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Record Number: 64

File Name (TITLE): Radiological Safety, Op. Ivy

Document Number (ID): WT-614

DATE: 11/1952

Previous Location (FROM): CIC

AUTHOR: JTF 132

Addditional Information:

OrMIbox: 4

CyMIbox: 2

WT-614

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Operation IVY

PACIFIC PROVING GROUNDS

November 1952

RADIOLOGICAL SAFETY

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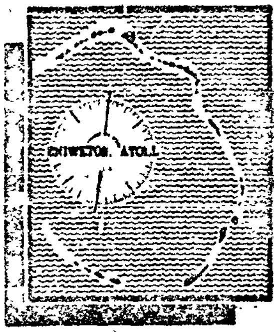

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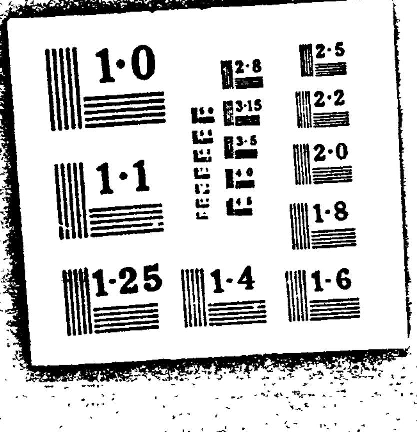

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Report to the Scientific Director

RADIOLOGICAL SAFETY

By

R. H. Maynard
Captain, U. S. Navy

and

J. D. Servis
Major, U. S. Army

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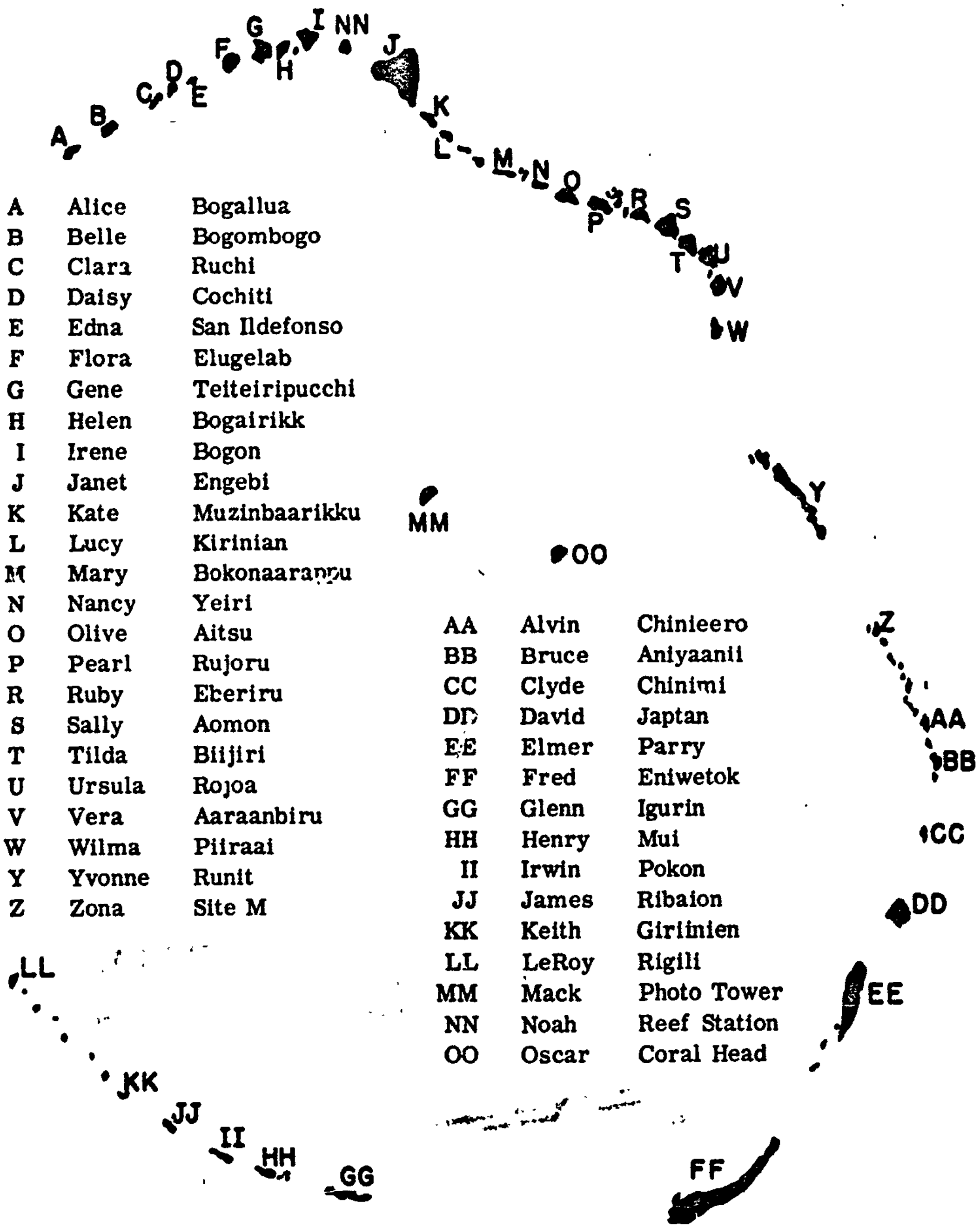

A	Alice	Bogallua
B	Belle	Bogombogo
C	Clara	Ruchi
D	Daisy	Cochiti
E	Edna	San Ildefonso
F	Flora	Elugelab
G	Gene	Teiteiripucchi
H	Helen	Bogairikk
I	Irene	Bogon
J	Janet	Engebi
K	Kate	Muzinbaarikku
L	Lucy	Kirinian
M	Mary	Bokonaarappu
N	Nancy	Yeiri
O	Olive	Aitsu
P	Pearl	Rujoru
R	Ruby	Eberiru
S	Sally	Aomon
T	Tilda	Biijiri
U	Ursula	Rojoa
V	Vera	Aaraanbiru
W	Wilma	Piiraai
Y	Yvonne	Runit
Z	Zona	Site M

AA	Alvin	Chinieero
BB	Bruce	Aniyaanii
CC	Clyde	Chinimi
DD	David	Japtan
EE	Elmer	Parry
FF	Fred	Eniwetok
GG	Glenn	Igurin
HH	Henry	Mui
II	Irwin	Pokon
JJ	James	Ribaion
KK	Keith	Girinien
LL	LeRoy	Rigili
MM	Mack	Photo Tower
NN	Noah	Reef Station
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ABSTRACT

This report contains a narrative description of the activities of Task Unit 7 (TU 7), the Radiological Safety (Rad-Safe) Unit f Task Group 132.1, during Operation Ivy. Chapters are devoted to the general discussion of the organization and activities of the scientific sections necessary to implement an atomic-test radiological-safety organization.

The appencices contain specific details of operational procedures.

Since radiological safety is a technical service and not a specific scientific program, objectives, procedures, and major results cannot be presented in abstract form other than to say that no serious radiation exposures occurred as a result of Operation Ivy.

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PREFACE

This documentation is intended both as a report on the accomplishments of Task Unit 7 (Radiological Safety) operating under Task Group 132.1, Joint Task Force 132, during Operation Ivy in the fall of 1952, and as a possible guide or source of information to personnel who may be detailed or ordered to organize or work with a similar organization in possible future operations of this nature.

