all or several atmospheric nuclear tests. These are generally monographs published and distributed through regular trade channels and are available in bookstores and libraries with the exceptions noted.

The second and third sections are documents generated by Joint Task Force 7 (JTF 7) and its subordinate organizations. The second section (B) contains planning documents for REDWING, and the third (C) after-action reports. These JTF 7 references are arranged in a fashion that reflects the JTF 7 organization.

The fourth section (D) lists other reports by non-task-force organizations concerning REDWING.

An availability code appears at the end of many reference citations for those who wish to read or obtain copies. Availability status was correct at the time the reference list was prepared. Many documents indicated as unavailable will become available during the declassification review process. The Department of Energy Coordination and Information Center (DOE CIC) and NTIS will be provided future DNA-WT documents bearing an "EX" after the report number.

Source documents with an availability code of DOE CIC may be reviewed at the following address:

Department of Energy
Coordination and Information Center
(Operated by Reynolds Electrical & Engineering Co., Inc)
ATTN: Mr. Richard V. Nutley
2753 S. Highland
P.O. Box 14100
Las Vegas, Nevada 89114
Telephone: (702) 734-3194; FTS: 598-3194.

Source documents bearing an NTIS availability code may be purchased at the following address:

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(Sales Office)
5285 Port Royal Road
Springfield, Virginia 22161
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When ordering by mail or phone, please include both the price code and the NTIS number. The price code appears in parentheses before the NTIS order number; e.g., (A07) AD 000 000.

Additional ordering information or assistance may be obtained by writing to the NTIS, Attention: Customer Service, or by calling (703) 487-4660.

Reference citations with no availability codes may be available at the location cited or in a library.

A. BASIC REFERENCES

A.1 Environmental Radioactivity, Second Edition
M. Eisenbud
Academic Press, New York
1973

A.2 Effects of Nuclear Weapons
S. Glasstone, and P.J. Dolan, ed.,
U.S. Government Printing Office (GPO Stock No. 008-046-000-93-0)
1977

A.3 Trip Report of Field Search for Exercise Desert Rock Documentation Conducted by Representatives of the Adjutant General 18 June to 14 July 1978
J.H. Hatcher, Adjutant General Center, U.S. Army
NTIS (A21/MF A01) AD 070933*

A.4 Compilation of Local Fallout Data from Test Detonations 1945-1962 Extracted from DASA 1251; Vol. 2, Oceanic U.S. Tests
H.A. Hawthorne, ed., GE-TEMPO
June 1979 DNA 1251 EX2
NTIS (PC A16/MF A01) AD A079 310*

A.5 Proving Ground: An Account of Radiobiological Studies in the Pacific 1946-1961
N.O. Hines
University of Washington Press, Seattle
1962

A.6 History of Air Force Atomic Cloud Sampling***
A.W. Minge
AF Systems Command Publication Series 61-142-1
January 1963

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

B. REDWING PLANNING DOCUMENTS

JOINT TASK FORCE 7

B.0.1 Operation Order 2-54***
7 May 1954

B.0.2 Planning Directive***
10 August 1955

B.0.3 Operation Plan 1-56
20 January 1956
NTIS ( ) A080 272*

B.0.4 Administrative Order 1-56***
20 January 1956

B.0.5 Movement Directive 1-56***
7 March 1956

B.0.6 Movement Directive 2-56***
25 April 1956

B.0.7 <u>Operational Check List Orders</u> (series)***
Dates and classifications vary
(One per event. Will be cited as "Operational Check List Order --SHOT")

B.0.8 "Public Health and Safety Precautions for Eniwetok Tests Announced"
Press Release, <u>New York Times</u>
April 27, 1952

TASK GROUP 7.1 (SCIENTIFIC)

B.1.1 Operations Order 1-54***
28 July 1954

B.1.2 Operations Plan 1-56***
20 January 1956

B.1.3 <u>Operational Letters</u> (series)***
Operations Officer TG 7.1
Dates vary
(Designated SHOT -- Number. Subject. About 10 per shot with subjects such as "Evacuation," "Reentry and Recovery," etc. Will be cited as "Operational Letter OSAGE-3," for example.)

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

Task Unit 1, Program 11

B.1.1.1 Program 11's Standard Cloud Sampling Mission Plan for REDWING***
Plank, H.A., LASL
16 April 1956 Letter 1174-JFE

Task Unit 3

B.1.3.1 Priority of Effects Program for Operation Redwing***
Chief AFSWP Letter to CJTF 7 with attachments
7/3/56 SWPEF 972.5

TASK GROUP 7.2 (ARMY)

B.2.1 Operations Order 2-54***
21 June 1954

B.2.2 Special Instruction Letter (series)***
Dates vary
(One per event. Will be cited as "Special Instructions Letter -- SHOT)

B.2.3 Pre-Shot Evacuation, Reentry, and Muster Order (series)***
Dates vary
(One per event. Will be cited as "Pre-Shot Evacuation, Reentry, and Muster Order -- SHOT")

TASK GROUP 7.3 (NAVY)

B.3.1 Operations Plan 1-56***
24 January 1956

B.3 .2 Operations Order 2-56***
17 February 1956

TASK GROUP 7.4 (AIR FORCE)

B.4.1 Operation Plan 4-54***
15 Jun 1954

B.4.2 Planning Directive 1-55***
10 October 1955

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

B.4.3 Programming Plan 2-55 (AFSWC)***
5 May 1955

B.4.4 Programming Plan 3-55 (AFSWC)***
9 May 1955

B.4.5 Operation Plan 1-56 (3 volumes)***
15 February 1956

B.4.6 Concept of Air Task Group Operations***
30 June 1955

B.4.7 Concept of Air Operations***
7 July 1955

TASK GROUP 7.5 (BASE SUPPORT)

B.5.1 Operation Plan 1-56***
Santa Fe Operations AEC
1 March 1956

C. REDWING AFTER-ACTION REPORTS

JOINT TASK FORCE SEVEN

C.0.1 Hq Div Installment History***
1956

C.0.2 History of Operation REDWING
M. Blumenson and H. Hexamer
1 Dec 1956
NTIS (A06/MF A01) AD A 951 592*

Joint Task Force AG Files

C.0.AG903 Radiation Surveys, Radioactive Fallout, Sample Returns Radsafe***
Adjutant General JTF 7
1956

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

TASK GROUP 7.1 (SCIENTIFIC)

C.1.1A Preliminary Report . . . (APACHE)***
10/15/56

C.1.1B Preliminary Report . . . (BLACKFOOT)***
7/25/56

C.1.1C Preliminary Report . . . (CHEROKEE)***
7/17/56***

C.1.1D Preliminary Report . . . (DAKOTA)***
7/26/56

C.1.1E Preliminary Report . . . (ERIE)***
7/21/56

C.1.1F Preliminary Report . . . (FLATHEAD)***
7/23/56

C.1.1H Preliminary Report . . . (HURON)***
7/26/56

C.1.1I Preliminary Report . . . (INCA)***
10/15/56

C.1.1K Preliminary Report . . . (KICKAPOO)***
10/15/56

C.1.1L Preliminary Report . . . (LACROSSE)***
7/5/56

C.1.1M Preliminary Report . . . (MOHAWK)***
10/15/56

C.1.1N Preliminary Report . . . (NAVAJO)***

C.1.1O Preliminary Report . . . (OSAGE)***
7/24/56

C.1.1S Preliminary Report . . . (SEMINOLE)***
7/21/56

C.1.1T Preliminary Report . . . (TEWA)***
10/3/56

C.1.1Y Preliminary Report . . . (YUMA)***
10/15/56

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.1.1Z Preliminary Report . . . (ZUNI)***
7/5/56

C.1.2 Task Group 7.1 History (U) 12 installments***
G.M. Gillings
1956

C.1.3 Report of the Commander, Task Group 7.1
8/56 WT-1359 EX
NTIS (A07/MF A01) AD A995 026*

Task Unit 3 (DOD Programs)

C.1.3.1 Technical Summary of Military Effects, Programs 1-9
AFSWP, FC WT-1344 EX
NTIS (A12/MF A01) AD 995 132*

Task Unit 7.1.3 Project (Weapon Test [WT]) Reports

C.1.3.1301 Ground Surface Air-Blast Pressure Versus Distance, Operation Redwing (U)
C.N. Kingery, C.H. Hoover, J.H. Keefer
Army Ballistic Research Labs, Aberdeen, MD
5/60 WT-1301 EX
NTIS (A05/MF A01) AD A995 110*

C.1.3.1302 Blast Measurements on a Medium Yield Surface Burst, Operation Redwing Project 1.2***
C.D. Broyles
Sandia Corporation
WT-1302

C.1.3.1303 Air Blast and Shock Phenomena by Photography, Operation Redwing, Project 1.3 (U)
L.G. Belliveau, P. Hanlon
Naval Ordnance Laboratory, Silver Spring, MD
9/59 WT-1303 EX
NTIS (A03/MF A01) AD 995 089*

C.1.3.1304 Measurement of Free-Air Atomic-Blast Pressures, Operation Redwing, Project 1.4***
N.A. Haskell, J.A. Fava
Air Force Cambridge Research Labs, Bedford, MD
2/59 WT-1304

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.1.3.1305 Transient Drag Loading of Actual and Idealized Shapes from High-Yield Detonations, Project 1.5***
H.S. Burden, J.D. Day
Army Ballistic Research Labs, Aberdeen, MD
3/60 WT-1305

C.1.3.1306 Drag Loading on Model Targets, Project 1.6
J. Petes, L. Slifer
Naval Ordnance Lab, White Oak, MD
1/60 WT-1306
NTIS (A06/MF A01) AD 357 969L*

C.1.3.1307 Crater Measurements, Operation Redwing, Project 1.8
F.E. Deeds
Army Engineer Research & Development Labs, Ft. Belvoir, VA
12/56 WT-1307 EX
NTIS (A03/MF A01) AD 995 097*

C.1.3.1308 Indirect Water Waves from Large-Yield Bursts, Operation Redwing, Project 19b
W.G. Van Dorn
Scripps Institution of Oceanography
6/59 WT-1308 EX
NTIS (A03/MF A01) AD 995 111*

C.1.3.1309 Blast Over Vegetated and Cleared Areas, Operation Redwing, Project 1.10***
C.D. Broyles
Sandia Corporation
1/59 WT-1309

C.1.3.1310 Gamma Exposure Versus Distance, Operation Redwing, Project 2.1
P. Brown, R.G. Larrick, D.E. Johnson, T.J. Hurley
Army Signal Engineering Laboratories, Ft. Monmoth, NJ
2/60 WT-1310 EX
NTIS (A03/MF A01) AD 995 100*

C.1.3.1311 Gamma Exposure Rate Versus Time, Operation Redwing, Project 2.2
P. Brown, G. Carp, B. Markow, R. Marmiroli
Army Signal Research and Development Laboratory, Ft. Monmouth, NJ
1/60 WT-1311 EX
NTIS (A03/MF A01) AD 995 112*

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.1.3.1312 Decontamination and Protection, Operation Redwing, Project 2.4
J.C. Maloney, M.A. Schmoke
Army Chemical Center, Edgewood, MD
4/57 WT-1312
NTIS (A03/MF A01) AD 357 965*

C.1.3.1313 Neutron-Flux Measurements, Operation Redwing, Project 2.51
C.W. Luke, et al.
Army Chemical Warfare Laboratories, MD
9/49 WT-1313 EX
NTIS (A04/MF A01) AD A995 142*

C.1.3.1314 Neutron Induced Soil Activation, Operation Redwing, Project 2.52***
M. Cowan
Sandia Corp
12/59 WT-1314

C.1.3.1315 Rocket Determination of Activity Distribution Within the Stabilized Cloud, Operation Redwing, Project 2.61
R.R. Soule, T.H. Shirasawa
Naval Radiological Defense Laboratory, San Francisco, CA
4/60 WT-1315 EX
NTIS (A04/MF A01) AD A995 113*

C.1.3.1316 Fallout Studies by Oceanographic Methods, Operation Redwing, Project 2.62A
F.D. Jennings, R.A. Schwartzlose, R.P. Huffler, D. Martin, J.D. Isaacs
Scripps Institution of Oceanography, La Jolla, CA
2/61 WT-1316 EX
NTIS AD A995 034*

C.1.3.1317 Characterization of Fallout, Operation Redwing, Project 2.63***
T. Triffet, P.D. La Riviere
Naval Radiological Defense Laboratory, San Francisco, CA
3/61 WT-1317

C.1.3.1318 Fallout Location and Delineation by Aerial Surveys, Operation Redwing, Project 2.64
R.T. Graveson, et al.
New York Operations Office AEC
12/60 WT-1318 EX
NTIS (A04/MF A01) AD A995 090*

C.1.3.1319 Land Fallout Studies, Operation Redwing, Project 2.65***
M. Morgenthau, H.E. Shaw, R.C. Tompkins, P.W. Krey
Army Chemical Warfare Laboratories, MD
2/60 WT-1319

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.1.3.1320 Early Cloud Penetrations, Operation Redwing, Project 2.66A***
E.A. Pinson, K.C. Kaericher, J.E. Banks, J. DeHord
Air Force Weapons Laboratory, Kirtland AFB, NM
2/60 WT-1320

C.1.3.1321 Ship-Shielding Studies, Operation Redwing, Project 2.71
H.R. Rinnert
Naval Radiological Defense Lab, San Francisco, CA
10/57 WT-1321
NTIS (A05/MF A01) AD 357 967*

C.1.3.1322 Shipboard Radiological-Countermeasure Methods, Operation Redwing, Project 2.8
R.H. Heiskell, et al.
Naval Radiological Defense Laboratory, San Francisco, CA
1/59 WT-1322
NTIS (A05/MF A01) AD 362 109*

C.1.3.1323 Standard Recovery Procedure for Tactical Decontamination of Ships, Operation Redwing, Project 2.9
F.S. Vine, W.L. Owen
Navy Bureau of Ships, Washington, D.C., Naval Radiological Defense Laboratory, San Francisco, CA
12/58 WT-1323
NTIS (A03/MF A01) AD 357 962*

C.1.3.1324 Verification of Shipboard Washdown Countermeasure, Operation Redwing, Project 2.10
W.J. Armstrong, M.M. Bigger, H.B. Curtis
Naval Radiological Defense Laboratory, San Francisco, CA; Navy Department, Washington, D.C.
2/59 WT-1324
NTIS (A03/MF A01) AD 357 963*

C.1.3.1325 Effect of Length of Positive Phase of Blast on Drag-Type and Semidrag-Type Industrial Buildings, Operation Redwing, Project 3.1***
G.K. Sinnamon, J.D. Haltiwanger, N.M. Newmark
University of Illinois, Urbana, IL; Air Force Weapons Laboratory, Kirtland AFB, NM
8/59 WT-1325

C.1.3.1326 Chorioretinal Burns, Operation Redwing, Project 4.1***
R.S. Fixott, J.E. Pickering, D.B. Williams, D.V.L. Brown, H.W. Rose
Air Force School of Aviation Medicine, Randolph AFB, TX
3/59 WT-1326

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*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.1.3.1327 Thermal and Blast Load Effects on a B-47E Aircraft in Flight, Operation Redwing, Project 5.1***
R.C. Laumann, W.M. Gran, R.H. Heineman, R.P. Lang
Cook Technological Center, Morton Grove, IL; Air Force Air Development Center, Wright-Patterson AFB, OH
2/60 WT-1327

C.1.3.1328 In-Flight Participation of a B-52, Operation Redwing, Project 5.2***
F.L. Williams
Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, OH; Boeing Aircraft Company
10/59 WT-1328

C.1.3.1329 In-Flight Participation of a B-66 Aircraft, Operation Redwing, Project 5.3***
R.W. Bachman
Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, OH; Douglas Aircraft Company, Long Beach, CA
3/61 WT-1329

C.1.3.1330 In-Flight Participation of a B-57B, Operation Redwing, Project 5.4***
H.M. Wells, D.M. Roha, D.V. Sallis, J.V. Ward
Air Force Air Development Center, Wright-Patterson AFB, OH; Martin Company, Baltimore, MD
7/60 WT-1330

C.1.3.1331 In-Flight Participation of F-84F Aircraft, Operation Redwing, Project 5.5***
M. Lewin, R. Heineman
Cook Technological Center, Morton Grove, IL; Air Force Aeronautical Systems Division, Wright-Patterson AFB, OH
6/60 WT-1331

C.1.3.1332 In-Flight Participation of an F-101A Aircraft, Operation Redwing, Project 5.6***
M.H. Lewin, R.G. Pruett, C.V. Dresser
Air Force Aeronautical Systems Division, Wright-Patterson AFB, OH; McDonnel Corporation, St. Louis, MO
7/59 WT-1332

C.1.3.1333 Thermal Flux and Albedo Measurements from Aircraft, Operation Redwing, Project 5.7***
R.L. Dresser, et al.
Air Force Cambridge Research Labs, Cambridge, MA; Technical Operations, Inc., Burlington, MA
9/61 WT-1333

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.1.3.1334 Evaluation of the A3D-1 Aircraft for Special Weapons Delivery Capability, Operation Redwing, Project 5.8***
Navy Bureau of Aeronautics, Washington, D.C., Douglas Aircraft Corp., El Segundo, CA
7/55 WT-1334

C.1.3.1335 Weapon Effects on Missile Structures and Materials, Operation Redwing, Project 5.9***
C.J. Cosenza, G.W. Mills, G.J. Roth
Air Force Aircraft Radiation Laboratory, Wright-Patterson AFB, OH
5/60 WT-1335

C.1.3.1336 Short-Baseline Narol Measurements, Operation Redwing, Project 6.1A***
R.A. Houghten, L.C. Humphrey
Air Force Cambridge Research Center, Bedford, MA
7/59 WT-1336

C.1.3.1337 Ionospheric Effects of Nuclear Detonations, Operation Redwing, Project 6.3***
A.K. Harris, et al.
Army Signal Engineering Laboratories, Ft. Monmouth, NJ; Air Force Cambridge Research Laboratories, Bedford, MD
10/59 WT-1337

C.1.3.1338 Basic Thermal Radiation Measurements from Ground Stations, Operation Redwing, Project 8.1A***
W.B. Plum et al.
Naval Radiological Defense Laboratory, San Francisco, CA
5/59 WT-1338

C.1.3.1339 Thermal Effects on Cellulosic Materials, Operation Redwing, Project 8.2***
W.L. Fons, C.P. Butler, H.D. Bruce
Calif. Forest Range and Experiment Sta., Forest Products Lab, USFS, and U.S. Naval Radiological Defense Laboratories, San Francisco, CA
7/56 WT-1339

C.1.3.1340 Evaluation of Self-Recording Thermal Radiation, Instruments, Operation Redwing, Project 8.3***
J.J. Mahoney et al.
Army Chemical Center, Edgewood, MD
3/59 WT-1440

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*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.1.3.1341 Thermal Effects on Strength of Aircraft Structural Sandwich-Type Panels, Operation Redwing, Project 8.4***
A. Julian, C.E. Eves
Cook Research Laboratories, Skokie, IL
3/58 WT-1441

C.1.3.1342 Airborne High-Resolution Spectral Analysis, Operation Redwing, Project 8.5 (U)
R. Zirkind
Navy Bureau of Aeronautics, Washington, DC
7/60 WT-1342 (SRD)
Ref. Copy: DASIAC 07529, AD 338 042L

C.1.3.1343 Cloud Photography, Operation Redwing, Project 9.1a***
L. Fussel
EG&G Inc.
5/57 ITR-1343

C.1.3.1344 See Reference C.1.3.1

C.1.3.1346 Attenuation of Telemetry frequencies by Nuclear Detonations, Operation Redwing, Project 6.6***
P.A. Caldwell et al.
Naval Research Laboratory, Washington, D.C.
2/60 WT-1346

C.1.3.1347 Measurement of Irradiance at High Time Resolution, Operation Redwing, Project 8.18***
W.B. Plum, R.J. Jenkins
Naval Radiological Defense Lab, San Francisco, CA
4/57 WT-1347

C.1.3.1348 Spectral Distribution of Irradiance with High Time Resolution, Operation Redwing, Project 8.1C***
W.B. Plum, W.J Parker
Naval Radiological Defense Laboratory, San Francisco, CA
7/58 WT-1348

C.1.3.1349 Background Radioactivity and Oceanographic Conditions, Operation Redwing, Project 2.62b
F.D. Jennings et al.
Scripps Institution of Oceanography, La Jolla, CA
4/60 WT-1349
NTIS AD 361 977*

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.1.3.1350 Evaluation of Standard Navy Dosimeters DT 60/PD and IM-107/PD in Residual Radiation Fields Aboard Ships, Operation Redwing, Project 2.72***
S.C. Rainey
Navy Bureau of Ships, Washington, DC; Navy Medical Research Institute, Bethesda, MD
4/59 WT-1350

C.1.3.1351 Field-Strength Measurement for Accurate Location of Electromagnetic Pulse Sources, Operation Redwing, Project 6.1B***
Sperry Rand Corp., Great Neck, NY
5/60 WT-1351

C.1.3.1352 Airborne Antennas and Phototubes for Determination of Nuclear-Weapon Yield***
A.J. Waters, R.E. Clapp
Advance Industries
8/59 WT-1352

C.1.3.1353 Measurement of Radio-Frequency Electromagnetic Radiation from Nuclear Detonations, Operation Redwing, Project 6.5***
C.J. Ong, R.T. Kowalski, D.D. Jacoby
Army Signal Engineering Laboratories, Ft. Monmonth, NJ
3/60 WT-1353

C.1.3.1366 See Reference C.1.7.1

C.1.3.1368 Contact Radiation Hazard Associated with Aircraft Contamination by Early Cloud Penetrations, Operation Redwing, Project 2.66B***
J.E. Banks, J.L. Dick, E.A. Pinson
Air Force Weapons Laboratory, Kirtland AFB, NM
5/59 WT-1368

C.1.3.1369 Direct Water-Wave Measurements, Operation Redwing, Project 1.9A
L.W. Kidd
Scripps Institution of OCeanography, La Jolla, CA
5/61 WT-1369 EX
NTIS (A07/MF Z01) AD A995 150*

Task Unit 7 (Radsafe)

C.1.7.1 Radiological Safety
G.L. Jacks, LASL
5/57 WT-1366 EX
NTIS (A03/MF A01) AD A995 027*

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.1.7.2 Radiological Safety, Operation Redwing***
1956

C.1.7.3 Consolidated List of Personnel Exposures***
(Lists of Task Force personnel with cumulative whole body ionizing radiation received 5/13/66 through 8/6/56. Lists exist at the Task Group level and for ships crews. Presumably compiled by TU7 soon after the tests.)
B.H. Purcell
1956

C.1.7.4 Personnel Radiation Exposure Records - Microfilm***
(Microfilm of 5x8 cards from which the lists (above) were probably derived. Alphabetic by name only.)
1956

TASK GROUP 7.2 (ARMY)

C.2.1 Task Group 7.2 Installments for Operation Redwing***
File 314.7
Historian JTF7, TG2
1956-1956

C.2.2 Final Report, Operation Redwing
Rober M. Lilly
Commander TG7.2, JTF7
7/31/56
NTIS (A09/MF A01) AD A995 079*

C.2.3 Communications Security Monitoring Report***
8600th AU
(n.d.)