This work cannot be rightly attributed to any one individual but has resulted from the whole-hearted cooperation and efforts of all the personnel in the unit.

ACKNOWLEDGMENTS

The Radiological Safety (Rad-Safe) Unit wishes to acknowledge the generous cooperation and service of the following experts, who served as technical advisers during Operation Ivy:

Dr. John C. Bugher, Director, Division of Biology and Medicine, AEC.

Dr. Thomas L. Shipman, Division Leader, Health Division, LASL.

CAPT Harry Haight, U. S. Navy, Assistant to Director, DMA.

Lt Col Gerald McDonnel, MC, U. S. Army, Weapons Defense Division, AFSWP.

Maj Payne Harris, MC, U. S. Army, Health Division, LASL.

Thomas N. White, Health Division, LASL.

Their experience and technical knowledge provided a background of confidence for the radiological-safety operations of the thermonuclear detonation.

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CHAPTER 1

TASK UNIT 7

In order to show fully the assigned mission, responsibilities, and functions of Task Unit 7 (TU 7), it is felt that in this portion of the report it would be advantageous to reproduce the directive which initiated the requirements. This is an extract from Annex H to Commander, Task Group 132.1 (CTG 132.1), Operations Order 1-52, dated 15 August 1952, and the subsequent Mike and King recovery-plan appendices to this annex which were added in the Forward Area (FA).

The extract follows:

1. General

a. A radiological safety unit (Task Unit-7) will be established within TG 132.1 to accomplish the missions of radiological safety ("Rad-Safe") specified in Annex P of CJTF 132 Operation Plan No. 2-52.

b. This Task Unit will operate a Rad-Safe center at Parry Island when the Task Group is ashore and aboard the USS Rendova when the Task Group is afloat.

c. This Task Unit will function as the technical Rad-Safe Unit for the Task Force.

2. Mission

The Rad-Safe Unit will provide for:

a. Radiological protection of TG 132.1 personnel.

b. Maintenance of Task Group operational efficiency in the presence of radiological hazards.

c. Technical assistance to Task Force and Task Group Commanders on matters pertaining to Rad-Safe.

3. Responsibilities

To effect accomplishment of the above mission, the Commander, Task Unit 7, will:

a. Organize and command a Rad-Safe Unit.

b. Perform all ground monitoring services associated with scientific missions as required, to include monitoring of water supplies at inhabited distant atolls and establishing suitable tables of allowable residual radiation levels for equipment, personnel, vehicles, boats, etc.

c. Furnish laboratory services and technical assistance to all task groups, to include:

(1) Procurement, storage, and issue of film badges and specified items of Rad-Safe personal equipment.

(2) Development and interpretation of exposed film badges.

(3) Maintenance of film badge exposure records.

(4) Provision of facilities at Parry Island Rad-Safe Building for:

(a) Calibration, repair, and maintenance of monitoring instruments and

(b) Storage and issue of spare parts for RADIAC equipment.

(5) Monitoring the removal and packaging of radioactive sources and samples.

d. Supply the Task Force and Task Group Commanders with post-shot surface situation maps as required.

e. Procure Rad-Safe clothing as required by TG 132.1 recovery personnel.

f. Procure and issue special high density goggles to specified personnel of JTF 132.

g. Provide technical personnel to inspect radiologically contaminated items for all task groups and certify destruction or disposal of same to JTF 132.

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h. Provide personnel and equipment decontamination facilities.

i. Conduct laboratory studies to determine the nature of radiological hazards.

j. Organize and maintain a Rad-Safe center on the USS Rendova.

k. Insure that all units comply with Rad-Safe regulations outlined in Appendix I.

l. Supervise and review reports of special radiological physical examinations for TG 132.1 personnel.

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CHAPTER 2

PROCUREMENT OF TEMPORARY-DUTY PERSONNEL

Since the period of operations of the Radiological Safety (Rad-Safe) Monitor Group was to be of short duration, it was decided to request support from the Armed Services and specified civilian installations. Civilian personnel, recognized experts in their field, were to be requested by name. Military personnel were to be selected by name and job requirement and with the purpose of extending the training of the military in Rad-Safe operations.

2.1 SOURCE OF PERSONNEL REQUIRED

Communications to each of the appropriate agencies were sent requesting the services of personnel for the operation, as follows:

2.1.1 U. S. Marine Corps

Radiological monitor (officer)	1
Radiological monitor (enlisted)	4

2.1.2 U. S. Army

Radiological monitors (officer)	7
Laboratory director	1 (SigC)
Laboratory technicians	4 (CmlC)
Supply clerks	2
Stenographer	1

2.1.3 U. S. Air Force

Radiological monitors (officer)	7
Radiological monitors (enlisted)	2
Photographic Assistants (photodosimetry)	4
Stenographer	1
Clerk typist	1

2.1.4 U. S. Navy

Radiological monitors (officer)	5
Electronics officer	1
Radiological instrument repairmen (electronic specialist)	3
Typist (yeoman)	1

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2.2 JOB DESCRIPTIONS

2.2.1 Officer Monitors

(a) Job Description. These officers serve as advisers and technical experts on all matters pertaining to the nonmedical aspects of radiological contamination. They assist project leaders in recovery plans for test equipment and make surveys of areas subjected to radiological contamination. They operate radiation-detection instruments and devices and assist in decontamination and laboratory operations.

(b) Qualifications Desired. Recent completion of a radiological-defense engineer course or experience as a radiological monitor at previous tests is desired.

2.2.2 Enlisted Monitors

(a) Job Description. Enlisted monitors perform surveys of areas subjected to radiological contamination. They operate radiation-detection instruments and devices to detect the presence of radiation in areas contaminated with radioactive materials and assist in decontamination operations as directed.

(b) Qualifications Desired. Previous experience at field tests or a graduate of a military Rad-Safe school is desired.

2.2.3 Laboratory Director

(a) Job Description. The laboratory director serves as technical director of the Rad-Safe laboratory. He supervises the assembly of technical information from radiochemical analyses to assist the commander in establishment of the true radiological hazards. He supervises the processing of film badges and the maintenance and repair of radiation-detection instruments.

(b) Qualifications Desired. Radiological-defense engineer training with experience in radiological-defense instrumentation is desired.

(c) Best Source. The U. S. Army Signal Corps Laboratories (Evans Signal Laboratory) or the U. S. Naval Radiological Defense Laboratory (NRDL) is the best source.

2.2.4 Laboratory Technicians

(a) Job Description. Laboratory technicians are selected enlisted personnel, specially trained in radiochemical analyses and radiation measurement, who will perform routine operations in laboratories assigned such functions.

(b) Qualifications Desired. Experience in civilian or military laboratories with commensurate educational background is desired.

(c) Best Source. The Chemical Corps Chemical and Radiological Laboratories, Army Chemical Center, Md., or NRDL, San Francisco, is the best source.

2.2.5 Photographic Assistants (Photodosimetry)

(a) Job Description. Photographic assistants are specialized photographic laboratory technicians who are skilled in the development of dental X-ray films, in the operation of film-density meters, and in the interpretation of readings.

(b) Qualifications Desired. Experience in a civilian or military health-physics laboratory or experience in a similar capacity at previous atomic-weapon tests is desired.

(c) Best Source. The Armed Forces Special Weapons Project (AFSWP) test groups stationed at Sandia Base are the best source.

2.2.6 Radiological-instrument Repairmen

(a) Job Description. These repairmen install, inspect, test, calibrate, maintain, and repair all types of radiological-detection instruments. They inspect and test devices in order to

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detect causes of faulty operation. They locate trouble and make the necessary repairs and adjustments on various types of survey meters, dosimeters, and allied equipment. They improvise or make substitutions for defective parts when exact replacements are not available.

(b) Qualifications Desired. Previous experience at atomic-weapon tests or laboratory experience in military atomic-defense schools is desired.

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CHAPTER 3

TRAINING AND INDOCTRINATION

This phase of TU 7 operations was divided into two parts: The first included the training of personnel to form a reserve pool of backup monitors whose function would be to perform the duties of monitors in the event that the regularly assigned monitor personnel received or approached the prescribed dosage limit for the operation. The second consisted of an indoctrination of TU 7 personnel in all phases of Operation Ivy.

3.1 TRAINING FOR BACKUP MONITORS

As mentioned above, it was necessary to conduct a series of lectures and practical exercises to qualify personnel in the duties of monitors for the various missions. Personnel were obtained from different units throughout the Task Force.

Those people who did not possess the training equivalent to that obtained in the Armed Forces six weeks course in atomic defense were required to take the training.

3.1.1 Training Subjects

The following subjects were included in the course of instruction:

(a) Introduction to Atomic Weapons — Conference (2 Hr). The scope of instruction included

1. Similarities and differences between atomic and high-explosive (HE) weapons.
2. Radioactivity, including concepts of half life and the nature of alpha, beta, and gamma emissions.
3. Methods of detection.
4. Theory of instrument operation through the discussion of the ionization of gases, and a correlation between this physical effect and the effect of ionization on the tissues of the human body.

(b) Instrumentation — Conference and Demonstration (1 Hr). The scope of instruction included

1. Cumulative-dosage types of instruments, i.e., film badges and dosimeters.
2. Dose-rate (intensity) types of radiac instruments, i.e., the AN/PDR-T1B and the IM-39/PD (Beckman MX-5).
3. Demonstration of these and other types of instruments, stressing the salient operational features of each.

(c) Calibration — Conference and Practical Exercise (3 Hr). Included in the scope of instruction were

1. Characteristics of instruments used by monitors.
2. Methodology of calibration.
3. Calculations involved in the use of standard radium sources.
4. Practical exercise using instruments and standard radium sources.

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(d) Monitoring—Conference and Practical Exercise (3 Hr). Included in the scope of instruction were

1. Definitions of terms encountered in monitoring procedures.

2. Discussion of the problems encountered in the different types of monitoring, i.e., air, ground, etc.

3. Practical monitoring exercise using appropriate instruments and sources, with the students plotting isointensity lines.

(e) Protective Clothing and Practical Decontamination—Conference and Demonstration (1 Hr). Included were a discussion of the theoretical nature of radioactive contamination, a discussion of the methods of decontamination to be used during Operation Ivy, and a demonstration of the protective clothing available and that to be used during the Operation whenever necessary.

(f) Monitor Responsibilities and Special Instructions Applicable to Operation Ivy.

3.2 IVY INDOCTRINATION

A primary responsibility, established at previous operations, of the Rad-Safe Unit is the training of personnel in the concept and principles of radiation safety. TU 7, as the principal technical Rad-Safe organization of Joint Task Force (JTF) 132, conducted a series of seminar discussions related to the technical operations involved in Operation Ivy. Recognized authorities within the Task Force were invited to address seminars related to their particular fields of interest. These guest discussion leaders presented short introductory lectures and then opened periods of guided discussion.

3.2.1 Seminar Subjects

(a) Concept of Operations. A presentation of the salient features of the FA operations was given. Pertinent features of the TG 132.1 Operations Order were discussed, along with the general plans for evacuation and reentry. Discussions pertaining to the general safety of personnel, ships, and aircraft were held. The Task Force organization was covered.

(b) Radiological-safety Operations. A presentation of the Task Force and Task Unit organization for radiation-safety operations was given. The nature of radiological hazards following the Mike and King detonations was discussed, and the radiological-safety regulations were reviewed. Discussions of the Mike and King recovery programs and of operations, both ashore and afloat, were included.

(c) Radiological Instrumentation. Included were discussions of field survey and personnel instruments, operational characteristics for humid and arid climatic conditions, laboratory instruments for test operations, NRDL instrument characteristics and operation, instrument calibration, and future instrumentation developments.

(d) Dosimetry. This subject covered photodosimetry and records procedures for the operation, film and dosimeter characteristics, and requirements and limitations.

(e) Communications. Rad-Safe radio networks, Rad-Safe codes, types of communications equipment, communications procedures, and field operations were included.

(f) Weather Relations. This subject covered atmospheric movements and fall-out considerations, calculation of radex from given wind conditions, and typical problems.

(g) Scientific Programs. Included were discussions of AEC and Department of Defense (DOD) projects participating in Operation Ivy, organization of programs, objectives and descriptions of projects, publications and expected dates of publications, and contributions of program and project monitors.

(h) Weapon Effects. This subject covered the family of weapons, general descriptions; blast, thermal, and nuclear radiation effects following atomic detonations; and scaling law applications and typical problems.

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(i) Mike and King Descriptive Material. The nature of the Mike and King devices and their detonations was discussed.

3.3 ADMINISTRATIVE DETAILS OF THESE PROGRAMS

The coordination of the activities discussed in Secs. 3.1 and 3.2 was accomplished by the Training Officer, a member of the Control Group. He contacted the necessary instructor personnel, scheduled the hours, and obtained locations and the necessary training aids and equipment to facilitate the execution of these programs.

3.4 RESULTS

Toward the end of the post-Mike period and just prior to King detonation, the services of many of the backup monitors were utilized. Some of these were men who acted specifically as monitors for missions, whereas others were volunteer scientific personnel on the project staff who acted as their own monitors for particular missions. This was quite helpful because many of the TU 7 monitor personnel had accumulated more than 2 r of exposure during the early post-Mike period; thus their services were made available on a standby basis rather than on an active basis. This also ensured an adequate supply of monitor personnel for the post-King period.

The orientation was successful in that, by giving a more complete picture of the operation, monitor personnel of TU 7 were able to plan their activities during the pre-Mike period more successfully. This knowledge was carried over into the activities of the post-Mike period and pre-King activities.

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CHAPTER 4

SUPPLY AND ADMINISTRATION

4.1 SUPPLY

Procurement of equipment presented problems that need to be considered between operations. Because of the temporary nature of Rad-Safe units, no table of required equipment was available prior to the organization of TU 7.

4.1.1 Methods of Procurement

Eight months prior to the operation a table of equipment was set up as a result of conferences with members of the Health Division, LASL, and examination of shipping documents of Operation Greenhouse. First estimates indicated a need for 13 tons of equipment occupying 5000 cu ft. These values proved to be somewhat high.

The following five procurement channels became apparent after study:

1. Equipment loan from Overseas Test Section, AEC, Los Alamos, N. Mex.
2. Equipment loan from H Division, LASL, Los Alamos, N. Mex.
3. Equipment loan from Weapons Effects Test Group, Field Command, AFSWP, Sandia Base, Albuquerque, N. Mex.
4. Outright purchase from funds of TG 132.1 by the Supply and Property Department, LASL.
5. Equipment loan and issue by supply agencies of the Department of the Army through action of the J-4 Section, JTF 132.

With a view to economy and utilization of available equipment, outright purchase from funds in the amount of $2500 was limited to nonmilitary expendable supplies, e.g., film badges and special envelopes.