TASK GROUP 7.3 (NAVY)

C.3.1 History of Operation Redwing*** 12 installments
M. Rothlisberger
7/56

C.3.2 Report of the Commander Task Group 7.3, Operation Redwing
1/8/67
NTIS (A09/MF A01) AD B951 765*

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

Task Group 7.3 Unit Reports

C.3.1.1 Ships Logs (cited as "log for ships name")***

C.3.1.2 U.S.S. Badoeng Strait: Final Report, Redwing***
1956

C.3.1.3 U.S.S. Mount McKinley: Report of Operations at Press and Observers Ship for Nuclear Weapons Test in Summer 1956 and Enewetak Proving Groups***
Ser. 466
6/1/56

C.3.1.4 Easy Report***
Marine Helicopter Transport Sq. 363
8/10/56

TASK GROUP 7.4 (AIR FORCE)

C.4.1 History of Task Group 7.4 (June 55 - Mar 45)*** (13 installments)

C.4.2 Final Report***

C.4.3 Final History, Task Group 7.4, Operation Redwing***
1957

Test Aircraft Unit

C.4.1.1 History of Test Aircraft Unit (Mar - July 56)*** 5 installments

Test Base Unit

C.4.1.2 History, 4930 Support Group (Test) (June 55 - Aug 57)***
(installments)

Test Services Unit

C.4.1.3 History of Test Services Unit*** (2 vols)
1956

C.4.1.4 History of Search and Rescue Element***
9/56

---

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

C.4.1.5 Weather Reporting Element Activities*** (2 vols)
1956

C.4.1.6 Meteorological Report on Operation Redwing, Part I, MET Data (12 vol); Part II, MET Analysis (3 vol)
Weather Central Element JTF7
1956
NTIS (A11) AD A995 058 (V. I, Pt. 3),* NTIS (A15) AD A995 059 (V. I, Pt. 5),* NTIS (A14) AD A995 060 (V. I Pt. 7),* NTIS (A15) AD A995 061 (V. I, Pt. 9),* NTIS (A11) AD A995 (062 (V. I, Pt. 12)*

TASK GROUP 7.5

C.5.1 Report of the Commander Task Group 7.5***

C.5.2 Completion Report Operation Redwing
Holmes & Narver, Inc.
1954-56
NTIS (A17/MF A01) AD A995 068*

C.5.3 Operation Redwing, Pacific Proving Ground, Spring 1956, Report of the Manager***
Albuquerque Field Office, Atomic Energy Commission ALO
1956

D. OTHER REDWING REFERENCES

D.1 Gordon Jacks, personal communication, June 1980.

D.2 A Fallout Forecasting Technique with Results Obtained at the Eniwetok Proving Grounds
N.A. Schuert
April 1957 USNRDL TR-139
NTIS (MF A01) AD 133 541*

D.3 DMA letter MAT:EAB to Husler***

D.4 Bikini-Eniwetok Studies 1964, Part 1. Ecological Observations
A.D. Welander
Laboratory of Radiation Biology, University of Washington
September 1966 UWFL-93 (Part I)
NTIS UWFL-93 (PT I)*

*Available from NTIS; order number appears before the asterisk.

**Available at DOE CIC.

***Not available.

APPENDIX A

RADIOLOGICAL SAFETY AND RELATED DOCUMENTS

SAFETY MEASURES -- OPERATION REDWING
Remarks Presented at Department of State, 10 February 1956, by Major General John C. MacDonald

ANNEX C TO CJTF SEVEN PLANNING DIRECTIVE No. 1-55
Concept of Radiological Safety Operations for REDWING

ANNEX D TO CJTF SEVEN PLANNING DIRECTIVE No. 1-55
Concept of the Weather Plan for Operation REDWING

GENERAL OUTLINE FOR RADIOLOGICAL MONITOR COURSE

APPENDIX 1 TO ANNEX K TO CJTF SEVEN No. 1-56
Radiological Safety Regulations

OPERATIONAL LETTER INCA-7 -- RE-ENTRY AND RECOVERY PLAN

ANNEX A TO TASK GROUP 7.4 MATERIEL ROLL-UP PLAN
Supply Air Force

ANNEX B TO TASK GROUP 7.4 MATERIEL ROLL-UP PLAN
Supply Task Group 7.2

ANNEX R TO CJTF SEVEN No. 1-56
Troop and Equipment List

SAFETY MEASURES -- OPERATION REDWING
REMARKS PRESENTED AT DEPARTMENT OF STATE
10 February 1956
By Major General John C. MacDonald

I. INTRODUCTION

Operation Redwing will have many international implications. You are familiar, I am sure, with the unfortunate situation produced by the contamination of Marshallese natives by the first shot of Operation Castle on 1 March 1954. For the past two years, Joint Task Force SEVEN has been studying new techniques in the forecasting of fallout patterns in order that the situation which developed in March 1954 will not occur again. In the next few minutes I will discuss the safety measures which will be taken during Operation Redwing. The text of my remarks and some of the charts will be reproduced and sent to you within the next week so that you may have this information available during the coming months.

II. IMPROVED WEATHER DATA

Any forecast of fallout patterns is only as good as the weather information available. Further, meteorology is an inexact science at best. Since there are very few weather reporting stations which operate on a year-around basis in the Central Pacific, it has become necessary to establish additional weather reporting stations which will operate during the periods of atomic test series. The weather reporting network which will be utilized for the coming operation will be greater than on any previous operation at the Pacific Proving Ground. Data from all reporting stations in the Northern Pacific area will be utilized in preparing weather forecasts.

III. NEW WEATHER TECHNIQUES

1. Tropical Meteorology. The Task Force has continued to support an extensive study of tropical meteorology. This research has been conducted in Honolulu under the direction of Dr. C.E. Palmer of UCLA. Dr. Palmer's group, including a number of Task Force personnel, has developed considerable information concerning the specialized field of tropical meteorology which will be very useful in making weather forecasts at Eniwetok. One specific area which has been studied has to do with "vertical components." Wind currents do not move necessarily in horizontal planes. Previously, it has not been possible to include vertical components of winds in the calculation of fallout patterns. We believe that on Operation Redwing these vertical components can be considered so as to make fallout pattern forecasts more reliable.

2. The radioactive clouds of very high-yield weapons rise above 100,000 feet. The wind structure at these altitudes is important in forecasting fallout patterns. During Operation Redwing the Task Force plans to use improved equipment to obtain wind data at high altitudes:

a. Better balloons have been developed which will give us much more data above 60,000 feet than we have obtained in the past.

b. We plan to use LOKI missiles which will be fired from destroyers. These missiles are expected to reach altitudes of 130,000 feet. They will eject at selected altitudes strips of metal foil which can be tracked by the radar equipment on the destroyer. If this technique is successful we will have wind data above 100,000 feet for the first time.

IV. IMPROVED FALLOUT FORECAST

A fallout prediction unit was used during Operation Teapot at the Nevada Test Site last Spring. This group of experts made important improvements in the forecasting of fallout patterns. We will have a similar fallout prediction unit at the Task Force Headquarters during Operation Redwing. We feel that we can make much more reliable forecasts of fallout patterns now than we could two years ago. The data obtained during Operation Castle has permitted us to develop models of the clouds produced by megaton yield weapons. Therefore, we will be using megaton cloud models to forecast fallout patterns of new megaton weapons for the first time.

The National Bureau of Standards has produced a fallout computer device for the U.S. Weather Bureau. The idea for this fallout computer was suggested by Dr. Lester Machta of the Weather Bureau. Several of Dr. Machta's assistants, with at least one of his new machines, will be with us in the fallout prediction unit during Operation Redwing. Another type of optical fallout pattern computer has been developed at Los Alamos, and one or more of these optical computers will also be available to us in the fallout prediction unit. Lastly, a third type of fallout computer is being developed by Sandia Corporation.

V. CONCLUSION AS TO WEATHER AND FALLOUT FORECASTING

The Task Force has requested the AEC to effect the establishment of a Danger Area for Operation Redwing. The new Danger Area is shown on the chart [Figure 19]. The AEC has obtained the approval of the Department of State for this proposed area. We believe this Danger Area will be established as shown, and announcement of it will be made in the near future. The Department of State will notify foreign governments concerned through State Department channels. The Chief of Naval Operations will insure that appropriate notices to Mariners and Notices to Airmen are given wide distribution, including distribution to appropriate foreign and international agencies.

Since the first event of Operation Redwing is scheduled for 1 May, we believe the Danger Area should become effective on 20 April. The Danger Area will be kept in force until after the last shot, which may be as late as 1 September. It will not be possible to disestablish the Danger Area between shots, since it is impossible to predict more than two or three days in advance when we will be able to detonate the next shot.

A shot will not be fired unless the forecast of the pattern of significant fallout is entirely within the Danger Area. Navy P2V patrol aircraft will start searching this area after 20 April and will continue until after the last shot. These patrols, which are made for the purpose of discovering any transient shipping, will be intensified before each shot, especially in the areas of the forecast fallout.

If a transient ship is discovered in the area of forecast fallout for any shot, that shot will not be detonated until the area is cleared. The search planes will attempt to advise the master of the transient ship to leave the Danger Area, and the plane commander will indicate a course which will permit the ship to clear the area as soon as possible. If the search plane cannot communicate with the transient ship, the search plane commander will notify Task Force Headquarters by radio. A destroyer or other ship will be dispatched to communicate to the transient vessel by radio, by flag signal, or otherwise, a request to leave the Danger Area. In the event the master of the transient ship refuses to leave the area, this information will be passed to . . . [the] Task Force Commander, who will request advice from CINCPAC and CNO, meanwhile postponing any detonations.

VII. RADSAFE MONITORING STATIONS

The Task Force will place qualified RadSafe monitors with equipment on a number of inhabited atolls to the east and south of the Pacific Proving Ground. This was not done on Operation Castle. The special RadSafe monitoring stations, operated by trained personnel, equipped with two-way radio communications and radiac instruments, will be established on WOTHO, UJELANG, UTIRIK, RONGERIK, KUSAIE, KAPINGAMARANGI, TARAWA, KWAJALEIN and RONGELAP . . . . In addition, weather stations on MAJURO, PONAPE, WAKE, MIDWAY, JOHNSTON, TRUK, GUAM and IWO JIMA . . . will be equipped with radiation detection and measuring instruments. These weather stations will report radiation intensities to the Task Force.

The trained RadSafe monitor personnel at the populated atolls will be able to advise the natives, through interpreters, of safety measures they should adopt if hazardous fallout occurs. The RadSafe personnel can assist the native inhabitants until they are evacuated, if this becomes necessary. The RONGELAP natives who were contaminated on Operation Castle suffered some skin lesions, loss of hair, and temporary blood changes because of the contamination they received. If they had been advised to wash themselves repeatedly in the lagoon at RONGELAP after the dangerous fallout began, they probably would not have suffered any visible ill effects.

Joint Task Force 7 is developing plans for the evacuation of natives from inhabited islands, should the situation demand such action.

VIII. MARINE BIOLOGY SURVEY

An extensive program for the study of the contamination of Pacific Ocean areas is planned. This ocean study program may be considered in three parts:

a. Weapons Effects Test. Program 2 of the weapons effects test effort will be concerned with fallout. Project 2.62 of this program is known as oceanographic analysis of fallout contours. This project will be conducted by Scripps Institution of Oceanography. Fast ships will enter the fallout area as soon as possible to take samples for analysis and to measure vertical penetration of the contamination over wide sea areas. In addition, the

Scripps vessel "Horizon" will obtain numerous water and plankton samples for analysis.

b. Radiobiology Marine Survey. The Division of Biology and Medicine of the AEC has recently requested that a ship be provided to make two cruises in the vicinity of the Pacific Proving Ground. The first cruise will be made about a month after the first shot. The second cruise will be made after the last shot. Each cruise will traverse the sections indicated on the large chart. (Radiobiological Survey Chart) During these cruises, samples of plankton, fish and water will be collected every 25 nautical miles at varying depths. The Division of Biology and Medicine believes that this radiobiological survey of marine life will be of great importance as a basis for factual public statements concerning the extent of radioactivity in the sea and marine life near the PPG, and for advice to both Japanese and American fishing interests.

c. Other Marine Surveys. The International North Pacific Fisheries Commission is planning a large operation this summer to study the distribution of salmon and other fish. Ships, both commercial and research, from Japan, Canada and United States will participate. None of these ships will enter the Danger Area. The Japanese will probably have several ships operating in the area north and northwest of the Pacific Proving Ground, outside the Danger Area, where the greatest fallout intensity was noted after Operation Castle. Our information on this International Survey was obtained from . . . [the] Division of Biology and Medicine, AEC.

IX. POST SHOT AERIAL SURVEYS

After each shot of the Redwing series, aircraft will track the radioactive cloud so that we will know if unexpected wind changes are carrying significant fallout into populated areas. In addition, aircraft with monitoring equipment will fly over populated areas south and east of the Pacific Proving Ground to detect any contamination on the land masses and on the surface of the sea. This area will be searched after each shot to make sure that no contamination has fallen near the populated atolls east of Bikini.

X. SUMMARY

We believe that the improved weather and fallout forecasting techniques which I outlined will insure that all of the significant fallout will occur within the Danger Area. We also believe that we will learn promptly of any significant fallout which might possibly occur outside the Danger Area. Finally, we believe that we are making adequate arrangements for the proper protection of native populations in the event of an emergency.

HEADQUARTERS, Joint Task Force SEVEN
Washington, 25, D.C.
10 August 1955

Annex C to CJTF SEVEN Planning Directive No. 1-55

CONCEPT OF RADIOLOGICAL SAFETY OPERATIONS FOR REDWING

1. Radiological safety of all task force military and civilian personnel is a command responsibility and radiological safety activities will be performed through normal command channels.

2. The Commander, Joint Task Force SEVEN will:

a. Specify the measures necessary to insure the radiological safety of task force personnel and furnish technical advisory assistance to task group radiological safety officers.

b. Inform CINCPAC of radiological hazards which may exist in areas outside the task force responsibility.

c. Maintain a fallout plotting center (FOPC) with displays of current air and surface radexes, radiological situation maps of atolls, peripheral aerial and surface areas and such allied data as may be appropriate.

d. Maintain a fallout prediction unit (FOPU) with the assigned mission of preparing a fallout forecast for each shot.

e. Provide radiological monitoring stations and technical advisory assistance to the Trust Territory of the Pacific Islands. The number of monitoring stations and extent of other services will be determined later.

f. Arrange for monitors and couriers to accompany radioactive and special cargo shipments on sample return aircraft and to monitor loading and unloading of such cargo.

3. Task Group Commanders will:

a. Provide radiological safety units within their task groups and insure that these units are prepared to carry out the radiological safety missions of their respective task groups.

b. Provide necessary radiac equipment and special clothing. The requirements of CTG 7.5 will be included in the allowances of CTG 7.1 for necessary issue to TG 7.5 personnel during the operational phase and for subsequent loan or sale to CTG 7.5 for post-operational use at the PPG.

4. The Commander, TG 7.1, having the major technical radiological safety unit, will:

a. Perform all ground monitoring services associated with scientific missions except those in conjunction with aircraft and airborne collection of scientific data.

b. Provide laboratory services and technical assistance to all task groups, to include:

(1) Provision of standard type film badges and specified supplementary idems of personnel radiological safety equipment.

(2) Laboratory services to develop and interpret film badges.

(3) Records of exposures from film badges.

(4) Laboratory services for the radiochemical analysis of water samples.

(5) Monitoring the removal and packaging of radioactive sources and samples, except as indicated in paragraph 4.a. above.

c. Provide radiological safety surface situation maps after shot times to the task force and task group commanders.

d. Provide and maintain radiac equipment and protective clothing as necessary for TG 7.1, TG 7.5 and any other specified recovery personnel.

e. Provide technical personnel to assist task group commanders in the inspection of radiologically contaminated items and the certification of destruction, disposal or unserviceability of such items, as required.

f. Maintain a radiological safety center (RADSAFE CENTER) aboard the TAP and other ships as necessary at BIKINI, and on PARRY Island for the control of TG 7.1 radiological safety operations at BIKINI and ENIWETOK respectively.

g. Provide personnel and equipment decontamination facilities for radiological safety recovery and survey operations.

h. Assume radiological safety responsibilities of TG 7.5 during the operational phase.

i. Integrate within TG 7.1 key radiological safety personnel made available by CTG 7.5. Such personnel will assist CTG 7.1 during the operational phase and will be assigned duties consistent with their training in radiological safety.

5. The Commander, TG 7.2, will:

a. Perform all ground monitoring services associated with ENIWETOK Island except in those areas or activities assigned to other task groups.

b. Provide own radiological safety monitors and decontamination personnel.

c. Provide own radiac equipment and protective clothing.

d. Provide own repair, spare parts and calibration facilities for radiac equipment.

e. Make available through Army Depot Supply, on requisition to all task groups, military radiac equipment and spare parts, high density goggles, and special clothing, including shoes.

f. Provide contaminated clothing laundry facilities for TG 7.4.

g. Provide contaminated miscellaneous equipment storage area with the necessary security.

6. The Commander, TG 7.3 will:

a. Provide own radiological safety monitors including one airborne monitor for each multi-engine aircraft crew assigned to TG 7.3.

b. Provide own radiac equipment.

c. Provide own repair, spare parts and calibration facilities for radiac equipment.

d. Provide monitors and decontamination crews aboard each ship within the task group.

e. Provide facilities for personnel decontamination on the CURTISS (AV-4) and other ships, as required.

f. Provide space aboard the TAP for the radiological safety unit of TG 7.1.

g. Provide decontamination crews and facilities for own aircraft aboard the CVE at ENIWETOK ATOLL. Limited assistance ashore will be furnished by CTG 7.4, as required.

h. Provide decontamination crews and facilities for all aircraft at BIKINI ATOLL.

i. Provide necessary helicopter air service for radiological surveys and post-shot recovery operations at BIKINI (monitors furnished by TG 7.1).

j. Collect lagoon water samples.

k. Provide water spray equipment aboard all vessels likely to be in the fallout area.

l. Provide radiological aerial reconnaissance service in the vicinity of the task force fleet and shot atoll for a period of six hours commencing at H-Hour.

m. Provide logistic support for CJTF SEVEN radiological monitoring stations located in the Northern Marshall Islands. The number of stations and exact location will be determined later.

n. Provide for air-to-ground reporting of approximate air radiation intensities encountered by all aircraft operating between ENIWETOK and BIKINI from H-Hour to H plus 24 hours. It is not contemplated that aircraft should be scheduled for this specific requirement alone. Reports will be routed to the RADSAFE OFFICE at the task force command post by the most expeditious means. Reports will be prepared and coded in accordance with paragraph 7.1., below.

7. The Commander, TG 7.4 will:

a. Provide own radiological safety monitors, including one airborne monitor for each multi-engine aircraft crew assigned to TG 7.4.

b. Provide own repair and calibration facilities for radiac equipment.

c. Provide facilities for personnel decontamination on ENIWETOK Island.

d. Provide decontamination crews and facilities for own aircraft on ENIWETOK ATOLL.

e. At ENIWETOK ATOLL, assist TG 7.3 in aircraft decontamination with TG 7.4 equipment, as required.

f. Provide necessary helicopter and liaison air service for radiological surveys and post-shot recovery operations at ENIWETOK ATOLL (monitors furnished by TG 7.1).

g. Provide monitoring services and crews for the removal of radioactive samples or data collected by aircraft.

h. Provide cloud tracking aircraft for post-shot radiological safety "situation data" up to radius of 500 miles in the significant quadrant for a period of 48 hours, starting at approximately H plus 6 hours. Reports will be prepared and coded in accordance with paragraph 7.1., below.

i. Provide aircraft for post-shot aerial radiological survey of the Northern Marshall Islands starting at approximately H plus 6 hours. Reports will be prepared and coded in accordance with paragraph 7.1, below.

j. Provide for air-to-ground reporting of approximate radiation (air) intensities encountered by all aircraft operating between ENIWETOK and BIKINI from H-Hour to H plus 24 hours. It is not contemplated that aircraft should be scheduled for this specific requirement alone. Reports will be routed to the RADSAFE OFFICE at the task force command post by the most expeditious means. Reports will be prepared and coded in accordance with paragraph 7.1., below.

k. Provide for the reporting of radiation intensities encountered at outlying weather stations. Reports will be routed to the JTF SEVEN RADSAFE OFFICE via the weather CW net. Reports will be prepared and coded in accordance with paragraph 7.1., below.

l. Employ simple codes (to be furnished separately by CJTF SEVEN) in conjunction with the periodic weather reconnaissance reports to report approximate air radiation intensities encountered on regularly established weather reconnaissance or cloud tracking flights and for reports required from aircraft operating during the BIKINI phase between ENIWETOK and BIKINI from H-Hour to H plus 24 hours. Reports will indicate the approximate position, altitude and order of magnitude of radiation encountered.

8. The Commander, TG 7.5 will:

a. Develop a schedule of requirements for radiological safety services required from CTG 7.1 and assist CTG 7.1 in a decontamination of AEC facilities and equipment, as necessary.

b. Provide key radiological personnel for integration into and training with the radiological safety organization of TG 7.1 during the operational phase. The total number and qualifications of such personnel will be as determined necessary by CTG 7.5, commensurate with the assumption of responsibilities indicated in paragraph 8.c., below.

c. Assume residual task force radiological safety functions at the PPG upon completion of the operational phase. Required equipment and supplies will be made available at that time to CTG 7.5 on a loan or sale basis from stocks provided by CTG 7.1.

HEADQUARTERS, Joint Task Force SEVEN
Washington, 25, D.C.
10 August 1955

Annex D to CJTF SEVEN Planning Directive No. 1-55

CONCEPT OF THE WEATHER PLAN FOR OPERATION REDWING

1. Weather data will be provided to CJTF SEVEN from the following sources:

   a. JTF SEVEN Weather Central to be located on PARRY Island.

   b. Forecasting and observing station located on ENIWETOK Island.

   c. Outlying weather stations to be temporarily established by JTF SEVEN at TARAWA, KUSAIE, KAPINGAMARANGI and RONGERIK.

   d. Aircraft Weather Reconnaissance Unit to be based at ENIWETOK Island. Kwajalein Naval Air Station will be utilized in case of necessity.

   e. Aerological units afloat normal to TG 7.3 vessels.

   f. Special coded observations from TG 7.3 search aircraft.

   g. Weather Bureau stations at MAJURO, PONAPE, WAKE.

   h. Routine intercept of the Pacific Ocean Area weather broadcast network.

   i. Forecast and observing station located at the KWAJALEIN NAS.

2. JTF SEVEN weather unit missions are as follows:

   a. JTF SEVEN Weather Central will:

      (1) Collect, plot, analyze and display weather information covering the Pacific Ocean area, with emphasis on the Central Pacific and Marshall Islands.

      (2) Prepare weather and upper air forecasts for CJTF SEVEN.

      (3) Prepare briefing charts and forecasts for use in the JTF SEVEN Headquarters.

      (4) Issue operational forecasts to JTF SEVEN subordinate commands as required.

      (5) Coordinate the aircraft weather reconnaissance effort with respect to tracks to be flown and typhoon reconnaissance.

      (6) Coordinate the operational effort of the outlying weather stations and the ENIWETOK Island weather station.

      (7) Assume overall responsibility for informing units participating in Operation REDWING of tropical storms and typhoons in accordance with existing area directives.

      (8) Insure that all weather reports from outlying stations and weather reconnaissance aircraft are delivered promptly to AACS at ENIWETOK for transmission on the Pacific Ocean Area weather broadcast network.

b. ENIWETOK Weather Station will:

(1) Provide in conjunction with JTF SEVEN Weather Central operational forecasts and such other weather information and services as may be appropriate to air operations.

(2) Provide a minimum of four upper air observations daily.

c. Outlying Weather Stations will:

(1) Take a minimum of four surface and upper air observations daily in accordance with current procedures; have the capability, during certain shot periods, of increasing the upper air observations to eight daily.

(2) Transmit the above observations to the Weather Central.

d. Aircraft Reconnaissance Unit will:

(1) Fly two weather missions daily of approximately 12 hours duration, commencing on first shot minus 30 days.

(2) Fly three weather missions daily of approximately 12 hours duration, commencing on each shot minus four days.

(3) Fly post-shot radiological safety missions as directed by CJTF SEVEN.

(4) Beginning on first shot minus 35 days, assume typhoon reconnaissance responsibility in the area bounded by the Equator, latitude 25°N, the meridian of 180° and longitude of 157°-42'E.

(5) Fly weather reconnaissance tracks to be established by separate directive prior to commencement of the operational phase.

e. Aerological units afloat in TG 7.3 will:

(1) Comply with existing weather directives in the Pacific Ocean Area when operating outside a 50-mile radius of the JTF SEVEN flagship.

(2) Make special weather observations as may be directed by JTF SEVEN Weather Central.

f. Anti-submarine aircraft will provide special weather observations in accordance with instructions to be issued at a later date.

3. JTF SEVEN Staff Weather Officer will:

a. Arrange with the U.S. Weather Bureau to increase the upper air soundings at WAKE, MAJURO and PONAPE from two to four per day during the on-site phase of Operation REDWING.

b. Arrange with the Commanding Officer, KWAJALEIN Naval Air Station to increase the upper air soundings at KWAJALEIN Island from two to four per day during the on-site phase of Operation REDWING.

4. CTG 7.4 will organize, man, train, administer and logistically support:

a. The JTF SEVEN Weather Central. Full scale operations will be established by first shot minus 35 days. Operational control will be exercised by CJTF SEVEN.

b. The forecasting and observing station located on ENIWETOK Island. Operational control will be exercised by the Weather Central Commander.

c. The outlying weather stations at TARAWA, KUSAIE, KAPINGAMARANGI, and RONGERIK. They will be fully operational by the first shot minus 35 days. Operational control will be exercised by CTG 7.4.

d. The aircraft weather reconnaissance unit. Operational control will be exercised by CTG 7.4.

5. CTG 7.3 will provide and retain operational control of:

a. Aerological units afloat.

b. Anti-submarine aircraft.

6. Instructions of general nature:

a. Warnings and advisories for typhoons or other storms will be assigned "EMERGENCY" (O) precedence. All transmitted observations, advisories, and warnings will list CINCPAC and all cognizant Navy and Air Force weather centrals in the Pacific Ocean as addressees.

b. For purposes of standardization, typhoon readiness conditions are defined in the Pacific Ocean as follows:

CONDITION III -- Typhoon winds or winds of fifty knots or more are anticipated within 48 hours.

CONDITION II -- Typhoon winds or winds of fifty knots or more are anticipated within 24 hours.

GENERAL OUTLINE FOR
RADIOLOGICAL MONITOR COURSE

First Day

1. General

a.	General Introduction to Radiological Safety	- 7.3 - 1 hour
b.	Elementary Structure of Matter	- 7.4 - 2 hours
c.	Radioactivity	- 7.4 - 2 hours
d.	Decay and Dosage Calculations	- 7.4 - 3 hours

Second Day

2. Medical Effects

a.	Medical Aspects	- 7.3 - 2 hours
b.	Biological Effects	- 7.3 - 2 hours

3. Instrumentation

a.	Basic Instrumentation	- 7.3 - 1 hour
b.	Dosimetric Instruments	- 7.3 - 1 hour
c.	Survey Instruments	- 7.4 - 2 hours

Third Day

4. Basic Radiological Safety

a.	Contamination Control	- 7.3 - 1 hour
b.	Monitoring Techniques	- 7.4 - 2 hours
c.	Change - House Operations	- 7.3 - 1 hour
d.	Personnel Decontamination and Monitoring	- 7.4 - 1 hour
e.	Field Monitoring and Calibration	- 7.4 - 2 hours
f.	Summary of first three days	- 7.3/7.4 - 1 hour

Fourth Day

5. Airborne and Aircraft Monitoring

a.	Practical Exercise	7.4 - 8 hours

Fifth Day

6. Airborne and Aircraft Monitoring
    a. Practical Exercise - 7.4 - 4 hours
7. Summary of the Course
    a. Review and Critique - 7.3/7.4 - 4 hours

HEADQUARTERS, Joint Task Force SEVEN
Washington, 25, D.C.
20 January 1956

Appendix 1 to Annex K to CJTF SEVEN No. 1-56

RADIOLOGICAL SAFETY REGULATIONS

1. General

   a. Radiological Defense (RadDefense) Operations or Radiological Safety (RadSafe) Operations, short term RadOps, are general terms. They are used to denote the means by which a unit can control and confine the damage and radiological effects of an atomic explosion or of radioactive material spread by other means, thereby preventing and avoiding health hazards to personnel. They are interpreted to include measures such as training, organization, distribution of radiological personnel, development of techniques and procedures, use of detecting equipment, protection or removal of exposed personnel and decontamination of personnel, structures and equipment.

   b. Following each detonation there will be areas of surface radiological contamination and areas of air radiological contamination. These areas are designated as Radiological Exclusion Areas (RADEX). Prior to shot times, the forecast air and surface RADEX will be disseminated by CJTF SEVEN in the target area. These RADEXES will represent a forecast from H-Hour until dissemination of a later surface and air RADEX at about H plus 6 hours. The later RADEXES will be based upon the master radiological "situation map" maintained in the RADSAFE OFFICE of CJTF SEVEN. Since the air RADEX after shot times will be based on monitored tracking by aircraft over significant large ocean areas, information promulgated from the forecast air RADEX may have to be extended beyond the originally anticipated six-hour period.

   c. The surface RADEX will be determined by actual survey with Radiation Detection, Indication and Computation (RADIAC) equipment after shot time. The most rapid method of accomplishing surface surveys in the early stages will be by aircraft and helicopter flight in and around the surface of contaminated areas. From the radiation intensities measured at a known altitude, it is possible to obtain an estimate of radiation dosage rates which would be encountered on the surface of the ground or water. Actual water samples from the lagoon wil also be utilized. Ground survey will follow these guides to determine definitely the contaminated regions and objects. Formal ground survey of the shot atoll, as feasible, will be accomplished on H plus 24 hours.

2. The Maximum Permissible Exposures (MPE's) and Maximum Permissible Limits (MPL's) as stated herein are applicable to a field experimental test of nuclear devices in peacetime wherein numbers of personnel engaged in these tests have been previously exposed or will be continuously exposed to potential radiation hazards. It may become necessary from a study of personnel records to reduce the MPE for certain individuals who have recently

been overexposed to radiation. Further, the MPE's and MPL's are subject to revision by the task force commander in individually designated cases when circumstances indicate the need and justification thereof.

3. Due to the special nature of field tests it is considered that a policy of strict adherence to the radiological standards prescribed for routine work is not realistic. The regulations set forth herein have been designated as a reasonable and safe compromise considering conservation of personnel exposures, the international import of the test and the cost aspects of operational delays chargeable to excessive radiological precautions. In all cases other than emergencies or tactical situations the ultimate criteria will be limited by the MPE's for personnel. Special instances may arise such as in the case of an air-sea rescue within the RADEX or in the case of tactical situation in which operations will be carried out without regard to the MPE's and MPL's prescribed herein. For such emergency or tactical operations the criteria prescribed below for tactical situations will be used as a guide. Wherever possible, however, film badges will be carried and RadSafe monitors will accompany such operations to determine the extent of the actual radiation hazard experienced in order that appropriate medical action may be initiated.

4. Task force radiation dosage control will start on first shot ready date minus fifteen days and terminate upon departure of individuals from the forward area, or on the last shot plus fifteen days, whichever occurs first. All personnel will be considered to have arrived at the Pacific Proving Ground by first shot ready date minus 15 days. Prior and subsequent to the period, radiation dosage control will be as prescribed by CTG 7.5.

5. a. The MPE for personnel involved in this operation is 3.9 roentgens (gamma only) per 13-week period. This exposure may be acquired without limitation on rate of exposure -- an individual exposure record should not indicate a total exposure greater than 3.9 roentgens for any given 13-week period.

   b. A special MPE of 20 roentgens (gamma only) is authorized for the operational period as defined by paragraph 4 above, for crew members of air sampling aircraft.

   c. Authorization for individual exposures in excess of the established MPE will be granted only by Commander, Joint Task Force SEVEN, and only in specific cases for which operational requirements provide justification.

   d. All exposure to external gamma radiation will be regarded as total body irradiation.

6. Those individuals exposed to ionizing radiation in excess of the value computed by paragraph 5.a., above, will be informed that appropriate remarks will be included in their medical records. Military personnel in

this category will be advised that they should not be exposed to further radiation until sufficient time has elapsed in order to bring their average radiation dose down to 0.3 roentgens per week. Civilian personnel in this category will be informed that limitations on further radiation exposure will be as determined by the laboratory or agency having administrative jurisdiction over such personnel.

7. All atoll land and lagoon areas in or near which a detonation takes place will be considered contaminated until cleared for operations by the task force commander. Entry to and exit from contaminated areas will be via RadSafe check points only.

8. Contaminated land and water areas will be delineated as such. Personnel entering these areas will be subject to clearances by the RadSafe Center, TG 7.1, and will normally be accompanied by a RadSafe monitor. RadSafe clothing and equipment will be issued to the personnel.

9. Contaminated land areas of intensities less than 10 mr/hr (gamma only) will be considered unrestricted from a RadSafe standpoint. Coming within this limitation will be designated specifically by CJTF SEVEN prior to unrestricted entry.

10. RadSafe monitors assigned to individuals or groups working in contaminated areas or within contaminated equipment during recovery operations will act in an advisory capacity to keep the recovery party leader informed of radiation intensities at all times. The recovery party leader is expected to accept this advice and act accordingly. It is the responsibility of both the leader and the members of the recovery party to adhere to the limit established in these regulations.

11. Film badges, dosimeters and protective clothing (coveralls, booties, caps, gloves, dust respirators, etc.) as deemed necessary will be issued to personnel entering contaminated areas by appropriate task group RadSafe supply sections.

12. All personnel within viewing distance of an atomic detonation who are not supplied with protective goggles will turn away from the detonation point and close their eyes during the time of burst. At least ten seconds should be allowed before looking directly at the burst.

13. The arrival and proposed use of radioactive sources at the Pacific Proving Ground will be reported to the RadSafe Officer of TG 7.1.

14. Transportation of radioactive material to and from the forward area shall be in accordance with AEC regulations for escorted shipment of such material. The assignment of couriers and RadSafe monitors will be the subject of separate instructions. No radioactive material shall be removed from the test site except as authorized in experimental projects.

15. All samples of radioactive material which are couriered in aircraft will be packaged and loaded so as to reduce radiation to a minimum. Prior to departure of such aircraft, Sample Return Director, JTF SEVEN will have a survey made of the aircraft cargo to determine if adequate precautions have been taken. The following criteria will determine space and packaging requirements:

   a. Prior exposure of aircraft crew, courier and passengers

   b. Anticipated future exposures on trip, considering length of trip, compartmental loading requirements and capability to isolate personnel from radioactive material.

16. All air and surface vehicles or craft used in contaminated areas will be checked through the appropriate task group decontamination section upon return from such areas.

17. The MPL's listed herein are to be regarded as advisory limits for control under average conditions. All readings of surface contamination are to be made with Geiger counters, with tube walls not substantially in excess of 30 mg/cm^2 with shield open unless otherwise specified. The surface of the probe should be held one inch to two inches from the surface that is under observation unless otherwise specified. For operational purposes the contamination MPL's presented below will not be considered applicable to spotty contamination provided such areas can be effectively isolated from personnel.

   a. Personnel and Clothing MPL's

      (1) Skin readings should not be more than 1.0 mr/hr. Complete decontamination by bathing will be utilized for readings in excess of this level. If the body is generally contaminated and especially if contamination is on the eyes or gonads, special efforts should be made to reduce the contamination level. In general, however, it is not considered profitable to abrade the skin or epilate the scalp in an attempt to reduce stubborn contamination below 1 mr/hr (about 1,000 cpm). Beta radiation exposure to the hands should not exceed 30.0 rep for the operational period, as defined in paragraph 4 above.

      (2) Underclothing and body equipment such as the internal surfaces of respirators should be reduced to 2 mr/hr.

      (3) Outer clothing should be reduced to 7 mr/hr.

   b. Vehicle MPL's. The interior surfaces of occupied sections of vehicles should be reduced to 7 mr/hr. The outside surfaces of vehicles should be reduced to less than 7 mr/hr (gamma only) at five or six inches from the surface.

   c. Ship and Boat MPL's

      (1) It is desired to point out that the employment of the ships and units in TG 7.3, insofar as radiological safety is concerned, is

not considered routine usage within the purview of NavMed P-1325, "Radiological Safety Regulations." Current revision of NavMed P-1325 indicates that its provisions do not apply for special operations such as field tests and that for such operations naval personnel will operate under regulations set forth by the task force commander as approved by the Chief of Naval Operations.

(2) In general, ships and boats operating in waters near shot sites after shot times may become contaminated. Monitors shall be aboard all such craft operating after shot time, either as passengers or members of the crew, until such time as radiological restrictions are lifted.

(3) Task group commanders will take necessary action to ensure that personnel of ships and boats are not overexposed to radiation and that ships and boats are not contaminated excessively. The criterion in both cases is that no personnel will be overexposed as defined by paragraph 5.a, above, except in emergencies or tactical operations, and that after the operational period no personnel will receive more than 0.3 roentgens per week from contaminated equipment.

(4) For ships and boats operating in contaminated waters, reasonable allowances will be made to differentiate between the relative contribution to the total flux from fixed contamination and that due to "shine" from contaminated waters. Fixed alpha contamination should not exceed 2,500 dpm (disintegrations per minute) per 150 cm^2 of area for enclosed areas (cabins, etc.) and 5,000 dpm per 150 cm^2 area for open surfaces where ventilation is good.

(5) At the conclusion of the operation, final clearances will be granted to task group commanders, or by commanding officers if so ordered, to those ships and boats showing no point of contamination greater than 15 mr/day (beta and gamma) and no detectable alpha. Other ships and boats will be granted operational clearances by task group commanders, or by commanding officers if so ordered. An operational clearance implies that contamination exists and that special procedures as necessary are instituted aboard ship.

(6) Individuals on board ships of the task force shall be protected collectively from hazards of blast, heat and radioactivity by movement and positioning of ships.

(7) Ships with personnel aboard shall not be permitted inside the 1.0 p.s.i line unless specifically directed otherwise. Bearings of danger from immediate radioactive fallout for ship operations will be established by CJTF SEVEN on the basis of forecast wind directions at the intended time of detonation. This danger section will be designated as surface RADEX. All ships of the task force shall be required to remain outside the RADEX, unless specifically

directed otherwise. However, if ships are directed tactically into the surface RADEX, movement of ships shall be governed by tactical exposure guides.

d. Aircraft MPL's

(1) The interior surfaces of occupied sections of aircraft should be reduced to 7 mr/hr.

(2) No aircraft in the air at H-Hour will be at slant ranges from ground zero less than as determined by the following effects unless specifically directed otherwise. (Based on maximum predicted yield and 20 mile visibility.)

Blast (at predicted shock arrival): 0.5 p.s.i.

Thermal (H-Hour): Fabric control surfaces: 1.0 cal/cm^2

Metal control surfaces: 6.0 cal/cm^2

(3) After detonation no aircraft shall operate inside the air RADEX, or closer than 10 nautical miles from the rising or visible cloud, unless specifically directed otherwise. Non-excepted aircraft involved in routine operations encountering unexpected regions of aerial contamination will execute a turnout immediately upon detecting such contamination. Cloud tracking aircraft will execute turnout from contaminated areas at a level of not more than 3.0 r/hr. If a tactical or emergency situation arises where aircraft must enter the air RADEX or visible cloud, tactical exposure allowances shall apply.