All the above agencies were extremely cooperative in providing equipment for the overseas operation and contributed immeasurably to the success of the operation.

In the interests of economy, effort, and maintenance, it is feasible to recommend a consolidation of test operations equipment under one agency. This would relieve the several agencies of equipment storage between operations and would simplify overseas transportation problems. Such a consolidation could consider both overseas and continental test equipment.

4.1.2 Transportation

Task Unit equipment was shipped primarily by water two months prior to the operation and arrived without material loss or damage. Early establishment of a supply echelon in the FA facilitated the delivery of unit equipment. Ninety-five per cent of the equipment was on hand one month prior to the operation.

Two trailers, radiochemical and photodosimetric, were loaded on and off-loaded from the USS Rendova at the San Diego Naval Air Station prior to and after the operation. Electrical cable-connection troubles were solved en route to the FA by members of the unit.

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Task Unit equipment was returned by water and air. The use of a "transportainer" aided immeasurably in the packaging and shipping of material returned. This transportainer was utilized as additional storage space during the operation.

4.1.3 Issue and Receipt

Only 75 per cent of protective clothing and equipment issued was recovered. The procurement of class X clothing, color-marked shoes, and cheaper plastic goggles is strongly recommended.

Canvas bootees and gloves were discarded in contaminated areas, resulting in a high loss rate. This action limited the spread of contamination, especially within the helicopters, and was considered justifiable.

All equipment issue was made by hand receipt, and equipment clearance was required of all personnel departing from the area.

4.2 ADMINISTRATION

Administration was largely a function of the Deputy Commander owing to length of assignment and location. Early records and correspondence were maintained by LASL H Division personnel. Later administration was accomplished by unit clerical help in the FA. The one available clerk was overworked, and administrative efficiency was hampered. The suggested formation of a clerical pool did not materialize.

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CHAPTER 5

CONTROL GROUP

To provide for the radiological safety of all personnel entering radiologically contaminated areas, a Rad-Safe Control Group was organized. This organization consisted primarily of survey groups and escort monitors at Eniwetok, Kwajalein, and Ujelang atolls. One member was also added to the Scientific Group aboard the Scripps Institute vessel, Horizon.

5.1 FUNCTIONS

The Control Group station was established in the forward ready room of the USS Rendova while afloat and in the Rad-Safe office in Building 57 when ashore. Current radiological-situation maps were maintained at this station for the information of project leaders and escort monitors.

This station provided current information to the Rad-Safe Information Center (RIC) pertaining to the location of all monitors engaged in operations. It maintained an operations table of details on all missions into contaminated areas scheduled for each day, including name of monitor, destination, general type of mission, transportation, and time of departure and arrival.

This station constituted the clearance point for all working parties prior to entry into contaminated areas.

Monitors assigned to the various scientific parties were familiarized with the problems that might be expected to arise in each operation.

When necessary, survey teams monitored all islands and posted radiation-level signs in specified areas so that work teams could plan their activities without exceeding the allowable exposure. Areas with levels of radioactivity higher than 100 mr/hr were outlined and marked by warning signs. Resurveys were made at frequent intervals to reestablish the 100 mr/hr line. Entries beyond the 100 mr/hr line required escort by a monitor.

The Control Group Officer met initially with the Scientific Deputy of TG 132.1 daily to plan operations for the following day.

5.1.1 Results

The operating procedure (Appendix C) was adequate for the operation, although the communications broke down at several critical times. In two instances contact was lost with the initial helicopter survey because of last-minute frequency changes for which the helicopter had no crystal and because of the excessive use of the main communication channel by other agencies. This deficiency was corrected by installing a separate Rad-Safe channel.

The initial helicopter survey, which departed 10 min after Mike detonation, was aborted prior to accomplishment of the mission because it had become contaminated by radioactive fall-out in the upper lagoon. This indicated the fallacy of early initial surveys.

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The premise that administrative and laboratory personnel could serve as monitor personnel did not prove satisfactory; unit efficiency suffered when this occurred. Arrangements must be made to have sufficient monitor personnel readily available.

The use of the AN/PDR-T1B and the MX-5 survey meters proved adequate for monitoring of radioactivity. The Jasper type of ion-chamber survey instrument, when corrected for humidity leaks, proved satisfactory for test monitoring.

Correlation between readings of radiation intensities at 50-ft altitudes and at ground levels could not be obtained with a consistency that would establish a rule. In general, the intensities at 50 ft could be multiplied by a factor of 3 as an approximation of intensities on the ground. This could be said to be true of Mike shot and would not be applicable to other shots with different characteristics.

The use of H-19 helicopters proved to be of great aid in radiation survey and recovery. Their use permitted a maximum time within contaminated areas and a minimum time of transportation within contaminated areas.

5.2 KWAJALEIN ACTIVITIES

Representatives of the Control Group supervised the monitoring of samples removed from F-84 aircraft of Project 1.3, snap samples of Project 5.4b, and samples for Project 7.3. They were responsible for a special program of dosimetric measurements for pilots of the cloud-sampling aircraft. Three dosimeters and five film badges of separate design were used in this program. This was done in order to determine average radiation exposures and to evaluate the effectiveness of the lead suits worn by the pilots.

The Kwajalein Control Group assisted the AEC New York Operations Office in the preliminary phases of establishment of a radiation-survey system throughout the Marshall Islands.

This Group procured drinking-water samples from Ponape, Kusaie, Majuro, and Kwajalein before and after both shots and forwarded samples to the Radiological Field Laboratory for analysis.

They designated and instructed escort monitors for radiological-sample courier planes originating at Kwajalein.

5.2.1 Kwajalein Results

Sample removal from F-84 aircraft was accomplished without accident or incident. Rehearsal aided in efficient accomplishment of the mission. The dosimetric program was gratifying in its results and as a contribution to the future safety of cloud-sampling personnel.

Drinking-water samples from Bikini, Kusaie, Majuro, Ponape, and Kwajalein were found to be free of radioactive contamination, but the collection and transportation of samples was so slow that an adequate advisory service was not provided. This program will be reviewed prior to future test operations.

Escort monitoring of sample-return planes was abused in some cases and was used simply as a means of quick return to the United States. These monitors should be provided from the TG 132.1 Rad-Safe Unit and should be responsible for radiation safety aboard the plane from source to destination. These samples, when properly packaged for shipment, do not present radiation hazards to personnel but do present problems when crew and passengers are not properly indoctrinated.

5.3 UJELANG ACTIVITIES

Control Group personnel assisted the Commander in Chief Pacific (CinCPac) in the evacuation of natives from Ujelang by LST 827 by providing radiological-safety services of survey and sample collection.

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5.3.1 Evacuation

The evacuation of the natives of Ujelang from the atoll to the LST 827 and their subsequent return to the island were accomplished without mishap. The evacuation took place on the afternoon of Oct. 27, 1952, and on the morning of Oct. 28, 1952; the reentry into the island occurred on the afternoon of Nov. 2, 1952.

There was no radioactivity detected on the island by either the aerial survey or the ground monitoring of the area prior to the return of the natives. The ground survey which followed the aerial sweep was made on the morning of November 2 and was conducted using an MX-5, a T1B, and a PDR-10A. The beta and gamma instruments were used in monitoring about the general living area, and the alpha detector was employed in checking the water supply (rain water collected in cisterns) and spot checking the ground about the island. In addition, lagoon- and fresh-water samples and dirt samples were collected on November 2; these were examined by the laboratory aboard the USS Rendova, and no activity of any type was discovered.