(4) All multi-engine task force aircraft in the air at H-Hour within 100 miles of the detonation point shall carry a person designated as radiological safety monitor, equipped with suitable radiac equipment and a RADEX plot. This monitor shall be capable of calculating allowable exposures under both tactical and operational conditions.

(5) All persons in aircraft at shot time, or at subsequent times, shall wear film badges when engaged in operations in or near the cloud or RADEX track.

(6) Crew members of aircraft in the air at zero hour will take special precautions to avoid (for at least 10 seconds) the direct and reflected light resulting from the burst, at the discretion of the airplane commander. This may be accomplished by protective high density goggles, by turning away from the burst with eyes closed, by covering the eyes with the forearm, by turning cockpit lights up to highest intensity or by any combination of the above.

c. In air and water the following continuous levels of radioactivity are considered safe from the standpoint of personnel drinking and breathing (μc-microcurie):

Water	Beta-Gamma Emitter
	5×10^{-3} μc/cc (calculated up to H+3 days)

18. In tactical situations the military commander must make the decision regarding allowable exposures. As military personnel are normally subject to only random exposure, health hazards are at a minimum. Current Department of Defense information on exposure to gamma radiation in tactical situations is indicated below:

    a. Uniform acute (immediate) exposure of 50 roentgens to a group of Armed Forces personnel will not appreciably affect their efficiency as a fighting unit.

    b. Uniform acute exposure of 100 roentgens will produce in occasional individuals nausea and vomiting but not to an extent that will render Armed Forces personnel ineffective as fighting units. Personnel receiving an acute radiation exposure of 100 or more roentgens should be given a period of rest and individual evaluation as soon as possible.

    c. Uniform acute exposure of approximately 200 roentgens or greater can be expected to render Armed Forces personnel ineffective as troops within a few hours through a substantial incidence of nausea, vomiting, weakness and prostration. Mortality produced by an acute exposure of 200 roentgens will be very low and eventual recovery of physical fitness may be expected.

    d. Field Commands should, therefore, assume that if substantial numbers of their men receive acute radiation exposures substantially above 100 roentgens there is a grave risk that their commands will rapidly become ineffective as fighting units.

19. The RadSafe Officer, TG 7.1, will maintain standard-type film badge records of radiation exposures for all task force personnel. Records will indicate full name, rank or rate, serial or service number, if applicable, organization, home station or laboratory, date of exposure and remarks such as limitations on assignment because of overexposure. Upon completion of the operation, disposition of these records will be as follows:

    a. A consolidated list of exposure listing all personnel in the Task Force by full name, rank, or rate, serial or service number, if applicable, organization, home station or laboratory and exposure in milliroentgens, will be forwarded to the Chief, AFSWP.

    b. A consolidated list of personnel and exposures, as indicated in paragraph 19.a, above, will be forwarded to the Director, Division of Biology and Medicine, AEC.

    c. A consolidated list of personnel and exposures for each Task Group will be forwarded to each Task Group Commander.

        (1) Upon receipt of this list, Task Group Commanders will forward the individual records of Navy and Air Force military and civilian

personnel to the individual's unit of permanent assignment for inclusion in the individual's health record (Medical History Sheets, Standard Form 600 and the Individual Health Record for Navy and Air Force personnel, respectively). For those military personnel exposed to ionizing radiation in excess of that defined in paragraph 5.1, above, a statement will be included to the effect that the individual is not to be subjected to ionizing radiation before a specific date, the date to be computed by the Task Group RadSafe Officer, to allow sufficient time to elapse in order to bring the average dose down to 0.3 roentgens per week. Limitations on Navy and Air Force civilian personnel with reference to overexposures will be as determined by the laboratory or agency having administrative jurisdiction over such personnel.

(2) Individual records of Army military and civilian personnel will be forwarded by Task Group Commanders in accordance with AR 40-414 dated 16 December 1954 to their unit of permanent assignment for inclusion in the individual's field military 201 file, or the civilian personnel 201 file (whichever is applicable). These records will indicate total exposure and inclusive dates and a space for remarks such as limitations on assignment (as indicated in paragraph 19.c(1), above) because of overexposures.

d. Individual records of AEC controlled and administered civilian personnel will be processed by Task Group commanders in accordance with special instructions prescribed by the laboratory or agency having administrataive jurisdiction over such personnel.

e. Upon completion of provisions of paragraph 19.a, b, c and d, above, letter reports will be submitted to Task Group Commanders through channels to the Surgeon General, USA; the Chief, Bureau of Medicine and Surgery, USN: the Surgeon General, USAF; and the Director, Division of Biology and Medicine, AEC, indicating, in general, the action taken to dispose of individual dose records, comments on overexposures, if applicable, and any pertinent remarks considered of interest to the above offices.

f. All exposed film badges, calibration films and curves, and cumulative dosage record cards for all personnel in Joint Task Force SEVEN will be forwarded by RadSafe Officer, Task Group 7.1, to the Director, Test Division, Albuquerque Operations Office, AEC, for permanent retention and storage.

20. Training. The inclusion of radiological safety organizations throughout the task force will require two general levels of training; basic indoctrination and technical training. The scope of instruction within each of those levels will vary in accordance with the requirements of different operational and staff levels. Basic indoctrination will include primary, nontechnical instruction in radiological safety measures and techniques. This must be imparted to all personnel of the task force to enable them to

perform their assigned duties efficiently within the allowable low exposures regardless of the presence of radioactive contaminants. Technical training will include the training of the majority of the personnel who will be required to staff the task force radiological safety organizations and perform the technical operations involved. This will be accomplished through the utilization of existing Service courses and establishment of suitable courses at task group level. This instruction will be designed to train radiological defense monitors, decontamination personnel and radiological instrument repairmen.

21. These regulations have the concurrence of the Surgeon General, USA; Chief, Bureau of Medicine and Surgery, USN; the Surgeon General, USAF; and the Director, Division of Biology and Medicine, AEC.

22. This appendix has been designed for reduced security classification in order to facilitate wide dissemination.

HEADQUARTERS, Task Group 7.1
Joint Task Force SEVEN
APO 437, P.O. Box 1
San Francisco, California

18 June 1956

SUBJECT: Operational Letter INCA-7 -- Re-entry and Recovery Plan

TO: Distribution

1. GENERAL: The information contained in this letter and its inclosure is the Task Group 7.1 re-entry and recovery plan for INCA.

2. AUTHORITY: TG 7.1 J-3, Eniwetok Atoll, Site Elmer, under the direction of CTG 7.1, is responsible for coordinating and supervising the activities in this re-entry and recovery plan and related D-Day activities for all TG 7.1 Task Units, Programs and Projects at Eniwetok Atoll.

3. COORDINATION:

a. TG 7.1 J-3 Parry (Elmer) will coordinate all items in the re-entry and recovery check list with the TG 7.1 Rad-Safe Officer. A radiological plot map will be displayed in the J-3 Office and maintained at that location by CTU-7.

b. TG 7.1 J-3 Parry (Elmer) will have a representative at the Parry (Elmer) Airstrip during recoveries involving aircraft.

c. Before proceeding to the Rad-Safe Center, all recovery party leaders should contact J-3 Elmer at least one hour prior to the published departure time to determine if existing conditions permit recovery at the listed time and to firm up last minute details concerning the proposed recovery.

4. SITUATIONAL SURVEY:

a. A preliminary situational survey by helicopter will be made by CTG 7.1 (accompanied by the TG 7.1 Rad-Safe Officer) beginning about H+1 and upon completion will provide the following information:

(1) Radiological contamination levels at those points needed in establishing a recovery time table.

(2) Estimate of damage to the major installations cited in the re-entry and recovery plan.

b. If necessary, a more detailed Rad-Safe survey will be conducted later on D-Day.

5. RECOVERY SCHEDULE: The recovery times listed in enclosure No. 1 are times desired by the projects. The ACTUAL recovery time table will be drawn up by CTG 7.1 on the following basis:

a. The maximum radiation dose allowable for this event in view of the total number of recoveries the personnel must make during this Operation.

b. The urgency of obtaining the data.

6. RAD-SAFE CONTROL:

a. The Rad-Safe Center and Decontamination Station is located near the Airstrip and the Personnel Pier on Parry (Elmer). All recovery teams entering contaminated areas will process through the Rad-Safe Center prior to departure.

b. Upon return from a contaminated area, aircraft recovery teams will land at the airstrip and will proceed at once to the Rad-Safe Decontamination Station. Boat recovery teams will disembark at the Marine Ramp, or the Personnel Pier (depending upon the type of boat) and will then proceed to the Rad-Safe Decontamination Station.

7. DEPARTURE ROUTINE: Once the start time for recoveries has been announced, the party leader of each recovery team should check with the TG 7.1 J-3 Office to determine the exact time of his recovery departure. For recovery involving aircraft, the recovery team should process through the Rad-Safe Center, and then meet with the J-3 representative and the pilot at the airstrip before takeoff to ensure that all concerned understand the manner in which the mission is to be executed. For boat recovery missions, a J-3 Representative will check out each recovery party at the Marine Ramp or Personnel Pier prior to departure.

8. SUPPORT:

a. AIRCRAFT:

(1) CTG 7.4 has been requested to make three helicopters available at the Parry (Elmer) Airstrip on call through TCA Parry (Elmer) at approximately 0630 hours on D-Day for possible hasty evacuation of five personnel at the manned station on Aniyaanii (Bruce), for the Rad-Safe survey and later for recovery missions.

(2) Since it is impossible to establish a regular airline schedule for D-Day, CTG 7.4 has been requested to hold L-20's in readiness on call through TCA Parry (Elmer).

b. BOAT: All boat and DUKW requirements listed in Inclosure No. 1 will be arranged for by J-3 Elmer.

9. RADIOLOGICAL ESTIMATE: It is assumed that the primary area of contamination will be Rojoa (Ursula) Complex and adjacent islands.

Inclosure No. 1 to Operational Letter INCA-7
Chronological Re-entry and Recovery Check List

DATE: D-DAY

NUMBER	TIME	ORGANIZATION	ITEM
1.	Midnight	JTF	JTF Main Weather Briefing.
2.	H-2	JTF	JTF Final Weather Briefing.
3.	H-1½	TU-9	By copter, 4 men . . . plus 200# of gear from Elmer to Yvonne Sta 1510. Proj will have POGO Net radio (For return info see entry 9.)
4.	H-30 mins	21.2	At Fred, Sample Controller B-57 takes off.
5.	H-30 mins	21.2	By LCM, 3 men . . . with 3/4-ton truck from Elmer to Fred. LCM released on arrival.
6.	H-Hr	Prog 5	Airborne, 1 B-57, 1 B-66, and 1 F-101A in assigned pattern.
7.	H-Hr	CJTF-7	Detonation.
8.	H+5 mins	21.2	At Fred, 6 F-84's take off at 5 min intervals for sampling missions.
9.	H+30 mins	TU-9	By copter, 4 men . . . from Yvonne Sta 1510 to Elmer.
10.	H+30 mins	J-4	By LCM, Sample Return Team with 2 jeeps . . . from Elmer to Fred.
11.	H+30 mins	31.1	By Water Taxi, 1 man with 2# microbarograph records from Fred to Elmer.
12.	H+1	CTG 7.1 TU-7	By copter, 4 men . . . depart Elmer Airstrip to conduct pre-entry radiological and damage survey of Eniwetok Atoll.
13.	H+1	TG 7.5	By copter, 1 man . . . from Elmer to Usula Baseball Field to check Powerhouse. Time at Powerhouse -- 20 minutes.
14.	H+1	21.2	At Fred, Sample Controller B-57 and 6 F-84's return Fred Airstrip. Samples for Flyaway #1 and Elmer analysis removed.

Inclosure No. 1 to Operational Letter INCA-7
Chronological Re-entry and Recovery Check List

DATE: D-DAY (continued)

NUMBER	TIME	ORGANIZATION	ITEM
15.	H+1½	21.2 21.3	By copter, 1 man . . . with 300# of cloud samples from Fred Sample Compound to Elmer Airstrip. Deliver samples to Proj vehicle. Several shuttles will be necessary.
16.	H+2	TU-2	By copter, 3 men . . . with hand tools from Elmer to Sally (Sta 2201) to open steel outer door, enter Sta and unfasten lead inner door. Copter stand by for return of personnel to Elmer. [radsafe monitor is named] Time in Sta -- 20 minutes.
17.	H+2	EG&G	By copter, 2 men . . . from Elmer to Wilma Photo Tower for film recovery. [radsafe monitor is named] Time at Tower -- 20 minutes.
18.	H+2	EG&G	By LCM, 2 men . . . from Elmer to Mack for film recovery. LCM will stand by at Mack. [radsafe monitor is named] Time at Mack -- 20 minutes.
19.	H+2	16.3 Hq USAF	By LCM, 5 men . . . from Bruce to Elmer (by copter if emergency prevails).
20.	H+2½	TU-2	By copter, 3 men . . . from Elmer to Sally (Sta 2201) to open lead inner door, unload cameras and put film in 7 or 8 available lead cassettes. Each cassette weighs 50#. 4 loaded cassettes will be recovered on this trip. Copter will stand by for return of personnel and cassettes to Elmer. [radsafe monitor is named] Time in Sta -- 20 minutes.
21.	H+3	TU-2	By copter 3 men . . . from Elmer to Sally (Sta 2201) to load monitor film in empty cassette and bring out four remaining casettes. Copter will stand by for return of cassettes and personnel to Elmer. [radsafe monitor is named] Time in Sta -- 20 minutes.
22.	H+3	1.10	By copter, 5 men . . . from Elmer to Pearl Sta 118.01. Project will furnish monitor. Time in Sta -- 15 minutes.

DATE: D-DAY (continued)

NUMBER	TIME	ORGANIZATION	ITEM
23.	H+5	J-4	By LCM, Sample Return Team with 2 jeeps . . . from Fred to Elmer (. . . will determine time and then request LCM via J-3).
24.	H+6	TU-9	By copter, 2 men . . . with 50# of equipment from Elmer to Sta 4 on Pearl for photo mission. Copter will not touch down. [radsafe monitor is named] Time over Sta 4 -- 20 minutes.
25.	H+6	21.2	At Fred, Flyaway #1 (with [1 man] on board) departs for CONUS.
26.	H+6	21.2	By LCM, 1 man . . . with 3/4-ton truck from Fred to Elmer.
D+1			
27.	0700	TU-7	By copter, 4 men . . . depart Elmer to conduct radiological survey of Eniwetok Atoll. Time at large -- 1½ hours.
28.	0730	1.10	By LCU, 7 men . . . with 2 DUKW's (each having an "A" frame) from Elmer to Pearl Sta 118.01 for recovery. LCU will stand by. Proj will furnish monitors. Time required at Pearl -- 2 hours.
29.	0800	1.1	By LCM, 5 men . . . with DUKW (having an "A" frame) from Elmer to Pearl for recovery. Proj will furnish monitors. Time required at Pearl -- 2 hours.

Headquarters
Task Group 7.4, Provisional
APO 187, San Francisco, California

ANNEX A TO TASK GROUP 7.4 MATERIEL ROLL-UP PLAN 2-56

SUPPLY (AIR FORCE)

1. Test Base Unit Supply will insure that priorities are arranged for timely return of high-value items to Air Force Supply channels.

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7. Under no condition will contaminated property by turned-in. Decontamination supplies and equipment will be tagged by the Unit Rad-Safe officer, showing date cleared for turn-in. A certificate will be placed on each turn-in slip, stating, "I certify that to the best of my knowledge and belief, no property listed hereon is radiologically contaminated."

8. Contaminated equipment and supplies will be disposed of in accordance with the provisions of AFM 67-1.

ANNEX B TO TASK GROUP 7.4 MATERIEL ROLL-UP PLAN 2-56

SUPPLY (TASK GROUP 7.2)

1. Property held on Memorandum Receipt from Accountable Officer, AP 330, will be turned-in accompanied by Turn-in Slip (DA AGO Form 447) prepared in quintuplicate. . . .

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10. Under no circumstances will contaminated property be turned-in. Decontamination supplies and equipment will be tagged by the Unit Rad-Safe Officer, showing date cleared for turn-in. A certificate will be placed on each Turn-in Slip, stating, "I certify that to the best of my knowledge and belief, no property listed hereon is radiologically contaminated."

11. Contaminated equipment and supplies will be disposed of in accordance with instructions issued by Task Group 7.2.

HEADQUARTERS, Joint Task Force SEVEN
APO 437
San Francisco, California
10 May 1956

Annex R to CJTF SEVEN No 1-56
Troop and Equipment List

1. **This annex lists the personnel and significant major items of equipment of the AEC, Army, Navy and Air Force during the operational phase of REDWING. It does not indicate the temporary location of personnel during shot periods.**

2. **It is published for the information and overall planning guidance of all concerned.**

A. HEADQUARTERS, JOINT TASK FORCE SEVEN

	Operational Strength				
HQ Component	Officers	Enlisted Men	Civilian	Location	Closed in PPG
Command	12*	11	1	Parry Island	19 Apr
Command	1	3	0	Washington, D.C.	
Command	4	3	0	Admiral's Aircraft (R5D)	19 Apr
J-1	5	15	0	Parry Island	14 Apr
J-1	5	9	0	Washington, D.C.	
J-2	3	3	0	Parry Island	15 Apr
J-2	0	1	0	Washington, D.C.	
CIC	3	0	0	Parry Island	
CIC	5	0	0	Eniwetok Island	27 Apr
CIC	1	0	0	Enyu Island	
J-3	20**	15	0	Parry Island	11 Apr
J-4	8	21	0	Parry Island	18 Apr
J-4	1	3	0	Washington, D.C.	
J-4 (LNO)	1	2	0	Travis AFB, California	
J-4 (LNO)	3	5	0	Hickam AFB, Hawaii	
J-4 (LNO)	3	3	0	NSC, Oakland, California	
J-4 (LNO)	1	2	0	Kwajalein NAS	
J-4 (Logistics)	1	1	0	Ft. Shafter, Tennessee	
J-5	6***	5	0	Parry Island	6 Apr
J-5	1	6	0	Washington D.C.	
Comptroller	1	4	0	Parry Island	25 Apr
Comptroller	2	9	0	Washington D.C.	
Total HQ JTF-7	87	121	1		

* Includes: One (1) Mil Assistant to the Scientific Deputy, one (1) Staff Surgeon, one (1) Aide to Deputy Commander (for Army), JTF 7.

** Includes: One (1) CONARC representative w/Scientific Test Branch, one (1) representative from Marine Corps w/Scientific Test Branch, one (1) representative from the Office of the Chief of Army Chemical Corps, one (1) technical observer from D.M/AEC.

*** Includes: one (1) representative from the Army Signal Corps Engineering Agency.

Annex R to CJTF SEVEN No 1-56
Troop and Equipment List

B. TASK GROUP 7.1

Unit Name	Operational Strength: Officers	Enlisted Men	Civilian	Operational Location	Date of Peak Strength
Hq TG 7.1	30	65	54	Parry Island	1 May
TASK UNIT					
7.1.1 (LASL Programs)	6	2	100	Parry Island	1 May
7.1.2 (UCRL Programs)		2	115	Parry Island	15 May
7.1.3 (DOD Programs)	246	217	314	Parry Island	1 May
			2	Wotho	1 May
		4		Rongerik Island	1 May
			4	Kusaie	1 May
		10		Kwajalein	1 May
			1	Johnston Island	1 May
		1		Wake	1 May
	4	8	4	Hawaii	1 May
			1	Palmyra	1 May
7.1.4 (Sandia Programs)			101	Parry Island	1 May
			2	Wotho	1 May
			2	Ujelang	1 May
			2	Rongerik	1 May
7.1.5 (Timing)	1	2	113	Parry Island	14 May
7.1.6 (Firing)			6	Parry Island	1 May
7.1.7 (RadSafe)	24	81	15	Parry Island	1 May
7.1.8 (LASL Doc Photo)		7	13	Parry Island	17 Apr
7.1.9 (UCRL Doc Photo)		1	5	Parry Island	15 May
7.1.10 (LASL Assembly)		1	51	Parry Island	28 May
7.1.11 (UCRL Assembly A)			7	Parry Island	15 May
7.1.12 (UCRL Assembly B)			8	Parry Island	15 May
	311	401	920		

NOTE: Operational location indicates Headquarters location only.
Location of personnel in each Task Unit fluctuate with each shot.