While aboard ship and during periods of possible fall-out, the ship was monitored every hour to prevent radioactive contamination. If the ship had been subjected to fall-out, the Commanding Officer was advised of protective procedures, such as maintenance of tightness of topside and ventilation openings, utilization of a washdown system, and operation of decontamination stations. Film badges and dosimeters were ready for issuance to those liable to exposure; however, no activity was experienced during the entire operation.

Equipment of Merrill Eisenbud, New York Operations Office, Projects 5.3 and 5.4a, was placed about the island. These instruments were put into operation prior to departure from the area to the evacuation position designated by Commander, Hawaiian Sea Frontier (ComHawSeaFron) and re-collected as previously advised by the project leaders on November 2. As far as could be ascertained no fall-out activity was detected.

The movement of the natives to and from the island was somewhat complicated because of the depth of the water in the channels of the atoll and about the island of Ujelang, the home of the natives. A total of 157 people, including two women well advanced in pregnancy (these women had been previously evacuated by air), children of all ages, and several very elderly people, comprised the population of the two kingdoms of the island. The movement of people was made in several shuttles via outrigger canoes from the beach to the ship's boats in the lagoon and via the ship's boats to the ship, which maintained station at sea approximately 4000 yd from the channel nearest the island. The people were loaded on and off the ship via the bow doors and ramp. Difficulties in movement were also experienced by the ground monitor; before the survey could be made it was necessary for him to swim from the ship's boat in the deep water of the lagoon to the shore and to launch a native outrigger for return to the boat in order to pick up monitoring instruments. No rubber boat was available.

During their stay aboard the ship the natives seemed very happy and content once their siege of seasickness had passed. The children played on the tank deck; berthing spaces were set aside on the portside in the living compartments normally used by troops; and awnings were rigged topside on the main deck for their use. The food, with rice as the main staple of their diet, was consumed in large quantities, and both the young and the old were delighted with the serving of ice cream. The use of the ship's store was extended to the people. They attended movies at night. Upon their departure from the ship the natives were given canvas for mending sails, clothes that were donated and collected by personnel aboard ship, large amounts of line, and other items to augment their possessions on shore.

The operation was a success in every extent. The assistance of Jack Tobin, the Trust Representative, was invaluable in maintenance of relations with the people. The Commanding Officer of LST 827 was extremely solicitous of the welfare of the natives and carried out his mission of evacuation of the Ujelang Atoll in a very capable manner.

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5.4 HORIZON ACTIVITIES

Control Group personnel were provided the Scripps Institute vessel, Horizon, in a technical advisory capacity. Over-all radiological-safety supervision was a command responsibility of CTG 132.3.

The Horizon was to take station approximately 72 miles north of ground zero at H hour. This position was of concern since wind predictions indicated possibilities of fall-out at this position. As a consequence the following equipment was placed aboard: one MX-5, one AN/PDR-T1B, one AN/PDR-18, one portable air sampler, eight sets of protective clothing, eight sets of self-reading dosimeters, and enough film badges to supply the crew.

5.4.1 Horizon Results

At 1240M Nov. 1, 1952, during medium precipitation, radioactive fall-out was detected. The level was low, about 1 mr/hr at the time of detection. The ship was immediately closed up, and the ventilating system was stopped. The spray system was placed in operation, and the ship started circling its position. Within approximately 20 min the level of contamination had increased to an average gamma reading of 5 mr/hr and a maximum beta-gamma reading of 15 mr/hr A message was dispatched at 011327M to CTG 132.3 as follows: "Air Dry 5x, Bullseye 15x, circling on Station." At 011400M the ship changed course to 180° true, speed 11.5 knots, as directed by CTG 132.3. The contamination level gradually increased to an average gamma reading of 8 mr/hr and a maximum gamma reading of 35 mr/hr. The spray system was left on at full force as the ship continued on its course of 180° at full speed. At 011520M a message was dispatched to CTG 132.3 as follows: "Air Dry 8x, Bullseye 35x, condition stabilizing. Course 180° T, speed 11.5 knots. Will report when clear of fall-out area." At 011630M the ship stopped; its position was latitude 12°41′ north, longitude 163°05′ east. Two air samples which indicated no detectable activity in the air were taken. Inasmuch as precipitation had ceased, this was a reliable indication that the ship was clear of the fall-out area. A survey was made of the ship's deck which indicated a slight drop in the level of contamination. The following message was dispatched to CTG 132.3 at 011720M: "Air Dry 6x, Bullseye 30x. Air samples indicate we are clear of fall-out area. Lying to. Position Lat 12°41′ N, Long 163°05′ E." The ventilation system was placed in operation, and the ship was unbuttoned at approximately 011700M. With the exception of work parties, all personnel were ordered to stay inside the ship. The ship was washed down with a high-pressure hose which lowered the contamination level considerably. The washdown was completed by 011930, and the following message was dispatched to CTG 132.3 at 012015M: "Air Dry 3x, Bullseye 20x, washdown completed. Proceeding to Seamount 72." A message summarizing the above contamination levels was also dispatched to CTG 132.1 at 012045M. A constant vigilance was maintained throughout the night following M day and during M + 1 day. No further fall-out was encountered. A survey of the ship was made at 020700M which showed the average gamma reading to be 1 mr/hr and the maximum gamma reading to be about 10 to 12 mr/hr. Decontamination was attempted by high-pressure salt water washdowns and by tossing overboard those items that were highly contaminated, such as small pieces of rope and canvas that were of small value. All personnel involved in decontamination operations were carefully checked and decontaminated when necessary. Very little contamination was brought inside the ship. The estimated maximum integrated gamma dosage received by any individual aboard the Horizon was 50 mr.

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CHAPTER 6

LABORATORY GROUP

The laboratory procured, repaired, and maintained various radiological-safety instruments for the Task Group and furnished technical assistance to the instrument-repair stations of the Army, Navy, and Air Force task groups. It also processed and recorded film-badge exposures for all JTF 132 personnel. In addition it collected, interpreted, and disseminated radiochemical data for radiological-safety operations and documentation.

6.1 ELECTRONICS SECTION

The instrument-repair shop was located in the Rad-Safe Building on Parry Island when the Unit was ashore and in the Aviation Electronics Workshop when the Unit was aboard the USS Rendova.

The monitoring load fell on 50 T1B instruments that were on loan from AFSWP. These instruments had previously been switch modified at the Nevada Proving Grounds. This switch modification consisted in replacing the "leaf" type switch with a "two-wafer" rotary switch. Also, a flexible coupling was installed on the switch shaft between the electrometer section of the switch and the switch wafers. In addition, the electrometer section of the switch had the porcelain fingers between contacts removed and the electrometer switch rotor fastened to the shaft by means of a lucite ring. This eliminated switching transients resulting from change in scale.

Attempts to modify the electrometer switch wafers during this operation met with moderate success. One feature of significance was noted, i.e., the flexible shaft coupling is required to provide maximum stability and freedom from transients. The solid shaft extending to the switching knob from the electrometer switch wafer results in transients when handling the instrument case.

Major failures were experienced with the electrical meter movement. Of the 25 instruments consistently used in the field, 13 meter replacements were required. Minor failures of the lucite screw mounts, holding the chamber and electrometer circuit to the instrument panel, were noted. When the instrument was dropped or jarred, the lucite screw mounts carried away. It was necessary to provide metal stops from the panel to the chamber and to the electrometer circuit section to maintain maximum stability.