C. TASK GROUP 7.2

Unit	Strength: Officers	Strength: Enlisted Men	Strength: Civilian	Operational Location	Closed in PPG
Hq & Hq Det	44	328	7	Eniwetok Is.	Permanent location is PPG for all units except Co. C, 505th MP Battalion
	1	35		Parry Is.	
		8		Japtan Is.	
		4		Ujelang	
		4		Wotho	
		4		Utirik	
Transport Det	7	131		Eniwetok Is.	
Service Det	17	238		Eniwetok Is.	
		1		Enyu Is.	
MP Det	2	36		Eniwetok Is.	
		1		Enyu Is.	
Co. C, 505th MP Battalion		49		Eniwetok Is.	Closed in PPG in March 1956
	2	82		Parry Is.	
	1	22		Rojoa Is.	
	1	7		Teiteiripucchi Is.	
	1	10		Runit Is.	
	1	36		Enyu Is.	
	1	28		Eninman Is.	
	1	15		Romurikku Is.	
ASA, 8600th AAU	3	26		Eniwetok Is.	
	1	12		Enyu Is.	
LORAN Sta, USCG	1	8		Eniwetok Is.	
Red Cross			1	Eniwetok Is.	
Totals	84	1,085	8		

VEHICLES:

Bus, 37 passenger	6
Truck, 1/4 ton	120
Truck, 3/4 ton	121
Truck, 2 1/2 ton	38
Truck, Dump	8
DUKW	50
Truck, 1 1/2 ton	11
Truck, Wrecker, 5 ton	2
Truck, tractor, 5 ton	6

Annex R to CJTF SEVEN No 1-56
Troop and Equipment List

D. TASK GROUP 7.3

Unit Name	Operational Strength: Officers	Enlisted Men	Civilian	Equipment	Closed in PPG
Staff, CTG 7.3	19	48			31 Mar
TU 7.3.0				FLAGSHIP UNIT	
TE 7.3.0.1	43	507	3	USS ESTES (AGC-12)	31 Mar
TE 7.3.0.2				Escort Element	
TU 7.3.1				CARRIER UNIT	
TE 7.3.1.1	49	675		USS BADOENG STRAIT (CVE-116)	16 Mar
TE 7.3.1	25	126	1	HMR-363	6 Feb(½)
				15 Helicopters	16 Mar(½)
TU 7.3.2				UTILITY UNIT	
	4	64		USS SIOUX (ATF-75)	22 Mar
	5	67		USS CHICKASAW (ATF-83)	2 Apr
	5	64		USS LIPAN (ATF-85)	30 Mar
	5	68		USS ABNAKI (ATF-96)	19 Mar
				YON-182	30 Mar
				YC-1420	19 Mar
				YCV-10	1 Feb
TU 7.3.3	5	6		SURFACE PATROL AND TRANSPORT UNIT (CDR-3)	
	11	145		USS KNUDSON (APD-10)	10 Apr
			43	USNS T-LST-618	27 Feb
			43	USNS T-LST-306	9 Nov
	12	209		USS J.E. KYES (DD-787)	10 Apr
	14	214		USS SHELTON (DD-790)	10 Apr
	11	144		USS SILVERSTEIN (DE-534)	10 Apr
	10	147		USS McGINTY (DE-365)	10 Apr
TU 7.3.4				PATROL PLANE UNIT	
	54	292		15 P2V-5 Aircraft	11 Apr
TU 7.3.5	88	1,735		NAVSTA KWAJALEIN	
TU 7.3.6				RAD SUPPORT UNIT	
	4	47		YAG-39 (USS G. EASTMAN)	8 Apr
	5	46		YAG-40 (USS GRANVILLE S. HALL)	8 Apr
	6	74		USS CROOK COUNTY (LST-611)	8 Apr
TU 7.3.7				BOAT POOL UNIT	
TE 7.3.7.1	18	242		USS CATAMOUNT (LSD-17)	2 Feb
TE 7.3.7.2	3	191		Boat Pool Element Bikini 19 LCM, 5 LCU, 1 LCPL, 2 LCPR, 2 24' pers boats 1 YFN	2 Feb
TE 7.3.7.3	1	34		Boat Pool Element Eniwetok In Place: 4 LCN, 2 LCPL	1 Feb
TU 7.3.8				SPECIAL DEVICES UNIT	
TE 7.3.8.1	29	531		USS CURTISS (AV-4)	10 Apr
TE 7.3.8.2				Escort Element	
7.3.9				ACCOMMODATION SHIP UNIT	
	12	210		Fleet Oiler	10 Apr
	4	17	146	USNS AINSWORTH (T-AP-181)	25 Apr
			27	MV HORIZON	3 Apr
Totals	442	5,903	263		
(TOTALS LESS NAVSTA KWAJ (TU 7.3.5) AND MV HORIZON)	354	2,168	236		

E. TASK GROUP 7.4

Unit Name	Operational Strength: Military Officers	Military Enlisted Men	Civilian Officers	Civilian Enlisted Men	Operational Location	Equipment	Closed in PPG
HQ TG 7.4	43	57	2	0	Eniwetok		20 Mar
TEST AIRCRAFT UNIT							
Hq TAU	2	0	1	0	Eniwetok Is.		20 Mar
Hq USAF Elm	0	4	0	0	Eniwetok Is.		30 Apr
Hq USAF Elm	4	3	2	0	Parry Is.		30 Apr
Drop & Cann Elm	15	41	0	0	Eniwetok Is.	1 B-36 2 B-52	16 Mar
Effects Elm	14	7	8	53	Eniwetok Is.	1 B-52 1 B-47 1 B-57 1 B-66 2 F-84F 1 F-101	21 Mar
IBDA Elm	11	35	0	0	Eniwetok Is.	3 B-47	30 Apr
Ionosphere Elm	6	12	0	0	Eniwetok Is.	1 C-97	30 Apr
*Navy Effects Elm	8	31	13	0		1 A3D 1 P2V	
Early Penetr Elm	16	40	0	0	Eniwetok Is.	5 B-57	30 Apr
Tech Photo Elm	13	34	0	0	Eniwetok Is.	3 RB-50	21 Mar
Samp & Decon Elm	30	170	0	0	Eniwetok Is.	6 B-57 10 F-84G	26 Mar
TEST SERVICE UNIT							
Hq TSU	6	11	0	0	Eniwetok Is.		11 Mar
Comm Elm	9	113	5	0	Eniwetok Is.		1 Mar
Comm Elm	0	10	0	0	Enyu Is.		
Comm Elm	1	38	0	0	Parry Is.		
Comm Elm	0	6	0	0	Japtan Is.		
Comm Elm	0	5	0	0	Rongerik		
Comm Elm	0	5	0	0	Kapingamarangi		
Comm Elm	0	5	0	0	Tarawa		
Comm Elm	0	5	0	0	Kusaie		
Doc Photo Elm	3	5	4	0	Eniwetok Is.		22 Mar
Doc Photo Elm	0	0	1	0	Parry Is.		
Doc Photo Elm	2	2	5	0	Enyu Is.		
MATS Term Elm	4	24	0	0	Eniwetok Is.		1 Mar
SAR & Wx Island Resupply Elm	30	106	0	0	Eniwetok Is.	7 SA-16	19 Mar
Wx Cent Elm	12	17	1	0	Parry Is.		21 Mar
Wx Recon Elm	52	266	2	0	Eniwetok Is.	10 WB-50	26 Mar
Wx Report Elm	8	33	0	0	Eniwetok Is.		4 Mar
Wx Report Elm	0	18	0	0	Rongerik		
Wx Report Elm	0	17	0	0	Kapingamarangi		
Wx Report Elm	1	16	0	0	Tarawa		
Wx Report Elm	0	15	0	0	Kusaie		
C-54 Supp Elm	9	27	0	0	Eniwetok Is.	3 C-54	23 Mar
TEST BASE UNIT							
4930th Supp Gru(T)	12	46	0	0	Eniwetok Is.		12 Feb
4931st Opns Sq	23	192	0	0	Eniwetok Is.		1 Apr
4931st Opns Sq	2	30	0	0	Enyu Is.		
4931st Opns Sq	0	1	0	0	Parry Is.		
4932nd Materiel Sq	15	297	0	0	Eniwetok Is.	4 C-47 8 L-20 1 L-21	12 Feb
4932nd Materiel Sq	0	1	0	0	Enyu Is.		
K-19 Lift Elm	16	30	1	0	Eniwetok Is.	10 H-19	25 Jan
Totals	367	1,775	45	53			

* TG 7.4 controls flight operations only. Operational Control other than flight operations is exercised by CTG 7.1.

Annex R to CJTF SEVEN No 1-56
Troop and Equipment List

F. TASK GROUP 7.5

Unit	Operational Strength: Officers	Operational Strength: Enlisted Men	Operational Location	Closed in PPG
Hq TG 7.5	20		Parry Island	In place
Holmes & Narver	300	993	Parry Island	In place
	20	140	Eniwetok Island	In place
	5	165	Rojoa Island	In place
	10	338	Runit Island	In place
		4	Japtan Island	In place
	5	125	Teiteiripucchi Island	In place
	60	284	Enyu Island	In place
	10	190	Romurikku Island	In place
	5	105	Eninman Island	In place
		3	Wotho	In place
		3	Ujelang	In place
		3	Utirik	In place
Total	435	2,353		

Boat Pool: 29 LCM, 14 LCU, 41 DUKW, 2 water taxi, 2 YCL (tug)

APPENDIX B

TERMS, ABBREVIATIONS, ACRONYMS, AND UNITS

Many of the definitions in this glossary relating to nuclear device and radiation phenomena have been quoted or extracted from The Effects of Nuclear Weapons (3rd edition), S. Glasstone and P.J. Dolan, 1977.

A3D-1. See B-66.

AA&GM. Anti-Aircraft Artillery and Guided Missile Center, Ft. Bliss, Texas (Army).

AACS. Airways and Air Communication Service (Air Force).

AAU. Administrative Area Unit (Army).

ACC. Army Chemical Center, Edgewood Arsenal, Maryland.

accelerometer. An instrument for determining the acceleration of the system with which it moves.

AD. Destroyer tender (Navy).

AEC. Atomic Energy Commission, Washington, D.C. Independent agency of the Federal government with statutory responsibilities for atomic energy matters. No longer exists; its functions have been assumed by the Department of Energy and the Nuclear Regulatory Commission.

AF. Store ship (Navy); also Air Force.

AFB. Air Force Base.

AFCRC. Air Force Cambridge Research Center.

AFSWC. Air Force Special Weapons Center, Kirtland AFB, New Mexico.

AFSWP. Armed Forces Special Weapons Project.

AGC. Amphibious force flagship, later LCC (Navy).

airburst. The detonation of a nuclear device in the air at a height such that the expanding fireball does not touch the Earth's surface when the luminosity (emission of light) is at a maximum.

air particle trajectory. The direction, velocity, and rate of descent of windblown radioactive particles.

AK. Cargo ship (Navy).

AKA. Attack cargo ship, later LKA (Navy).

allowable dose. See MPL.

ALOO. Albuquerque Operations Office of the AEC (now DOE).

alpha emitter. A radionuclide that undergoes transformation by alpha-particle emission.

alpha particle. A charged particle emitted spontaneously from the nuclei of some radioactive elements. It is identical with a helium nucleus, having a mass of 4 units and an electric charge of 2 positive units. See also radioactivity.

alpha rays. A stream of alpha particles. Loosely, a synonym for alpha particles.

AMN. Airman; enlisted Air Force personnel.

AMS. Army Map Service, Washington, D.C.

AN/PDR-39. An ion-chamber-type survey meter; this was the standard radsafe meter. Others in use included the Navy version, the AN/PDR-T1B, the AN/PDR-18A and -18B, and lower-range Geiger-Mueller instruments (AN/PDR-27, Beckman MX-5, and Nuclear Corporation 2610). Other radiac devices were also used.

AO. Oiler (Navy).

AOC. Air Operations Center.

AOG. Gasoline tanker (Navy).

AP. Transport ship (Navy).

APO. Army Post Office.

APD. High-speed transport ship (Navy).

APG. Aberdeen Proving Ground, Maryland.

ARA. Allied Research Associates, Boston, Massachusetts.

arming. The changing of a nuclear device from a safe condition (that is, a condition in which it cannot be accidentally detonated) to a state of readiness for detonation.

<u>ARS</u>. Salvage ship (Navy).

<u>ARSD</u>. Salvage lifting ship (Navy).

<u>ASA</u>. Army Security Agency.

<u>ATA</u>. Auxiliary ocean tug (Navy).

<u>ATF</u>. Fleet ocean tug (Navy).

<u>atoll</u>. A ring of coral reefs, usually with small islets, that surrounds a lagoon. Most are isolated reefs rising from the deep sea that have built up on submerged volcanoes. They vary considerably in size; the largest atoll, Kwajalein in the Marshall Islands, has an irregular shape that extends for 84 miles (135 km). See also <u>coral reef</u>.

<u>atomic bomb (or weapon)</u>. A term sometimes applied to a nuclear weapon utilizing fission energy only. See also <u>fission</u>, <u>nuclear device</u>.

<u>atomic explosion</u>. See <u>nuclear explosion</u>.

<u>attenuation</u>. The process by which radiation is reduced in intensity when passing through some material. It is due to absorption or scattering or both, but it excludes the decrease of intensity with distance from the source (<u>inverse square law</u>, which see).

<u>AU</u>. Army Unit.

<u>AV</u>. Seaplane tender (Navy).

<u>AVR</u>. Aircraft rescue vessel (Navy).

<u>AW</u>. Distilling ship (Navy).

<u>B-29</u>. A 4-engine, propeller-driven bomber developed by Boeing, used for weather reconnaissance, cloud tracking, aerial sampling and photography, and aerial refueling at the PPG. These versions designated RB-29, WB-29, and KB-29.

<u>B-36</u>. A long-range, strategic bomber powered by six pusher propeller engines, supplemented by four jet engines. Developed by Consolidated Aircraft. Used as the subject of effects experiments and as a sampler controller aircraft. Also designated FB-36, RB-36, and WB-36.

<u>B-47</u>. A 6-jet-engine bomber with sweptback wings and a double-wheel bicycle landing gear, developed by Boeing. Used as the subject of effects experiments.

<u>B-50</u>. A 4-engine bomber developed by Boeing, with some features like those of the B-29, but having a taller tail fin and larger engines and nacelles.

<u>B-52</u>. Eight-engine jet bomber built by the Boeing Company.

<u>B-57</u>. U.S. version of English Electric Canberra bomber used as cloud-sampling aircraft.

<u>B-66</u>. Twin-engine jet bomber built by Douglas Aircraft for the Air Force and for the Navy as the A3D-1.

<u>background radiation</u>. The radiation of man's natural environment, consisting of that which comes from cosmic rays and from the naturally radioactive elements of the Earth, including that from within man's body. The term may also mean radiation extraneous to an experiment.

<u>barge</u>. A floating platform used as the support for the cab, or shelter, in which nuclear devices were being prepared for testing.

<u>base surge</u>. The particulate dust cloud that rolls out from the bottom of the cloud column produced by the detonation of a nuclear device. For underwater bursts, the base surge is a cloud of water droplets, and the flowing properties are those of a homogeneous liquid.

<u>bathtub</u>. A washdown system used used on an aircraft carrier flight deck for decontaminating helicopter landing gear. The bathtub's purpose was to prevent water used to hose the aircraft wheels from running onto the flight deck. It was a low-walled canvas rectangle treated with waterproofing preservatives.

<u>bathythermograph</u>. A device for obtaining a record of temperature with depth in the upper 1,000 feet (300 meters) of the ocean, from a ship underway.

<u>becquerel (Bq)</u>. See <u>curie</u>.

<u>beta burns</u>. Beta particles that come into contact with the skin and remain for an appreciable time can cause a form of radiation injury sometimes referred to as "beta burn." In an area of extensive early fallout, the whole surface of the body may be exposed to beta particles.

<u>beta emitter</u>. A radionuclide that disintegrates by beta particle emission. All beta-active elements existing in nature expel negative particles, i.e., electrons or, more exactly, negatrons. Beta-emitting particles are harmful if inhaled or ingested or remain on the skin.

<u>beta particle (ray)</u>. A charged particle of very small mass emitted spontaneously from the nuclei of certain radioactive elements. Most, if not all, of the direct fission products emit negative beta particles (negatrons). Physically, the beta particle is identical to an electron moving at high velocity.

<u>bhangmeter</u>. A device that measures bomb yield based on light generated by the explosion.

<u>blast</u>. The detonation of a nuclear device, like the detonation of a high explosive such as TNT, results in the sudden formation of a pressure or shock wave, called a blast wave in the air and a shock wave when the energy is imparted to water or Earth.

blast wave. An air pulse in which the pressure increases sharply at the front followed by winds propagated from an explosion.

blast yield. That portion of the total energy of a nuclear explosion that manifests itself as blast and shock waves.

bomb debris. See weapon debris.

BRL. Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland (Army).

BuAer. Bureau of Aeronautics (Navy).

BuMed. Bureau of Medicine and Surgery (Navy).

burst. Explosion; or detonation. See also airburst, high-altitude burst, surface burst.

BuShips. Bureau of Ships (Navy).

C-47. A twin-engine transport aircraft manufactured by Douglas Aircraft Company (Air Force version of the DC-3).

C-54. A 4-engine military cargo and personnel transport manufactured by Douglas Aircraft Company (Air Force version of the DC-4).

C-97. Four-engine propeller driven transport plane built by Boeing Aircraft Company based on the B-29 with added fuselage section.

cab. The shelter that covers a nuclear device being prepared for test. May be located on a tower, on the Earth's surface, or on a barge.

Canberra. An RAF twin-turbojet, all-weather, tactical bomber developed by English Electric. Also built in the United States and used by the Air Force as the B-57.

cathode-ray tube. A vacuum tube in which cathode rays (electrons) are beamed upon a fluorescent screen to produce a luminous image. The character of this image is related to, and controlled by, one or more electrical signals applied to the cathode-ray beam as input information. The tubes are used in measuring instruments such as oscilloscopes and in radar and television displays.

cave. A heavily shielded enclosure in which radioactive materials can be remotely manipulated to avoid radiation exposure of personnel.

CDC. Center for Disease Control.

Ci; c. Abbreviation for curie, which see. Ci is preferred now but c was the abbreviation used in the 1950s.

CIC. Counter-Intelligence Corps (Army).
Combat Information Center (Navy).

CINCPAC. Commander-in-Chief, Pacific.

CJTF 7. Commander, Joint Task Force 7.

closed area. The land areas of Bikini and Enewetak and the water areas within 3 miles of them that the United States closed to unauthorized persons.

cloud chamber effect. See Wilson cloud.

cloud column (funnel). The visible column of weapon debris (and possibly dust or water droplets) extending upward from the point of a nuclear burst.

cloud phenomena. See fallout, fireball, radioactive cloud.

CNO. Chief of Naval Operations.

collimate. To align nuclear weapon radiant outputs within an assigned solid angle through the use of baffles in order to enhance measurements.

Co. Chemical symbol for cobalt.

cobalt. Metallic element with radionuclide ^{60}Co used as calibration source for gamma instruments.

ComAirPac. Commander Naval Air Force Pacific (Navy).

ComServPac. Commander Service Forces Pacific (Navy).

Condition "Purple". See Purple conditions.

Consolidated List. Consolidated List of Radiological Exposures. The list that covers all recorded individual radiological exposures for joint task force participants.

contamination. The deposit of radioactive material on the surfaces of structures, areas, objects, and personnel following a nuclear detonation. This material generally consists of fallout in which fission products and other device debris have become incorporated with particles of dust, vaporized components of device platforms, etc. Contamination can also arise from the radioactivity induced in certain substances by the action of neutrons from a nuclear explosion. See also decontamination, fallout, weapon debris.

coral reef. A complex ecological association of bottom-living and attached shelled marine animal fossils that form fringing reefs, barrier reefs, and atolls. The lagoons of barrier reefs and atolls are important places for the deposition of fine-grained calcium carbonate mud.

CPM. Counts per minute, a measure of radioactive material disintegration.

crater. The depression formed in the surface of the Earth by a surface or underground explosion. Crater formation can occur by vaporization of the surface material, by the scouring effect of airblast, by throwout of disturbed material, or by subsidence.

CRL. Chemical Research Laboratory (Army).

Cs. Chemical symbol for cesium.

C/S. Chief of Staff.

CTG. Commander Task Group.

curie (Ci). A unit of radioactivity; it is the activity of a quantity of any radioactive species in which 3.700 x 10^{10} (37 billion) nuclear disintegrations occur per second (approximately the radioactivity of 1 gram of radium). The gamma curie is sometimes defined correspondingly as the activity of material in which this number of gamma-ray photons is emitted per second. This unit is being replaced by the becquerel (Bq), which is equal to one disintegration per second.

cutie pie. A portable beta-gamma survey meter using an ionization chamber as the detector volume to measure radiation exposure. Usually used at higher radiation levels for both detecting and measuring ionizing radiation. A removable end-cap acts as a shield for the detector, allowing the instrument to indicate combined beta and gamma radiation when the cap is removed, or gamma radiation only when the cap is in place.

CVE. Escort aircraft carrier (Navy).

CW net. Carrier wave network. An organization of stations capable of direct radio communications on a common channel or frequency.

dan buoy. A floating temporary marker buoy such as one used in minesweeping and antisubmarine warfare operations.

D-day. The term used to designate the unnamed day on which a test takes place. The equivalent rule applies to H-hour. Time in plans is indicated by a letter that shows the unit of time employed in figures, with a minus or plus sign to indicate the amount of time before or after the reference event, e.g., D+7 means 7 days after D-day, H+2 means 2 hours after H-hour.

DDE. Escort destroyer (Navy).

DE. Destroyer escort (Navy).

debris (radioactive). See weapon debris.

decay (radioactive). The decrease in activity of any radioactive material with the passage of time due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, sometimes accompanied by gamma radiation, or by gamma photons alone. Every decay process has a definite half-life.

decontamination. The reduction or removal of contaminating radioactive material from a structure, area, object, or person. Decontamination may be accomplished by (1) treating the surface to remove or decrease the contamination; (2) letting the material stand so that the radioactivity is decreased as a result of natural decay; and (3) covering the contamination in order to attenuate the radiation emitted.

device. Nuclear fission and fusion materials, together with their arming, fuzing, firing, chemical-explosive components, that have not reached the development status of an operational weapon.

diagnostic measurements or experiments. Experiments whose purpose is to study the explosive disassembly of a nuclear detonation (as opposed to effects measurements, which see).

DM. Minelayer destroyer (Navy). Converted destroyers designed to conduct high-speed minelaying operations.

DMA. The Division of Military Applications of the Atomic Energy Commission.

DOD. Department of Defense. The Federal executive agency responsible for the defense of the United States. Includes the four services and special joint defense agencies. Reports to the President through the Secretary of Defense.

dose. A general term denoting the quantity of ionizing radiation absorbed. The unit of absorbed dose is the rad (which see). In soft body tissue the absorbed dose in rads is essentially equal to the exposure in roentgens. The biological dose (also called the RBE dose) in rems is a measure of biological effectiveness of the absorbed radiation. Dosage is used in older literature as well as exposure dose and simply exposure, and care should be exercised in their use. See also exposure.

dose rate. As a general rule, the amount of ionizing (or nuclear) radiation that an individual or material would receive per unit of time. It is usually expressed as rads (or rems) per hour or multiples or divisions of these units such as millirads per hour. The dose rate is commonly used to indicate the level of radioactivity in a contaminated area. See survey meter.

dosimeter. An instrument for measuring and registering the total accumulated dose of (or exposure to) ionizing radiation. Instruments worn or carried by individuals are called personnel dosimeters.

dosimetry. The measurement and recording of radiation doses and dose rates. It is concerned with the use of various types of radiation instruments with which measurements are made. See also dosimeter, survey meter.

DPM. Disintegrations per minute, a measure of radioactivity, literally atoms disintegrating per minute. Difficult to directly compare with roentgens per hour for mixtures of radionuclides.

drogue. A sea anchor or similar drag device used to pull out a parachute.

DTMB. David Taylor Model Basin, Carderock, Maryland (Navy).

DUKW. Two-and-one-half-ton amphibious truck (DUKW).

dynamic pressure. Air pressure that results from the mass air flow (or wind) behind the shock front of a blast wave.

effects measurements or experiments. Experiments whose purpose is to study what a nuclear explosion does to materials, equipment, and systems. Includes also measurement of the changes in the environment caused by the detonation, such as increased air pressures (blast), thermal and nuclear radiation, cratering, water waves, etc.

EG&G. Edgerton, Germeshausen & Grier, Boston, Massachusetts (now EG&G, Inc.). An AEC contractor. Provided timing and firing electronics and technical film coverage.

electromagnetic radiation. Electromagnetic radiations range from X-rays and gamma rays of short wavelength (high frequency), through the ultraviolet, visible, and infrared regions, to radar and radio waves of relatively long wavelength.

electron. A particle of very small mass and electrically charged. As usually defined, the electron's charge is negative. The term negatron is also used for the negative electron and the positively charged form is called a positron. See also beta particles.

EPG. Eniwetok Proving Ground.

ETA. Estimated time of arrival.

ETD. Estimated time of departure.

exposure. A measure expressed in roentgens of the ionization produced by gamma rays (or X-rays) in air. The exposure rate is the exposure per unit time (e.g., roentgens per hour). See dose, dose rate, roentgen.

exposure rate contours. Lines joining points that have the same radiation intensity to define a fallout pattern, represented in terms of roentgens per hour.

F-84G. Single-engine jet fighter developed by Republic Aircraft and used from IVY (1952) through REDWING (1956) as cloud sampler aircraft.

F-101. A twin-engine jet fighter developed by McDonnell Aircraft Company.

fallout. The process or phenomenon of the descent to the Earth's surface of particles contaminated with radioactive material from the radioactive cloud. The term is also applied in a collective sense to the contaminated particulate matter itself. The early (or local) fallout is defined, somewhat arbitrarily, as particles reaching the Earth within 24 hours after a nuclear explosion. The delayed (or worldwide) fallout consists of the smaller particles, which ascend into the upper troposphere and stratosphere and are carried by winds to all parts of the Earth. The delayed fallout is brought to Earth, mainly by rain and snow, over extended periods ranging from months to years.

fathometer. A depth-sounding instrument. The depth of water is measured by noting the time the echo of a sound takes to return from the bottom.

film badges. Used for the indirect measurement of ionizing radiation. Generally contain two or three pieces of film of different radiation sensitivities. They are wrapped in paper (or other thin material) that blocks light but is readily penetrated by gamma rays. The films are developed and the degree of fogging (or blackening) observed is a measure of the gamma-ray exposure, from which the absorbed dose is calculated. Film badges can also measure beta and neutron radiation.

fireball. The luminous sphere of hot gases that forms a few millionths of a second after a nuclear explosion as the result of the absorption by the surrounding medium of the thermal X-rays emitted by the extremely hot (several tens of millions of degrees) device residues. The exterior of the fireball in air is initially sharply defined by the luminous shock front and later by the limits of the hot gases themselves.

fission. The process of the nucleus of a particular heavy element splitting into two nuclei of lighter elements, with the release of substantial amounts of energy. The most important fissionable materials are uranium-235 and plutonium-239; fission is caused by the absorption of neutrons.

fission detectors. Radiation pulse detector of the proportional counter type in which a foil or film of fissionable materials is incorporated to make it respond to neutrons.

fission products. A general term for the complex mixture of substances produced as a result of nuclear fission. A distinction should be made between these and the direct fission products or fission fragments that are formed by the actual splitting of the heavy-element nuclei into nuclei of medium atomic weight. Approximately 80 different fission fragments result from roughly 40 different modes of fission of a given nuclear species (e.g., uranium-235 or plutonium-239). The fission fragments, being radioactive, immediately begin to decay, forming additional (daughter) products, with the result that the complex mixture of fission products so formed contains over 300 different radionuclides of 36 elements.

fixed alpha. Alpha radioactivity that cannot be easily removed as evidenced by no measured change in a swipe of a 100-cm^2 area.

fluorescence. The emission of light (electromagnetic radiation) by a material as a result of the absorption of energy from radiation. The term may refer to the radiation emitted, as well as to the emission process.

FOPC. Fallout Plotting Center.

FOPU. Fallout Prediction Unit.

forward area. The Pacific Proving Ground and adjoining areas (e.g., Kwajalein).

FPO. Fleet Post Office (Navy).

fusion. The combination of two light nuclei to form a heavier nucleus, with the release of the difference of the nuclear binding energy of the fusion products and the sum of the binding energies of the two light nuclei.

gamma rays. Electromagnetic radiations of high photon energy originating in atomic nuclei and accompanying many nuclear reactions (e.g., fission, radioactivity, and neutron capture). Physically, gamma rays are identical with X-rays of high energy; the only essential difference is that X-rays do not originate from atomic nuclei of high energy. Gamma rays can travel great distances through air and can penetrate considerable thickness of material, although they can neither be seen nor felt by human beings except at very high intensities, which causes an itching and tingling sensation of the skin. They can produce harmful effects even at a long distance from their source (The Effects of Nuclear Weapons, 3rd edition).

Geiger-Mueller (GM) counter. A gas discharge pulse counter for ionizing radiation. See also AN/PDR-39 and ion-chamber-type survey meter.

GMT. Greenwich Mean Time.

gray (Gy). A recently introduced ICRP term; 1 Gy equals 100 rad.

ground zero. See surface zero.

gunk. A viscous commercial preparation that is soluble both in water and petroleum derivatives. It acts as a wetting agent in removing grease and particulate matter from metal and other nonporous surfaces.

H-19. Large utility helicopter manufactured by Sikorsky Aircraft Division of United Aircraft Corporation.

H-hour. Time zero, or time of detonation. When used in connection with planning operations it is the specific hour on which the operation event commences. See D-day.

half-life. The time required for a radioactive material to lose half of its radioactivity due to decay. Each radionuclide has a unique half-life.

HASL, NYKOPO. Atomic Energy Commission's Health and Safety Laboratory, New York Operations Office.

HE. High explosive.

HF. High-frequency radio communications. The HF band is from 3 to 30 kHz.

high-altitude burst. Defined, somewhat arbitrarily, as a detonation in or above the stratosphere. The distribution of the energy of the explosion between blast and thermal radiation changes appreciably with increasing altitude.

HMR. Marine Helicopter Transport Squadron.

hodograph. A common hodograph in meteorology represents the speed and direction of winds at different altitude increments.

hot; hot spot. Commonly used colloquial term meaning a spot or area relatively more radioactive than some adjacent area.

IBDA. Indirect Bomb Damage Assessment. A revised target analysis based on new data such as actual weapon yield, burst height, and surface zero obtained by means other than direct assessment.

ICRP. International Commission on Radiological Protection.

initial radiation. Electromagnetic radiations of high energy emitted from both the fireball and the radioactive cloud within the first minute after a detonation. It includes neutrons and gamma rays given off almost instantaneously, as well as the gamma rays emitted by the fission products and other radioactive species in the rising cloud. Initial radiations from ground or nearground bursts activate both earth materials and device debris to create contamination.

inverse square law. The decrease in radiation intensity with distance from a single-point source is in proportion to the square of the distance removed.

ion-chamber-type survey meter. A device for measuring the amount of ionizing radiation. Consists of a gas-filled chamber containing two electrodes (one of which may be the chamber wall) between which a potential difference is maintained. The radiation ionizes gas in the chamber and an instrument connected to one electrode measures the ionization current produced.

ionization. The process of adding electrons to, or knocking electrons from, atoms or molecules, thereby creating ions. High temperatures, electrical discharges, and nuclear radiation can cause ionization.

ionizing radiation. Any particulate or electromagnetic radiation capable of producing ions, directly or indirectly, in its passage through matter. Alpha and beta particles produce ion pairs directly, while gamma rays and X-rays liberate electrons as they traverse matter, which in turn produce ionization in their paths.

ionosphere. The region of the atmosphere, extending from roughly 40 to 250 miles (64 to 400 km) above the Earth, in which there is appreciable ionization. The presence of charged particles in this region profoundly affects the propagation of radio and radar waves.

irradiation. Exposure of matter to radiation.

isodose lines. Dose or dose-rate contours. In fallout, contours plotted on a radiation field within which the dose rate or the total accumulated dose is the same.

isotope. Atoms with the same atomic number (same chemical element) but different atomic weight; i.e., the nuclei have the same number of protons but a different number of neutrons.

JCS. Joint Chiefs of Staff.

JTF 7. Joint Task Force 7 and its predecessor, JTF 132, was a combined force of personnel of the Department of Defense (Air Force, Army, Marine Corps, Navy), the AEC, and their contractors. JTF 7 was responsible for all aspects of nuclear weapon tests in the Pacific testing area from 1953 to 1958.

kiloton convention. Relates nuclear explosion energy to TNT explosion energy by using the approximate energy release of 1,000 tons of TNT as the measuring unit.

kinetic energy. Energy associated with the motion of matter.

L-20. Single-engine, 2-place light aircraft used in Enewetak airlift.

LASL. Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

LCM. Mechanized landing craft (Navy).

LCP(L). Personnel landing craft, large (Navy).

LCP(R). Personnel landing craft, ramp (Navy).

LCT. Tank landing craft (Navy).

LCU. Utility landing craft (Navy).

LML. Lookout Mountain Laboratory, Hollywood, California (Air Force).

Loran. Long-range aid to navigation system. Loran stations were maintained by the U.S. Coast Guard Station on Enewetak Island and Johnston Atoll.

LSD. Dock landing ship (Navy).

LSIL. Infantry landing ship, large (Navy).

LST. Tank landing ship.

magnetometer. An instrument for measuring changes in the geomagnetic field.

MATS. Military Air Transport Service; later, Military Airlift Command.

megaton (energy). Approximately the amount of energy that would be released by the explosion of one million tons of TNT.

microcurie. One-millionth of a curie.

micron. One-millionth of a meter (i.e., 10^{-6} meter or 10^{-4} centimeter); it is roughly four one-hundred-thousandths (4×10^{-5}) of an inch.

milliroentgen. One-thousandth of a roentgen.

MPL. Maximum Permissible Limit. That amount of radioactive material in air, water, foodstuffs, etc. that is established by authorities as the maximum that would not create undue risk to human health.

mR; mr. Abbreviation for milliroentgen.

MSTS. Military Sea Transportation Service, (Navy).

mushroom cap. Top of the cloud formed from the fireball of a nuclear detonation.

MV. Motor vessel.

MWB. Motor whale boat.

NAS. Naval Air Station.

NBS. National Bureau of Standards.

NCO. Noncommissioned officer.

NCRP. National Committee on Radiation Protection and Measurements. Before 1956 simply the National Committee on Radiation Protection.

NEL. Naval Electronics Laboratory.

neutron. A neutral elementary particle (i.e., with neutral electrical charge) of approximately unit mass (i.e., the mass of a proton) that is present in all atomic nuclei, except those of ordinary (light) hydrogen. Neutrons are required to initiate the fission process, and large numbers of neutrons are produced by both fission and fusion reactions in nuclear explosions.

neutron flux. The intensity of neutron radiation. It is expressed as the number of neutrons passing through 1 cm^2 in 1 second.

NPG. Nevada Proving Ground, now the Nevada Test Site (NTS).

nmi. Nautical miles.

NRDL. Naval Radiological Defense Laboratory.

NRL. Naval Research Laboratory.

NSC, TI. Naval Schools Command, Treasure Island, California.

NTPR. Nuclear Test Personnel Review.

NTS. Nevada Test Site.

nuclear cloud. See radioactive cloud.

nuclear device (or weapon or bomb). Any device in which the explosion results from the energy released by reactions involving atomic nuclei, either fission or fusion, or both. Thus, the A- (or atomic) bomb and the H- (or hydrogen) bomb are both nuclear weapons. It would be equally true to call them atomic weapons, since the energy of atomic nuclei is involved in each case. However, it has become more or less customary, although it is not strictly accurate, to refer to weapons in which all the energy results from fission as A-bombs. In order to make a distinction, those weapons in which part of the energy results from thermonuclear (fusion) reactions of the isotopes of hydrogen have been called H-bombs or hydrogen bombs.

nuclear explosion. Explosive release of energy due to the splitting, or joining, of atoms. The explosion is observable by a violent emission of ultraviolet, visible, and infrared (heat) radiation, gamma rays, neutrons, and other particles. This is accompanied by the formation of a fireball. A large part of the energy from the explosion is emitted as blast and shock waves when detonated at the Earth's surface or in the atmosphere. The fireball produces a mushroom-shaped mass of hot gases and debris, the top of which rises rapidly. See also radiation, gamma rays, fireball, nuclear weapon, fission, fusion, blast.

nuclear fusion. See thermonuclear fusion.

nuclear radiation. Particulate and electromagnetic radiation emitted from atomic nuclei in various nuclear processes. The important nuclear radiations, from the weapons standpoint, are alpha and beta particles, gamma rays, and neutrons. All nuclear radiations are ionizing radiations, but the reverse is not true; X-rays, for example, are included among ionizing radiations, but they are not nuclear radiations since they do not originate from atomic nuclei.

nuclear tests. Tests carried out to supply information required for the design and improvement of nuclear weapons and to study the phenomena and effects associated with nuclear explosions.

nuclide. Any species of atom that exists for a measurable length of time. The term nuclide is used to describe any atomic species distinguished by the composition of its nucleus; i.e., by the number of protons and the number of neutrons. Isotopes of a given element are nuclides having the normal number of protons but different numbers of neutrons in this nuclei. A radionuclide is a radioactive nuclide.

NYKOPO. New York Operations Office (Atomic Energy Commission).

off-scale. Radiation (or other physical phenomena) greater than the capacity of a measuring device to measure.

ONR. Office of Naval Research, Washington, D.C.

ORNL. Oak Ridge National Laboratory, Tennessee.

oscilloscope. The name generally applied to a cathode-ray device.

overpressure. The transient pressure, usually expressed in pounds per square inch, exceeding the ambient pressure, manifested in the shock (or blast) wave from an explosion.

P2V. Twin-engine patrol bomber used for maritime patrol and antisubmarine warfare. Developed by Lockheed for the U.S. Navy. Used in nuclear tests as controller and transient ship search.

PC. Patrol craft (Navy).

peak overpressure. The maximum value of the overpressure (which see) at a given location.

permissible dose. That dose of ionizing radiation that is not expected to cause appreciable bodily injury to a person at any time during his lifetime.

phantom. A volume of material closely approximating the density and effective atomic number of tissue. The phantom absorbs ionizing radiation in the same manner as tissue; thus, radiation dose measurements made within the phantom provide a means of approximating the radiation dose within a human or animal body under similar exposure conditions. Materials commonly used for phantoms are water, masonite, pressed wood, plexiglas, and beeswax.

pig. A heavily shielded container (usually lead) used to ship or store radioactive materials.

POL. Petroleum, oil, and lubricants. The storage area for these products is referred to as a POL farm.

PPG. Pacific Proving Ground (after 1956 designated the Eniwetok Proving Ground, or EPG).

prompt radiation. Neutrons and gamma rays emitted almost simultaneously following a nuclear fission or fission.

proton. A particle carrying a positive charge and physically identical to the nucleus of the ordinary hydrogen atom.

Purple conditions. A shipboard warning system used in radiological defense. Various numbered conditions were sounded when radioactive fallout was encountered. Responses to the sounded warnings included closing of various hatches and fittings, turning off parts of the ventilation system, and removing personnel from a ship's open decks. The higher the Purple condition number, the more severe the radiological situation.

"Q"-clearance. A security clearance granted by the Atomic Energy Commission, based upon a background investigation.

R; r. Symbol for roentgen.

R5D. Four-engine propeller transport manufactured by the Douglas Aircraft Company for the Navy and the Air Force, where it was designated C-54. Commercial versions were designated DC-4.

Ra. Chemical symbol for radium.

rad. Radiation absorbed dose. A unit of absorbed dose of radiation; it represents the absorption of 100 ergs of ionizing radiation per gram (or 0.01 J/kg) of absorbing material, such as body tissue. This unit is presently being replaced in scientific literature by the Gray (Gy), numerically equal to the absorption of 1 joule of energy per kilogram of matter.

RadDefense. Radiological defense. Defense against the effects of radioactivity from atomic weapons. It includes the detection and measurement of radioactivity, the protection of persons from radioactivity, and decontamination of areas, places, and equipment. See also radsafe.

radex area. Radiological exclusion area. Following each detonation there were areas of surface radiological contamination and areas of air radiological contamination. These areas were designated as radex areas. Radex areas were used to chart actual or predicted fallout and also used for control of entry and exit.

radiation. The emission of any rays, electromagnetic waves, or particles (e.g., gamma rays, alpha particles, beta particles, neutrons) from a source.

radiation decay. See decay (radioactive).

radiation detectors. Any of a wide variety of materials or instruments that provide a signal when stimulated by the passage of ionizing radiation; the sensitive element in radiation detection instruments. The most widely used media for the detection of ionizing radiation are photographic film and ionization of gases in detectors (e.g., Geiger counters), followed by materials in which radiation induces scintillation.

radiation exposure. Exposure to radiation may be described and modified by a number of terms. The type of radiation is important: alpha and beta particles, neutrons, gamma rays and X-rays, and cosmic radiation. Radiation exposure may be from an external radiation source, such as gamma rays, X-rays, or neutrons, or it may be from radionuclides retained within the body emitting alpha, beta, or gamma radiation. The exposure may result from penetrating or nonpenetrating radiation in relation to its ability to enter and pass through matter -- alpha and beta particles being considered as nonpenetrating and other types of radiation as penetrating. Exposure may be related to a part of the body or to the whole body. See also whole-body irradiation.

radiation intensity. Degree of radiation. Measured and reported in roentgens (R), rads, rems, and rep, multiples and divisions of these units, and multiples and divisions of these units as a function of exposure rate (per hour, day, etc.).

radioactive (or nuclear) cloud. An all-inclusive term for the cloud of hot gases, smoke, dust, and other particulate matter from the weapon itself and from the environment, which is carried aloft in conjunction with the rising fireball produced by the detonation of a nuclear weapon.

radioactive nuclide. See radionuclide.

radioactive particles. See radioactivity.

radioactive pool. A disk-like pool of radioactive water near the surface formed by a water-surface or subsurface detonation. The pool gradually expands into an annular form, then reverts to a larger irregular disk shape at later times with a corresponding attenuation of radioactivity.

radioactivity. The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the nuclei of an (unstable) nuclide. As a result of this emission the radioactive nuclide is converted (decays) into the isotope of a different (daughter) element, which may (or may not) also be radioactive. Ultimately, as a result of one or more stages of radioactive decay, a stable (nonradioactive) end product is formed.

radiological survey. The directed effort to determine the distribution and dose rate of radiation in an area.

radionuclide. A radioactive nuclide (or radioactive atomic species).

radiosonde. A balloon-borne instrument for the simultaneous measurement and transmission of meteorological data, consisting of transducers for the measurement of pressure, temperature, and humidity; a modulator for the conversion of the output of the transducers to a quantity that controls a property of the radiofrequency signal; a selector switch, which determines the sequence in which the parameters are to be transmitted; and a transmitter, which generates the radiofrequency carrier.

radiosonde balloon. A balloon used to carry a radiosonde aloft. These balloons have daytime bursting altitudes of about 80,000 feet (25 km) above sea level. The balloon measures about 5 feet (1.5 meters) in diameter when first inflated and may expand to 20 feet (6 meters) or more before bursting at high altitude.

radium. An intensely radioactive metallic element. In nature, radium is found associated with uranium, which decays to radium by a series of alpha and beta emissions. Radium is used as a radiation source for instrument calibration.

radsafe. Radiological safety. General term used to cover the training, operations, and equipment used to protect personnel from potential overexposures to nuclear radiation during nuclear tests.

rainout. Removal of radioactive particles from a nuclear cloud by rain.

rawin. Radar wind sounding tests that determine the winds aloft patterns by radar observation of a balloon.

rawinsonde. Radar wind sounding and radiosonde (combined).