No major difficulties were experienced with the MX-5 instruments used for personnel monitoring and decontamination work. Several light-sensitive Geiger-Mueller (G-M) tubes were corrected.

The new lightweight type of ion-chamber instrument, IM-71/PD(XE-1), called the "Jasper," sponsored by the Army Signal Corps, initially developed humidity leaks but, after repair, functioned satisfactorily and was used as a replacement for the T1B.

One T1B was modified by cutting out a portion of the metal box and replacing the portion with aluminum foil. This permitted high-range measurement of the low-energy radiation,

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which was extremely prevalent following Mike detonation.

Major repair problems did not arise because instruments were provided in excess. Inoperative instruments were deadlined and returned to the United States for major repairs.

Alpha-radiation-detection instruments whose probes had been sealed against humidity leaks were adequate for this operation.

6.2 PHOTODOSIMETRY AND RECORDS SECTION

The responsibilities of this section were to

1. Issue, receive, process, and interpret all photographic film badges.
2. Issue, receive, read, and record all Task Group 132.1 (TG 132.1) personnel dosimeters.
3. Maintain records of exposures which will be available to proper authorities.
4. Forward photodosimetry reports to the appropriate service surgeon or civilian laboratory at the completion of the operation.
5. Forward processed film to AFSWP for final storage at the completion of the operation. A record of exposures will accompany this shipment.
6. Forward all film records to the Division of Biology and Medicine, AEC.

6.2.1 Operational Activities

Except for minor changes the procedures of photodosimetry were followed according to the operating procedure given in Appendix D. This procedure proved of great value in orienting all personnel and is suggested as a guide in the standardization of future test photodosimetry operations. Difficulties were experienced because of lack of space and a shortage of clerical help. Owing to difficulties of mixing, the use of Ansco developer did not prove as satisfactory as Kodak developer and fixer. An all-weather calibration site was sorely needed for long-period calibration exposures; use of an empty warehouse is not a reliable expedient.

6.2.2 Summary of Exposures

No serious overexposure of Task Force personnel was encountered, although several incidents of exposures exceeding the Task Force limit did occur.

Nineteen personnel of TG 132.4 participated in the flights of the C-54 and the SA-16 aircraft into the material falling from the Mike cloud within 1 to 2 hr after detonation. The SA-16 aircraft was engaged in search and rescue operations for which tolerance limits had been waived. The C-54 aircraft was engaged in photographic operations at altitudes which appeared to be less than 2000 ft and at times less than 1½ hr after detonation. This maneuver violated preshot instructions to fly the photographic mission at 5000 ft no earlier than 2 hr after detonation. The film-badge readings for these personnel varied from a low of 8.6 to a high of 17.8 r.

Two personnel of TG 132.1 exceeded the Task Force tolerance limit of 3.9 r during continued recovery operations following King shot. Both were minor in nature and less than 4.1 r.

No overexposures occurred within TG 132.2 or TG 132.3.

A total of 5000 film badges were utilized and processed during Operation Ivy.

6.3 RADIOCHEMICAL SECTION, LABORATORY GROUP

The mobile Radiological Field Laboratory, AN/MDQ-1(XE-3), designed by the Nucleonics Branch, Signal Corps Engineering Laboratories (SCEL), was assigned to the Rad-Safe group during Operation Ivy to participate in its health-physics program. The mission of the laboratory was to obtain information on the radiation hazards existing in airborne material, liquids, and solids to supplement the gamma-flux measurements obtainable by area surveys.

The samples received were assayed to determine the intensity of alpha, beta, and

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gamma radiations. In addition, beta and gamma energies and decay rates were determined as required. The techniques used are described in detail in the first draft of the "Manual for the Radiological Field Laboratory." Briefly, beta activities were determined with the end-window tubes, shielded in lead pigs, connected to either decade or binary scalers. Gamma activities were obtained with the same setup but with a lead-aluminum-lead sandwich between the sample and the detector to screen out the betas. This sandwich unavoidably absorbed some soft gammas. Calculations indicate that about 8 per cent of gammas with energies of 1.2 Mev and 50 per cent of gamma energies below 0.3 Mev are removed by the sandwich and are therefore included in the beta rather than in the gamma count. The reported beta and gamma activities should therefore be regarded as indicating soft and hard radiations, respectively, rather than strictly betas and gammas.

Alpha activities were measured with a scintillation probe coupled to a scaler. Beta energies were obtained by Feather analysis using aluminum absorbers, and gamma energies were determined by absorption with lead. Decay rates were determined by plotting beta-gamma activities as a function of time.

The accuracy of the data was ensured by calibration of the counting equipment with standard radioactive sources. Each setup was checked by a daily determination of its standard factor and a periodic chi-square analysis. The nine-tenths error of the raw count was maintained at a level below 1 per cent, whereas the over-all precision of the results was held to a maximum spread of ±5 per cent. Results were reported daily to RIC. Data on activities were turned in the same day that the samples were received.

Because of the evacuation of personnel from land bases for Mike shot, the field laboratory was stationed on the hangar deck of the USS Rendova, CVE 114. Electrical power and water were obtained from the ship. The operating personnel consisted of four enlisted men with chemical backgrounds provided by the Army Chemical Center and supervised by P. Shapiro, chemist from SCEL. Capt R. Dempsey, assigned to the Rad-Safe Unit from SCEL, was in charge of the laboratory. Since the enlisted men had no previous experience with this radiological laboratory, a 3-week training period was given in which practice exercises illustrating the techniques required during the operation were carried out.

6.3.1 Radiological Assays

The specific data obtained were reported as completed and will not be repeated here. A total of 275 samples were analyzed. Table 6.1 summarizes the types of samples assayed and the operations performed.

The airborne material analyzed was of three types. The first type was collected by a vacuum-operated air filter, run continuously just outside the field laboratory, sampling air from the hangar deck of the USS Rendova. No significant radioactivity was found here. The second type was obtained from portable air samplers. One stationed on the flight deck of the USS Rendova after Mike shot showed no radioactivity. Another, carried during an aerial survey immediately after Mike shot, showed significant beta and gamma but no alpha activity (see Table 10.27). The third type was taken from filters in aircraft which had flown through the cloud resulting from Mike shot. These showed extremely high beta counts and considerable gamma activity but no significant alpha activity.

Cascade-impactor samples were assayed to obtain information on the activity present in various particle sizes of airborne particulate matter. One series taken immediately after Mike shot showed beta and gamma activity on all stages, with most of the activity on slides 3 and 4. Another series taken M + 6 day showed only beta activity, most of which was found on slides 2 and 3 and on the filter paper beyond slide 4.

As can be seen from Table 6.1, most of the samples analyzed were sea water taken at various stations in Eniwetok Lagoon at two levels, at the surface and at a depth of 30 ft. The results obtained were utilized by TG 132.3 to govern the return of naval vessels into the lagoon after the evacuation and to control the intake water to evaporators on the ships.

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Table 6.1—SUMMARY OF RADIOLOGICAL ASSAYS

	Alpha	Beta	Gamma	Energy	Decay rate
Airborne					
Filter	7	7	7	3	2
Cascade impactor	10	10	10		
Water					
Sea	205	205	205	2	1
Fresh	36	36	36		
Solid					
Swipes	17	17	17	2	
Evaporator deposits	3	3	3		
Soil	5	7	7	4	2
Food	3	3	3		
Total	286	288	288	11	5

Sea water was also assayed regularly at the bathing beach off Elmer; the results indicated that the facilities were safe for swimming. In addition, radioassays of sea water were utilized to indicate hazards that might be encountered in shallow-water diving operations required for recovery of equipment.