Raydist Corporation. A Norfolk, Virginia firm that provided navigational aid service for test aircraft in the Bikini area during weapon tests in the Pacific Proving Ground.

Raydist slave stations. Support instrumentation used in the positioning of experimental effects aircraft.

RB-29. Reconnaissance version of the B-29.

RB-36. Reconnaissance version of the B-36.

RBE. Relative biological effectiveness. A factor used to compare the biological effectiveness of absorbed radiation doses (i.e., rads) due to different types of ionizing radiation. For radiation protection the term has been superseded by Quality Factor.

rem. A special unit of biological radiation dose equivalent; the name is derived from the initial letters of the term "roentgen equivalent man (or mammal)." The number of rems of radiation is equal to the number of rads absorbed multiplied by the RBE of the given radiation (for a specified effect). The rem is also the unit of dose equivalent, which is equal to the product of the number of rads absorbed multiplied by the Quality Factor and the distribution factor for the radiation. The unit is presently being replaced by the sievert (Sv).

rep. An obsolete special unit of absorbed dose.

residual nuclear radiation. Nuclear radiation, chiefly beta particles and gamma rays, that persists for a time following a nuclear explosion. The radiation is emitted mainly by the fission products and other bomb residues in the fallout, and to some extent by earth and water constituents and other materials in which radioactivity has been induced by the capture of neutrons.

R-hour. Reentry hour.

roentgen (R; r). A special unit of exposure to gamma (or X-) radiation. It is defined precisely as the quantity of gamma (or X-) rays that will produce electrons (in ion pairs) with a total charge of 2.58×10^{-4} coulomb in 1 kilogram of dry air under standard conditions. An exposure of 1 roentgen results in the deposition of about 94 ergs of energy in 1 gram of soft body tissue. Hence, an exposure of 1 roentgen is approximately equivalent to an absorbed dose of 1 rad in soft tissue.

rollup. The process for orderly dismantling of facilities no longer required for nuclear test operations and their transfer to other areas.

RSSU. Radiological Safety Support Unit (Army).

SA-16. Air Force general-purpose amphibian for air-sea rescue work. Manufactured by Grumman Aircraft Engineering Corporation, New York. Redesignated UY-16.

SAC. Strategic Air Command (Air Force).

sampler aircraft. Aircraft used for collection of gaseous and particulate samples from nuclear clouds to determine the level of radioactivity or the presence of radioactive substances.

SAR. Search and rescue operations.

SC. Sandia Corporation, Albuquerque, New Mexico.

scattering. The diversion of radiation (thermal, electromagnetic, and nuclear) from its original path as a result of interactions (or collisions) with atoms, molecules, or larger particles in the atmosphere or other media between the source of the radiations (e.g., a nuclear explosion) and a point some distance away. As a result of scattering, radiations (especially gamma rays and neutrons) will be received at such a point from many directions instead of only from the direction of the source. See also skyshine.

SCEL. Signal Corps Engineering Laboratories, Ft. Monmouth, New Jersey (Army).

scintillation. A flash of light produced by ionizing radiation in a fluor or a phosphor, which may be crystal, plastic, gas, or liquid.

seamount. A submarine mountain rising above the deep sea floor, commonly from 3,000 to 10,000 feet (1 to 3 km) and having the summit 1,000 to 6,000 feet (0.3 to 1.8 km) below sea level.

shear (wind). Refers to differences in direction (directional shear) of wind at different altitudes.

shielding. Any material or obstruction that absorbs (or attenuates) radiation and thus tends to protect personnel or equipment from the effects of a nuclear explosion. A moderately thick layer of any opaque material will provide satisfactory shielding from thermal radiation, but a considerable thickness of material of high density may be needed for gamma radiation shielding. See also attenuation.

shock. Term used to describe a destructive force moving in air, water, or earth caused by detonation of a nuclear detonation.

shock wave. A continuously propagated pressure pulse (or wave) in the surrounding medium, which may be air, water, or earth, initiated by the expansion of the hot gases produced in an explosion.

sievert (Sv). A recently introduced ICRP measure of "dose equivalent" that takes into account the Quality Factor of different sources of ionizing radiation. One sievert equals 100 rem.

SIO. Scripps Institution of Oceanography, La Jolla, California.

skyshine. Radiation, particularly gamma rays from a nuclear detonation, reaching a target from many directions as a result of scattering by the oxygen and nitrogen in the intervening atmosphere.

slant range. The straight-line distance of an aircraft at any altitude from surface zero or the distance from an airburst to a location on the ground.

SRI. Stanford Research Institute, Stanford, California.

stratosphere. Upper portion of the atmosphere, approximately 7 to 40 miles (11 to 64 km) above the Earth's surface, in which temperature changes but little with altitude and cloud formations are rare.

streamline. In meteorology, the direction of the wind at any given time.

surface burst. A nuclear explosion on the land surface, an island surface or reef, or on a barge.

surface zero. The point on the surface of land or water at, or vertically below or above, the center of the burst of a nuclear weapon.

survey meters. Portable radiation detection instruments especially adapted for surveying or inspecting an area to establish the existence and amount of radiation present, usually from the standpoint of radiological protection. Survey instruments are customarily powered by self-contained batteries and are designed to respond quickly and to indicate directly the exposure-rate conditions at the point of interest. See AN/PDR-36, Geiger-Mueller counter, and ion-chamber-type survey meter.

survey, radiation. Evaluation of the radiation hazards associated with radioactive materials.

T-AP. Personnel transport (Military Sea Transportion Service).

TAU. Test Aircraft Unit.

TBU. Test Base Unit.

TDY. Temporary duty assignment.

TG. Task Group.

TE. Task Element.

thermal radiation. Electromagnetic radiation emitted in two pulses from a surface or airburst from the fireball as a consequence of its very high temperature; it consists essentially of ultraviolet, visible, and infrared radiation. In the first pulse, when the temperature of the fireball is extremely high, ultraviolet radiation predominates; in the second pulse, the temperatures are lower and most of the thermal radiation lies in the visible and infrared regions of the spectrum.

thermonuclear fusion. Refers to the processes in which very high temperatures are used to bring about the fusion of light nuclei, such as those of the hydrogen isotopes (deuterium and tritium), with the accompanying liberation of energy. The high temperatures required to initiate the fusion reaction are obtained by means of a fission explosion. See also fusion.

TNT equivalent. A measure of the energy released as the result of the detonation of a nuclear device or weapon, expressed in terms of the mass of TNT that would release the same amount of energy when exploded. The TNT equivalent is usually stated in kilotons (thousands of tons) or megatons (millions of tons). The basis of the TNT equivalence is that the explosion of 1 ton of TNT is assumed to release 1 billion calories of energy. See also megaton, yield.

trapped radiation. Electrically charged particles moving back and forth in spirals along the north-south orientation of the Earth's magnetic field between mirror points, called conjugate points. Negatively charged particles drift eastward as they bounce between northern and southern conjugate points and positively charged particles drift westward, thus forming shells or belts of radiation above the Earth. The source of the charged particles may be natural, from solar activity (often called Van Allen belts), or artifical, resulting from high-altitude nuclear detonations.

tropopause. The boundary dividing the stratosphere from the lower part of the atmosphere, the troposphere. The tropopause normally occurs at an altitude of about 25,000 to 45,000 feet (7.6 to 13.7 km) in polar and temperate zones, and at 55,000 feet (16.8 km) in the tropics. See also stratosphere, troposphere.

troposphere. The region of the atmosphere, immediately above the Earth's surface and up to the tropopause, in which the temperature falls fairly regularly with increasing altitude, clouds form, convection is active, and mixing is continuous and more or less complete.

Trust Territory. The Marshall Islands were included in the Trust Territory of the Pacific Islands under the jurisdiction of the United Nations. Assigned by the United Nations to the United States in trust for administration, development, and training.

TU. Task Unit.

TSU. Test Services Unit.

TSUP. Test Support Unit (Provisional).

type commander. The officer or agency having cognizance over all Navy ships of a given type. This is in addition to the particular ship's assignment in a task force, fleet, or other tactical subdivision.

UCLA. University of California, Los Angeles.

UCRL. University of California Radiation Laboratory, Livermore, California.

UF-1. The Navy designation for the SA-16A.

UHF. Ultra-high frequency.

ultraviolet. Electromagnetic radiation of wavelengths between the shortest visible violet (about 3,850 angstroms) and soft X-rays (about 100 angstroms).

USFS. U.S. Forest Service.

USNS. United States Navy Ship; vessels of this designation are manned by civilian crews.

VA. Veterans, Administration.

VC. Fleet composite squadron, formerly VU (Navy).

versene. A detergent.

VHF. Very-high-frequency radio communications. The VHF band is from 30 to 300 kHz.

Viking. Radio call sign of VIP aircraft.

VP. Aviation patrol squadron (Navy).

VR. Air transport squadron (Navy).

WADC. Wright Air Development Center, Wright-Patterson AFB, Ohio (Air Force).

warhead. The portion of the missile or bomb containing the nuclear device.

WASP. Five-inch shells fired to spread radar-trackable material (window) to study high-altitude winds.

WB-29. Weather reconnaissance version of B-29 used for cloud tracking and sampling.

weapon debris. The radioactive residue of a nuclear device after it has been detonated, consisting of fission products, various products of neutron capture, weapon casing and other components, and uranium or plutonium that has escaped fission.

whole-body irradiation. Exposure of the body to ionizing radiation from external radiation sources. Critical organs for the whole body are the lens of the eye, the gonads, and the red-blood-forming marrow. As little as only 1 cm^3 of bone marrow constitutes a whole-body exposure. Thus, the entire body need not be exposed to be classed as a whole-body exposure.

Wilson cloud. A mist or fog of minute water droplets that *temporarily* surrounds a fireball following a nuclear detonation in a humid atmosphere. This is caused by a sudden lowering of the pressure (and temperature) after the passing of the shock wave (cloud chamber effect) and quickly dissipates as temperatures and pressures return to normal.

window. See WASP.

worldwide fallout. Consists of the smaller radioactive nuclear detonation particles that ascend into the upper troposphere and the stratosphere and are carried by winds to all parts of the Earth. The delayed (or worldwide) fallout is brought to Earth, mainly by rain and snow, over extended periods ranging from months to years.

WT. Prefix of Weapon Test (WT) report identification numbers. These reports were prepared to record the results of scientific experiments.

YAG. Miscellaneous auxiliary ship (Navy).

YC. Open lighter, non-self-propelled (Navy).

YCV. Aircraft transportation lighter, non-self-propelled (Navy).

YFN. Covered lighter, non-self-propelled (Navy).

YFNB. Large covered lighter (Navy).

yield. The total effective energy released in a nuclear detonation. It is usually expressed in terms of the equivalent tonnage of TNT required to produce the same energy release in an explosion. The total energy yield is manifested as nuclear radiation (including residual radiation), thermal radiation, and blast and shock energy, the actual distribution depending upon the medium in which the explosion occurs and also upon the type of weapon. See TNT equivalent.

yield (blast). That portion of the total energy of a nuclear detonation that is identified as the blast or shock wave.

yield (fission). That portion of the total explosive yield attributable to nuclear fission, as opposed to fusion. The interest in fission yield stems from the interest in fission product formation and its relationship to radioactive fallout.

YO. Fuel oil barge, self-propelled (Navy).

YOG. Gasoline barge, self-propelled (Navy).

YOGN. Gasoline barge, non-self-propelled (Navy).

YON. Oil storage barge, non-self-propelled (Navy).

ZI. Zone of Interior (conterminous United States).

APPENDIX C

ISLAND SYNONYMS

CAPITALIZED entries are the code names used by the joint task force for the islands. Underscored entries are the names of the islands as used in this report. All other entries are spellings of the islands that may appear in other literature.

Aaraanbiru	VERA - Alembel - Arambiru (Enewetak Atoll)
ABLE	Bokbata - Bokobyaada (Bikini Atoll)
Adrikan	YOKE - Arriikan (Bikini Atoll)
Aej	OLIVE - Aitsu (Enewetak Atoll)
Aerokoj	OBOE - Airukiiji (Bikini Atoll)
Aerokojlol	PETER - Airukiraru (Bikini Atoll)
Airukiiji	OBOE - Aerokoj (Bikini Atoll)
Airukiraru	PETER - Aerokojlol (Bikini Atoll)
Aitsu	OLIVE - Aej (Enewetak Atoll)
Alembel	VERA - Aaraanbiru - Arambiru (Enewetak Atoll)
ALFA	Bokaetoktok - Bokoaetokutoku (Bikini Atoll)
ALICE	Bokoluo - Bogallua (Enewetak Atoll)
ALVIN	Jinedrol - Chinieero (Enewetak Atoll)
Ananij	BRUCE - Aniyaanii (Enewetak Atoll)
Anerowij	TOM - Munjor - Munjur (Enewetak Atoll)
Aniyaanii	BRUCE - Ananij (Enewetak Atoll)
Aomen	GEORGE - Aomoen (Bikini Atoll)
Aomoen	GEORGE - Aomen (Bikini Atoll)
Aomon	SALLY (Enewetak Atoll)
Arambiru	VERA - Alembel - Aaraanbiru (Enewetak Atoll)
Arriikan	YOKE - Adrikan (Bikini Atoll)
BAKER	Bokonejien (Bikini Atoll)
BELLE	Bokombako - Bogombogo (Enewetak Atoll)
Bigiren	ROGER - Bikdrin (Bikini Atoll)
Biijiri	TILDA - Bijire - Bijile - Bikile (Enewetak Atoll)
Bijile	TILDA - Bijire - Biijiri - Bikile (Enewetak Atoll)
Bijire	TILDA - Bijile - Biijiri - Bikile (Enewetak Atoll)
Bikdrin	ROGER - Bigiren (Bikini Atoll)
Biken	LEROY - Rigile - Rigili (Enewetak Atoll)
Bikile	TILDA - Bijire - Bijile - Biijiri (Enewetak Atoll)
Bikini	HOW - (Bikini Atoll)
Billae	WILMA - Piiraai - Piirai (Enewetak Atoll)
Billee	LUCY - Kidrinen - Kirinian (Enewetak Atoll)
Bogairikk	HELEN - Bokaidrikdrik - Bogeirik - Bokaidrik (Enewetak Atoll)
Bogallua	ALICE - Bokoluo (Enewetak Atoll)
Bogan	IRWIN - Boken - Pokon (Enewetak Atoll)
Bogeirik	HELEN - Bokaidrikdrik - Bogairikk - Bokaidrik (Enewetak Atoll)
Bogen	REX - Jedrol - Jieroru (Enewetak Atoll)
Bogombogo	BELLE - Bokombako (Enewetak Atoll)

Bogon	IRENE - Boken (Enewetak Atoll)
Bokaetoktok	ALFA - Bokoaetokutoku (Bikini Atoll)
Bokaidrik	HELEN - Bokaidrikdrik - Bogairikk - Bogeirik (Enewetak Atoll)
Bokaidrikdrik	HELEN - Bogairikk - Bogeirik - Bokaidrik (Enewetak Atoll)
Bokandretok	WALT (Enewetak Atoll)
Bokbata	ABLE - Bokobyaada (Bikini Atoll)
Bokdrolul	BRAVO - Bokororyuru (Bikini Atoll)
Boken	IRENE - Bogon (Enewetak Atoll)
Boken	IRWIN - Pokon - Bogan (Enewetak Atoll)
Bokenelab	MARY - Bokonaarappu - Bokonarppu (Enewetak Atoll)
Bokinwotme	EDNA - Sanildefonso (Enewetak Atoll)
Boko	SAM (Enewetak Atoll)
Bokoaetokutoku	ALFA - Bokaetoktok (Bikini Atoll)
Bokobyaada	ABLE - Bokbata (Bikini Atoll)
Bokoluo	ALICE - Bogallua (Enewetak Atoll)
Bokombako	BELLE - Bogombogo (Enewetak Atoll)
Bokonaarappu	MARY - Bokenelab - Bokonarppu (Enewetak Atoll)
Bokonarppu	MARY - Bokenelab - Bokonaarappu (Enewetak Atoll)
Bokonejien	BAKER (Bikini Atoll)
Bokonfuaaku	ITEM (Bikini Atoll)
Bokororyuru	BRAVO - Bokdrolul (Bikini Atoll)
BRAVO	Bokdrolul - Bokororyuru (Bikini Atoll)
BRUCE	Ananij - Aniyaanii (Enewetak Atoll)
Buganegan	HENRY - Mut - Mui (Enewetak Atoll)
CHARLIE	Nam - Namu (Bikini Atoll)
Chieerete	WILLIAM - Jelete (Bikini Atoll)
Chinieero	ALVIN - Jinedrol (Enewetak Atoll)
Chinimi	CLYDE - Jinimi (Enewetak Atoll)
CLARA	Kirunu - Eybbiyae - Ruchi (Enewetak Atoll)
CLYDE	Jinimi - Chinimi (Enewetak Atoll)
Coca	(Bikini Atoll)
Cochita	DAISY - Louj - Lidilbut (Enewetak Atoll)
DAISY	Louj - Cochita - Lidilbut (Enewetak Atoll)
DAVID	Japtan - Muti (Enewetak Atoll)
DOG	Iroij - Yurochi (Bikini Atoll)
Drekatimon	OSCAR (Enewetak Atoll)
Dridrilbwij	GENE - Teiteiripucchi (Enewetak Atoll)
EASY	Uorikku - Odrik (Bikini Atoll)
Eberiru	RUBY - Eleleron (Enewetak Atoll)
EDNA	Bokinwotme - Sanildefonso (Enewetak Atoll)
Eleleron	RUBY - Eberiru (Enewetak Atoll)
Elle	NANCY - Yeiri (Enewetak Atoll)
ELMER	Parry - Medren (Enewetak Atoll)
Elugelab	FLORA - Eluklab (Enewetak Atoll)
Eluklab	FLORA - Elugelab (Enewetak Atoll)
Eneman	TARE - Eninman (Bikini Atoll)
Eneu	NAN - Enyu (Bikini Atoll)
Enewetak	FRED - Eniwetok (Enewetak Atoll)
Engebi	JANET - Enjebi (Enewetak Atoll)
Eniairo	KING (Bikini Atoll)
Enidrik	UNCLE - Eniirikku - (Bikini Atoll)