Drinking water was monitored before and after Mike shot at various installations on Eniwetok Atoll and at Kusaie, Majuro, Ponape, Kwajalein, and Bikini islands. No radiation hazards were found in any drinking-water samples.

Various types of solid samples were assayed. Swipes taken aboard the USS Rendova and other ships after Mike and King shots indicated the amount of fall-out and the success of decontamination operations. Analyses of deposits from the evaporators on the USS Rendova were negative, whereas similar samples taken from the USS Lipan showed positive but low beta activity. A number of soil samples were obtained from various islands and were assayed in conjunction with recovery-party operations. Although considerable beta and gamma activities were found in some instances, no alpha hazard was recorded. Food taken from the drier operating on Yvonne after Mike shot showed no activity and could thus be used safely.

6.3.2 Evaluation of the Field Laboratory

In general, the laboratory successfully performed the mission assigned to it; the work load was well within its capacity. On a one-shift basis it could have handled at least twice as many samples had the need arisen. However, the following general comments are included for consideration in the event a laboratory of this type is to be used on future operations.

Considerable maintenance was required on the electronic equipment within the laboratory. An electronic engineer should be included as a member of the operational team for the laboratory to expedite needed repairs.

A definite need exists for the ability to differentiate between the radioactivity due to hard betas and soft gammas. Present results indicate that most of the gamma activity in residual radiation is quite soft and is absorbed when betas are filtered out in a differential count.

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CHAPTER 7

DECONTAMINATION GROUP

The Decontamination Group provided the necessary installations and operations for protection of personnel against the effects of radiological contamination outside the area of contamination. They did so by providing personnel-decontamination stations, equipment-decontamination areas, and entry and exit check points.

They established a personnel-entry and -departure control system to ensure a regulated procedure of decontamination. They prescribed appropriate decontamination techniques for naval task elements and lent technical assistance to Holmes and Narver (H&N) personnel in the decontamination of heavy equipment.

7.1 ACTIVITIES

The activities of this Group were divided into several phases:

1. Equipment decontamination. A control check point was established at the boat landing just north of the personnel pier on Parry Island. Departing vehicles had their interior surfaces lined with paper. All landing craft with vehicular or other mobile equipment were instructed to land at the designated boat landing, where the control officer of the check point monitored the equipment. If it was "clean," the equipment was moved to its destination; if it was contaminated, the equipment was moved to the decontamination area just above the landing area, where decontamination procedures were applied. Steps consisted in removing paper lining (when applicable), sweeping, and hosing with high-pressure water jets from the decontamination apparatus. If these procedures were successful, the equipment was released for removal to its destination. If the procedures were unsuccessful, the equipment was moved to the contaminated storage area in the field just north of the Rad-Safe Building on Parry Island. Work was accomplished by the decontamination team, which consisted of three enlisted men. This team worked at all decontamination areas on call from the appropriate control-check-point officer.

2. Small boats. In general, the same methods were used for small boats, with the exception that paper lining was not used.

3. Aircraft. A control check point was established at the airstrip on Parry Island. Aircraft departing on missions into highly contaminated areas had their interiors lined with paper. On return from a mission the paper liners were removed as required, and the interiors were cleaned by brushes and industrial-type vacuum cleaners.

4. Personnel. Prior to departure of personnel for the contaminated areas, complete suits of protective clothing were donned. This outfit consisted of the following:

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1 fatigue hat
1 pair of coveralls
1 pair of Rad-Safe socks
1 pair of Rad-Safe shoes
1 pair of bootees for each embarkation and disembarkation of personnel to and from aircraft or vehicle, etc.
1 pair of appropriate gloves (cotton, surgical, work, etc.)
1 respirator (to be worn if needed)

Insistence was made on the use of Rad-Safe socks and shoes so that, in the event of contamination, no personal clothing would be lost. All items of clothing found contaminated were confiscated by the Decontamination Group. For personal items this necessarily involved administrative procedures which were undesirable.

On return from a mission the vehicle, boat, or aircraft was met at the check point by the check-point officer, the personnel were monitored, and appropriate instructions were issued. By means of signs and verbal instructions, personnel were guided to the personnel-decontamination station in the south end of the Rad-Safe Building on Parry Island. This center was located very conveniently near each of the check points so that "tracking" of contamination was held to a minimum. On entrance into the center, personnel disrobed, discarded protective clothing and items of equipment into the appropriately marked containers, showered, and then passed into the drying room, where they were again monitored. If "clean," they passed into the "clean" change room, retrieved their personal clothing, dressed, and returned to their organization. If found still contaminated, they were returned to the shower. In several cases, localized "hot" spots were found on the body extremities; these were safely decontaminated by applying a hand brush and more soap.

Various chemical solutions and complexing agents were available to aid in the decontamination, but their use was not necessitated.

7.2 RESULTS

After bathing, no cases of lingering contamination were noted. In several instances, where vehicles and/or equipment were found to be above the permissible limits, storage in the contaminated storage area allowed this contamination to decay to within permissible limits within a very few days. In no case was any item of equipment "deadlined" for more than five days as a result of its being a radiological hazard.

Contaminated clothing and personal equipment were allowed to decay to within permissible limits and were then laundered. Shoes were cleaned by brushing with a stiff-bristle brush. No cases of contaminated respirators were noted.

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CHAPTER 8

RADIOLOGICAL-SAFETY INFORMATION CENTER

As a center of, and as a rigid control of dissemination of, necessary radiological information following each of the detonations, an information center was established. Sources of information were the Rad-Safe Control Group, the Laboratory Group, Task Group Rad-Safe officers, and the Task Force Rad-Safe Office. This Center coordinated and consolidated information for use of Task Force and Task Group commanders in the determination of R hour.

The radiological-safety information was maintained on daily situation maps, laboratory reports, and radex charts. Information summaries were prepared at the completion of the day and prior to recovery conferences for the following day.

The RIC was established in the Air Intelligence Office aboard the USS Rendova on MX – 1 day. It continued operations from this point until reentry was completed on M + 2 day. From M + 2 until K + 7 days this Office was maintained in the Rad-Safe Building on Parry Island.

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CHAPTER 9

SPECIAL RADIOLOGICAL-SAFETY MISSIONS

Special monitoring service was required for transport of radioactive samples to the United States and for tritium transfer during the preshot operations.

9.1 SAMPLE TRANSPORT

JTF 132, by means of Operations Order 2-52, designated CTG 132.1 as the responsible agent for radiological safety of personnel transporting radioactive samples to the United States. To implement this directive, the Kwajalein Control Group officer was delegated the responsibility for radiological safety of personnel transporting radioactive samples. He monitored the collection of samples from test aircraft, the packaging of these samples, and the loading of these samples on Military Air Transport Service (MATS) aircraft. He obtained monitor escorts for each plane.

9.1.1 Results

Owing to a shortage of available monitors and to deviations from scheduled shipments, difficulties were experienced during post-Mike shipments. For example, an incident occurred in which a monitor obtained to escort a shipment left the aircraft prior to the arrival of the radioactive shipment at its destination with the statement that he was relieved to get away from the shipment. The psychological impact of this statement upset the aircraft crew to the extent that they felt their welfare was being endangered during the remainder of the trip and so reported on arrival at the home station.