Eniirikku	UNCLE - Enidrik (Bikini Atoll)
Eninman	TARE - Eneman (Bikini Atoll)
Eniwetok	FRED - Enewetak (Enewetak Atoll)
Enjebi	JANET - Engebi (Enewetak Atoll)
Enyu	NAN - Eneu (Bikini Atoll)
Eybbiyae	CLARA - Kirunu - Ruchi (Enewetak Atoll)
FLORA	Eluklab - Elugelab (Enewetak Atoll)
FOX	Lomilik - Romurikku (Bikini Atoll)
FRED	Enewetak - Eniwetok (Enewetak Atoll)
GENE	Dridrilbwij - Teiteiripucchi (Enewetak Atoll)
GEORGE	Aomen - Aomoen (Bikini Atoll)
Giriinien	KEITH - Kidrenen - Grinem (Enewetak Atoll)
GLENN	Ikuren - Igurin (Enewetak Atoll)
Grinem	KEITH - Kidrenen - Giriinien (Enewetak Atoll)
HELEN	Bokaidrikdrik - Bogairikk - Bogeirik - Bokaidrik (Enewetak Atoll)
HENRY	Mut - Buganegan - Mui (Enewetak Atoll)
HOW	Bikini (Bikini Atoll)
Igurin	GLENN - Ikuren (Enewetak Atoll)
Ikuren	GLENN - Igurin (Enewetak Atoll)
Inedral	URIAH (Enewetak Atoll)
Ionchebi	MIKE (Bikini Atoll)
IRENE	Boken - Bogon (Enewetak Atoll)
Iroij	DOG - Yurochi (Bikini Atoll)
IRWIN	Boken - Bogan - Pokon (Enewetak Atoll)
ITEM	Bokonfuaaku (Bikini Atoll)
JAMES	Ribewon - Libiron - Ribaion (Enewetak Atoll)
JANET	Enjebi - Engebi (Enewetak Atoll)
Japtan	DAVID - Muti (Enewetak Atoll)
Jedrol	REX - Jieroru - Bogen (Enewetak Atoll)
Jelete	WILLIAM - Chieerete (Bikini Atoll)
Jieroru	REX - Jedrol - Bogen (Enewetak Atoll)
JIG	Yomyaran (Bikini Atoll)
Jinedrol	ALVIN - Chinieero (Enewetak Atoll)
Jinimi	CLYDE - Chinimi (Enewetak Atoll)
KATE	Mijikadrek - Mujinkarikku - Muzinbaarikku (Enewetak Atoll)
KEITH	Kidrenen - Giriinien - Grinem (Enewetak Atoll)
Kidrenen	KEITH - Giriinien - Grinem (Enewetak Atoll)
Kidrinen	LUCY - Billee - Kirinian (Enewetak Atoll)
KING	Eniairo (Bikini Atoll)
Kirinian	LUCY - Kidrinen - Billee (Enewetak Atoll)
Kirunu	CLARA - Eybbiyae - Ruchi (Enewetak Atoll)
Lele	SUGAR - Reere (Bikini Atoll)
LEROY	Biken - Rigile - Rigili (Enewetak Atoll)
Libiron	JAMES - Ribewon - Ribaion (Enewetak Atoll)
Lidilbut	DAISY - Louj - Cochita (Enewetak Atoll)
Lojwa	URSULA - Rojoa (Enewetak Atoll)
Lomilik	FOX - Romurikku (Bikini Atoll)
Louj	DAISY - Cochita - Lidilbut (Enewetak Atoll)

LOVE	Rochikarai (Bikini Atoll)
LUCY	Kidrinen - Billee - Kirinian (Enewetak Atoll)
Lujor	PEARL - Rujiyoru - Rujoru (Enewetak Atoll)
Lukoj	VICTOR - Rukoji (Bikini Atoll)
MACK	Unibor (Enewetak Atoll)
MARY	Bokenelab - Bokonaarappu - Bokonarppu (Enewetak Atoll)
Medren	ELMER - Parry (Enewetak Atoll)
Mijikadrek	KATE - Mujinkarikku - Muzinbaarikku (Enewetak Atoll)
MIKE	Ionchebi (Bikini Atoll)
Mui	HENRY - Mut - Buganegan (Enewetak Atoll)
Mujinkarikku	KATE - Mijikadrek - Muzinbaarikku (Enewetak Atoll)
Munjor	TOM - Anerowij - Munjur (Enewetak Atoll)
Munjur	TOM - Munjor - Anerowij (Enewetak Atoll)
Mut	HENRY - Buganegan - Mui (Enewetak Atoll)
Muti	DAVID - Japtan (Enewetak Atoll)
Muzinbaarikku	KATE - Mijikadrek - Mujinkarikku (Enewetak Atoll)
Nam	CHARLIE - Namu (Bikini Atoll)
Namu	CHARLIE - Nam (Bikini Atoll)
NAN	Eneu - Enyu (Bikini Atoll)
NANCY	Elle - Yeiri (Enewetak Atoll)
OBOE	Aerokoj - Airukiiji (Bikini Atoll)
Odrik	EASY - Uorikku (Bikini Atoll)
OLIVE	Aej - Aitsu (Enewetak Atoll)
Oroken	ZEBRA - Ourukaen (Bikini Atoll)
OSCAR	Drekatimon (Enewetak Atoll)
Ourukaen	ZEBRA - Oroken (Bikini Atoll)
Parry	ELMER - Medren (Enewetak Atoll)
PEARL	Lujor - Rujiyoru - Rujoru (Enewetak Atoll)
PERCY	Taiwel (Enewetak Atoll)
PETER	Aerokojlol - Airukiraru (Bikini Atoll)
Piiraai	WILMA - Billae - Piirai (Enewetak Atoll)
Piirai	WILMA - Billae - Piiraai (Enewetak Atoll)
Pokon	IRWIN - Boken - Bogan (Enewetak Atoll)
Reere	SUGAR - Lele (Bikini Atoll)
REX	Jedrol - Bogen - Jieroru (Enewetak Atoll)
Ribaion	JAMES - Ribewon - Libiron (Enewetak Atoll)
Ribewon	JAMES - Libiron - Ribaion (Enewetak Atoll)
Rigile	LEROY - Biken - Rigili (Enewetak Atoll)
Rigili	LEROY - Biken - Rigile (Enewetak Atoll)
Rochikarai	LOVE (Bikini Atoll)
ROGER	Bikdrin - Bigiren (Bikini Atoll)
Rojoa	URSULA - Lojwa (Enewetak Atoll)
Romurikku	FOX - Lomilik (Bikini Atoll)
RUBY	Eleleron - Eberiru (Enewetak Atoll)
Ruchi	CLARA - Kirunu - Eybbiyae (Enewetak Atoll)
Rujiyoru	PEARL - Lujor - Rojoru (Enewetak Atoll)
Rujoru	PEARL - Lujor - Rujiyoru (Enewetak Atoll)
Rukoji	VICTOR - Lukoj (Bikini Atoll)
Runit	YVONNE (Enewetak Atoll)

SALLY	Aomon (Enewetak Atoll)
SAM	Boko (Enewetak Atoll)
Sanildefonso	EDNA - Bokinwotme (Enewetak Atoll)
SUGAR	Lele - Reere (Bikini Atoll)
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Yomyaran	JIG (Bikini Atoll)
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University of Montana
ATTN: Documents Div

Moorhead State College
ATTN: Library

Mt Prospect Public Lib
ATTN: Librarian

Murray State Univ Lib
ATTN: Library

Nassau Library System
ATTN: Librarian

Natrona County Public Library
ATTN: Librarian

Nebraska Library Comm
ATTN: Librarian

Univ of Nebraska at Omaha
ATTN: Librarian

Nebraska Western College Library
ATTN: Librarian

Univ of Nebraska at Lincoln
ATTN: Director of Libraries

Univ of Nevada at Reno
ATTN: Governments Pub Dept

Univ of Nevada at Las Vegas
ATTN: Director of Libraries

New Hampshire University Lib
ATTN: Librarian

New Hanover County Public Library
ATTN: Librarian

Nebraska University Library
ATTN: Acq Dept

OTHER (Continued)

New Mexico State Library
ATTN: Librarian

New Mexico State University
ATTN: Lib Documents Div

University of New Mexico
ATTN: Director of Libraries

University of New Orleans Library
ATTN: Govt Documents Div

New Orleans Public Lib
ATTN: Library

New York Public Library
ATTN: Librarian

New York State Library
ATTN: Doc Control, Cultural Ed Ctr

New York State Univ at Stony Brook
ATTN: Main Lib Doc Sect

New York State Univ Col at Cortland
ATTN: Librarian

State Univ of New York
ATTN: Library Documents Sec

State Univ of New York
ATTN: Librarian

New York State University
ATTN: Documents Center

State University of New York
ATTN: Documents Dept

New York University Library
ATTN: Documents Dept

Newark Free Library
ATTN: Librarian

Newark Public Library
ATTN: Librarian

Niagara Falls Pub Lib
ATTN: Librarian

Nicholls State Univ Library
ATTN: Docs Div

Nieves M. Flores Memorial Lib
ATTN: Librarian

Norfolk Public Library
ATTN: R. Parker

North Carolina Agri & Tech State Univ
ATTN: Librarian

Univ of North Carolina at Charlotte
ATTN: Atkins Library Documents Dept

Univ of North Carolina at Greensboro, Library
ATTN: Librarian

OTHER (Continued)

North Carolina Central University
ATTN: Librarian

North Carolina State University
ATTN: Librarian

North Carolina University at Wilmington
ATTN: Librarian

University of North Carolina
ATTN: BA SS Division Documents

North Dakota State University Lib
ATTN: Docs Librarian

University of North Dakota
ATTN: Librarian

North Georgia College
ATTN: Librarian

North Texas State University Library
ATTN: Librarian

Northeast Missouri State University
ATTN: Librarian

Northeastern Illinois University
ATTN: Library

Northeastern Oklahoma State Univ
ATTN: Librarian

Northeastern University
ATTN: Dodge Library

Northern Arizona University Lib
ATTN: Government Documents Dept

Northern Illinois University
ATTN: Librarian

Northern Iowa University
ATTN: Library

Northern Michigan Univ
ATTN: Documents

Northern Montana College Library
ATTN: Librarian

Northwestern Michigan College
ATTN: Librarian

Northwestern State Univ
ATTN: Librarian

Northwestern State Univ Library
ATTN: Librarian

Northwestern University Library
ATTN: Govt Publications Dept

Norwalk Public Library
ATTN: Librarian

OTHER (Continued)

University of Notre Dame
ATTN: Document Center

Oakland Comm College
ATTN: Librarian

Oakland Public Library
ATTN: Librarian

Oberlin College Library
ATTN: Librarian

Ocean County College
ATTN: Librarian

Ohio State Library
ATTN: Librarian

Ohio State University
ATTN: Libraries Documents Division

Ohio University Library
ATTN: Docs Dept

Oklahoma City University Library
ATTN: Librarian

Oklahoma City University Library
ATTN: Librarian

Oklahoma Dept of Libraries
ATTN: U.S. Govt Documents

University of Oklahoma
ATTN: Documents Div

Old Dominion University
ATTN: Doc Dept Univ Library

Olivet College Library
ATTN: Librarian

Omaha Pub Lib Clark Branch
ATTN: Librarian

Oregon State Library
ATTN: Librarian

University of Oregon
ATTN: Documents Section

Ouachita Baptist University
ATTN: Librarian

Pan American University Library
ATTN: Librarian

Passaic Public Library
ATTN: Librarian

Paul Klapper Library
ATTN: Documents Dept

Pennsylvania State Library
ATTN: Government Publications Section

OTHER (Continued)

Pennsylvania State University
ATTN: Library Document Sec

University of Pennsylvania
ATTN: Director of Libraries

Penrose Library
University of Denver
ATTN: Penrose Library

Peoria Public Library
ATTN: Business, Science & Tech Dept

Free Library of Philadelphia
ATTN: Govt Publications Dept

Philipsburg Free Public Library
ATTN: Library

Phoenix Public Library
ATTN: Librarian

University of Pittsburg
ATTN: Documents Office G 8

Plainfield Public Library
ATTN: Librarian

Popular Creek Public Lib District
ATTN: Librarian

Association of Portland Lib
ATTN: Librarian

Portland Public Library
ATTN: Librarian

Portland State University Library
ATTN: Librarian

Prescott Memorial Lib
Louisiana Tech Univ
ATTN: Librarian

Princeton University Library
ATTN: Documents Division

Providence College
ATTN: Librarian

Providence Public Library
ATTN: Librarian

Cincinnati & Hamilton County Public Library
ATTN: Librarian

Public Library of Nashville and Davidson County
ATTN: Library

University of Puerto Rico
ATTN: Doc & Maps Room

Purdue University Library
ATTN: Librarian

OTHER (Continued)

Quinebaug Valley Community Col
ATTN: Librarian

Ralph Brown Draughon Lib
Auburn University
ATTN: Microforms & Documents Dept

Rapid City Public Library
ATTN: Librarian

Reading Public Library
ATTN: Librarian

Reed College Library
ATTN: Librarian

Reese Library
Augusta College
ATTN: Librarian

University of Rhode Island Library
ATTN: Govt Publications Office

University of Rhode Island
ATTN: Director of Libraries

Rice University
ATTN: Director of Libraries

Richard W. Norton Mem Lib
Louisiana College
ATTN: Librarian

Richland County Pub Lib
ATTN: Librarian

University of Richmond
ATTN: Library

Riverside Public Library
ATTN: Librarian

University of Rochester Library
ATTN: Documents Section

Rutgers University, Camden Library
ATTN: Librarian

Rutgers State University
ATTN: Librarian

Rutgers University
ATTN: Director of Libraries

Rutgers University Law Library
ATTN: Federal Documents Dept

Salem College Library
ATTN: Librarian

Samford University
ATTN: Librarian

San Antonio Public Library
ATTN: Bus Science & Tech Dept

OTHER (Continued)

San Diego County Library
ATTN: C. Jones, Acquisitions

San Diego Public Library
ATTN: Librarian

San Diego State University Library
ATTN: Govt Pubs Dept

San Francisco Public Library
ATTN: Govt Documents Dept

San Francisco State College
ATTN: Govt Pub Collection

San Jose State College Library
ATTN: Documents Dept

San Luis Obispo City-County Library
ATTN: Librarian

Savannah Pub & Effingham Libty Reg Lib
ATTN: Librarian

Scottsbluff Public Library
ATTN: Librarian

Scranton Public Library
ATTN: Librarian

Seattle Public Library
ATTN: Ref Doc Asst

Selby Public Library
ATTN: Librarian

Shawnee Library System
ATTN: Librarian

Shreve Memorial Library
ATTN: Librarian

Silas Bronson Public Library
ATTN: Librarian

Simon Schwob Mem Lib
Columbus College
ATTN: Librarian

Sioux City Public Library
ATTN: Librarian

Skidmore College
ATTN: Librarian

Slippery Rock State College Library
ATTN: Librarian

South Carolina State Library
ATTN: Librarian

University of South Carolina
ATTN: Librarian

OTHER (Continued)

University of South Carolina
ATTN: Government Documents

South Dakota Sch of Mines & Tech
ATTN: Librarian

South Dakota State Library
ATTN: Federal Documents Department

University of South Dakota
ATTN: Documents Librarian

South Florida University Library
ATTN: Librarian

Southdale-Hennepin Area Library
ATTN: Government Documents

Southeast Missouri State University
ATTN: Librarian

Southeastern Massachusetts University Library
ATTN: Documents Sec

University of Southern Alabama
ATTN: Librarian

Southern California University Library
ATTN: Documents Dept

Southern Connecticut State College
ATTN: Library

Southern Illinois University
ATTN: Librarian

Southern Illinois University
ATTN: Documents Ctr

Southern Methodist University
ATTN: Librarian

University of Southern Mississippi
ATTN: Library

Southern Oregon College
ATTN: Library

Southern University in New Orleans, Library
ATTN: Librarian

Southern Utah State College Library
ATTN: Documents Department

Southwest Missouri State College
ATTN: Library

Southwestern University of Louisiana, Libraries
ATTN: Librarian

Southwestern University School of Law Library
ATTN: Librarian

OTHER (Continued)

Spokane Public Library
ATTN: Reference Dept

Springfield City Library
ATTN: Documents Section

St. Bonaventure University
ATTN: Librarian

St. Joseph Public Library
ATTN: Librarian

St. Lawrence University
ATTN: Librarian

St. Louis Public Library
ATTN: Librarian

St. Paul Public Library
ATTN: Librarian

Stanford University Library
ATTN: Govt Documents Dept

State Historical Soc Lib
ATTN: Docs Serials Section

State Library of Massachusetts
ATTN: Librarian

State University of New York
ATTN: Librarian

Stetson Univ
ATTN: Librarian

University of Steubenville
ATTN: Librarian

Stockton & San Joaquin Public Lib
ATTN: Librarian

Stockton State College Library
ATTN: Librarian

Superior Public Library
ATTN: Librarian

Swarthmore College Lib
ATTN: Reference Dept

Syracuse University Library
ATTN: Documents Div

Tacoma Public Library
ATTN: Librarian

Tampa, Hillsborough County Public Lib
ATTN: Librarian

Temple University
ATTN: Librarian

Tennessee Technological University
ATTN: Librarian

OTHER (Continued)

University of Tennessee
ATTN: Dir of Libraries

Terteling Library
College of Idaho
ATTN: Librarian

Texas A & M University Library
ATTN: Librarian

University of Texas at Arlington
ATTN: Library Documents

University of Texas at San Antonio
ATTN: Library

Texas Christian University
ATTN: Librarian

Texas State Library
ATTN: U.S. Documents Sect

Texas Tech University Library
ATTN: Govt Docs Dept

Texas University at Austin
ATTN: Documents Coll

Texas University at El Paso
ATTN: Documents and Maps Lib

University of Toledo Library
ATTN: Librarian

Toledo Public Library
ATTN: Social Science Dept

Torrance Civic Center Library
ATTN: Librarian

Traverse City Public Library
ATTN: Librarian

Trenton Free Public Library
ATTN: Librarian

Trinity College Library
ATTN: Librarian

Trinity University Library
ATTN: Documents Collection

Tufts University Library
ATTN: Documents Dept

Tulane University
ATTN: Documents Dept

University of Tulsa
ATTN: Librarian

UCLA Research Library
ATTN: Public Affairs Svc/US Docs

OTHER (Continued)

Uniformed Svcs Univ of the Hlth Sci
ATTN: LRC Library

University Libraries
ATTN: Dir of Libraries

Upper Iowa College
ATTN: Documents Collection

Utah State University
ATTN: Librarian

University of Utah
ATTN: Special Collections

University of Utah
ATTN: Dept of Pharmacology
ATTN: Director of Libraries

Valencia Library
ATTN: Librarian

Vanderbilt University Library
ATTN: Govt Docs Sect

University of Vermont
ATTN: Director of Libraries

Virginia Commonwealth University
ATTN: Librarian

Virginia Military Institute
ATTN: Librarian

Virginia Polytechnic Inst Lib
ATTN: Docs Dept

Virginia State Library
ATTN: Serials Section

University of Virginia
ATTN: Public Documents

Volusia County Public Libraries
ATTN: Librarian

Washington State Library
ATTN: Documents Section

Washington State University
ATTN: Lib Documents Section

Washington University Libraries
ATTN: Dir of Libraries

University of Washington
ATTN: Documents Div

Wayne State University Library
ATTN: Librarian

Wayne State University Law Library
ATTN: Documents Dept

Weber State College Library
ATTN: Librarian

Wagner College
ATTN: Librarian

OTHER (Continued)

Wesleyan University
ATTN: Documents Librarian

West Chester State Coll
ATTN: Documents Dept

West Covina Library
ATTN: Librarian

University of West Florida
ATTN: Librarian

West Hills Community Coll
ATTN: Library

West Texas State University
ATTN: Library

West Virginia Coll of Grad Studies Lib
ATTN: Librarian

University of West Virginia
ATTN: Dir of Libraries

Westerly Public Library
ATTN: Librarian

Western Carolina University
ATTN: Librarian

Western Illinois University Lib
ATTN: Librarian

Western Washington Univ
ATTN: Librarian

Western Wyoming Community College Lib
ATTN: Librarian

Westmoreland Cty Comm Coll
ATTN: Learning Resource Ctr

Whitman College
ATTN: Librarian

Wichita State Univ Library
ATTN: Librarian

William & Mary College
ATTN: Docs Dept

William Allen White Library
Emporia Kansas State College
ATTN: Govt Documents Div

William College Library
ATTN: Librarian

Willimantic Public Library
ATTN: Librarian

Winthrop College
ATTN: Documents Dept

University of Wisconsin at Whitewater
ATTN: Governments Documents Library

OTHER (Continued)

Wisconsin Milwaukee University
ATTN: Librarian

Wisconsin Oshkosh University
ATTN: Librarian

Wisconsin Platteville University
ATTN: Librarian

Wisconsin University at Stevens Point
ATTN: Docs Section

University of Wisconsin
ATTN: Govt Pubs Dept

University of Wisconsin
ATTN: Acquisitions Dept

Worcester Public Library
ATTN: Librarian

Akron Public Library
ATTN: Govt Publication Librarian

Alabama St Dept of Archives & History
ATTN: Military Records Division

Atlanta University Center
ATTN: Librarian

OTHER (Continued)

Yale University
ATTN: Director of Libraries

Yeshiva University
ATTN: Librarian

Yuma City County Library
ATTN: Librarian

Wright State Univ Library
ATTN: Govts Documents Dept

Wyoming State Library
ATTN: Librarian

University of Wyoming
ATTN: Documents Div

University of Alabama
ATTN: Reference Dept/Documents

University of Alaska
ATTN: Director of Libraries

University of Alaska
ATTN: Govt Publication Librarian

Adams State College
ATTN: Govt Publication Library