The shipment was packaged so as to eliminate a radioactive hazard and did not present a hazard in this incident, but the circumstances surrounding the action point out a need for a specific group of sample-return monitors responsible to the Rad-Safe Unit for the safe delivery of samples.

The remaining eight shipments were returned to Los Alamos, Baltimore, and Boston without incident.

9.1.2 Tritium Monitoring

In order to provide for a radiation-safety program during the preshot interval of preparation, Joe B. Webber of H-1 Group, LASL, was designated as special monitor for the tritium-transfer phases of the operation. His equipment, which consisted of modified air-flow ionization chambers and portable urinalysis sets, aided in the control of the tritium hazards within the cab. No exposures or incidents occurred during this critical operation.

Fortunately the tritium monitoring occurred prior to any detonations; therefore airborne residual activity did not discharge the detection elements. A more versatile field detection instrument is desirable.

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CHAPTER 10

RADIOLOGICAL-SURVEY RESULTS

10.1 MIKE SHOT

Location: Elugelab Island (Flora), Eniwetok Atoll.
Height of burst: Ground surface.
Yield: 6 to 12 Mt.
Time fired: 0715, Nov. 1, 1952.

10.1.1 Cloud Disposition

Twenty-four-, forty-eight-, and seventy-hour trajectories indicated a column of air 3 miles in height, from 40,000 to 55,000 ft, moving generally east under the tropopause. Below this altitude the cloud column was forecast to move generally west-northwest, whereas, above the tropopause, cloud parcels were forecast to move west.

The final observed wind pattern placed all fall-out north of ground zero. Air radex gave an exclusion area bearing clockwise 280° true to 090° true.

At H + 70 min the atomic cloud had reached an altitude greater than 120,000 ft and, in its rapid climb, was forced to billow out at the tropopause level, although continuing to rise to a still greater height. This billowing-out effect reached a distance of 30 miles in diameter in approximately 40 min and resulted in fall-out as far south as a line between Runit and Rigili islands (10 miles).

The wind pattern for this shot was nearly ideal from the Rad-Safe standpoint.

10.1.2 Ground Contamination

An initial aerial-survey helicopter became contaminated from radioactive "rain-out" at H + 40 min in the vicinity of Piiraai Island. This rain-out was distinctly muddy in appearance and left a residual contamination of 2 r/hr at H + 1 hr on the aircraft.

A damage survey at H + 4 hr revealed some approximate intensities at Engebi, Bogon, and Bogallua. Readings on an AN/PDR-T1B meter in a helicopter 150 ft above the center of Engebi were greater than 50 r/hr. Similar readings 500 ft above the blockhouse on Bogon were 10 r/hr. Similar readings above the blockhouse at Bogallua at an altitude of 1500 ft were 2.5 r/hr.

A complete atoll survey was accomplished by helicopter at H + 24 hr and indicated contamination of all northern and western islands. The islands of Chinieero, Aniyaanii, Chinimi, Japtan, Parry, and Eniwetok were found free of contamination. These helicopter readings at 25 ft, when multiplied by a factor of 3, gave an approximation of ground readings. The relation between the 25-ft and the ground readings varied between 2 and 4; therefore this factor could not be considered absolute (Fig. 10.1).

Self-decontamination of the islands was accomplished by radioactive decay and weathering (Tables 10.1 to 10.25). Weathering effects were most apparent during the first four to five

(Text continues on page 65.)

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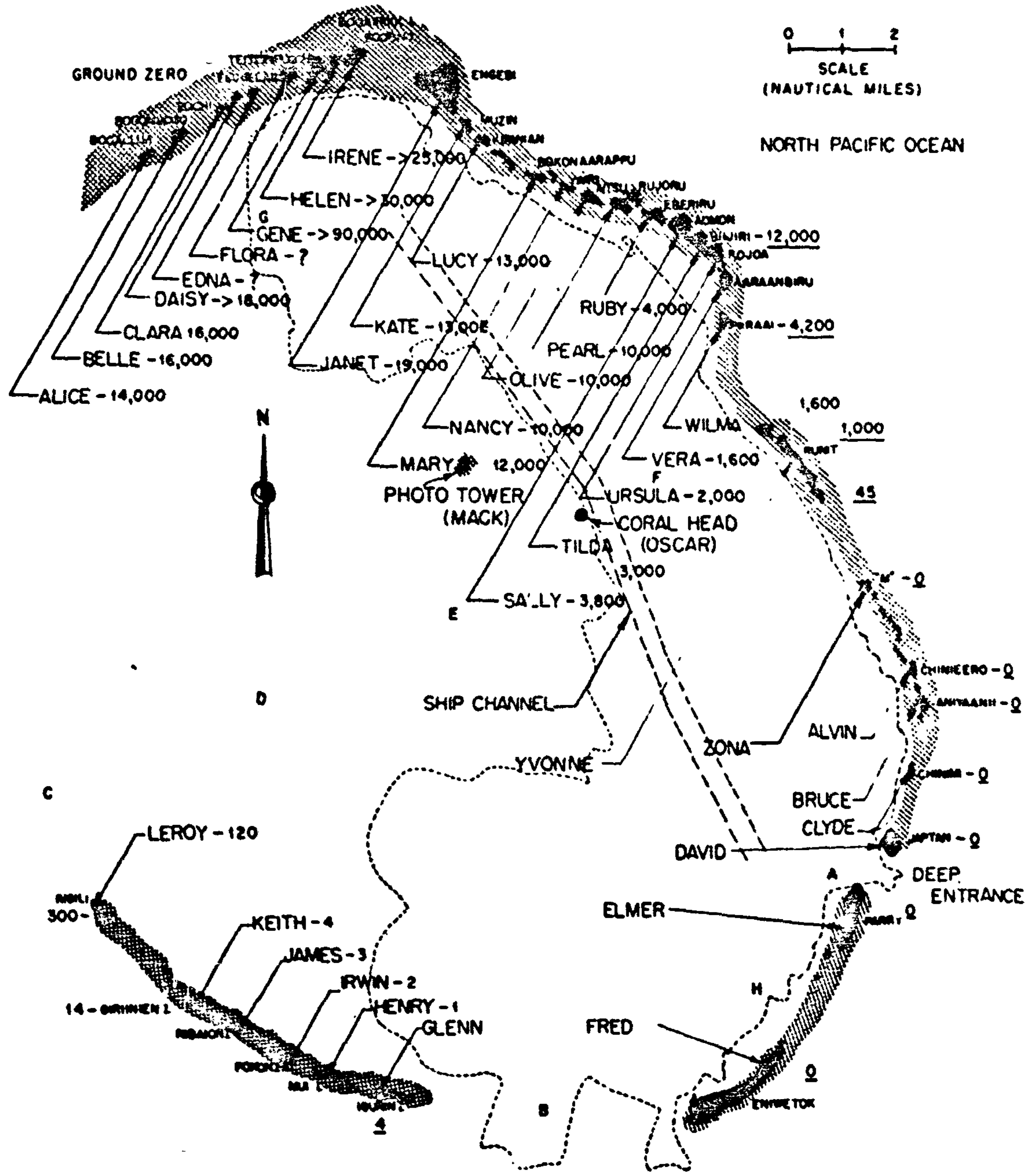

Fig. 10.1—Mike shot, H + 24 hr. Underlined readings are ground values in milliroentgens per hour; other readings are helicopter readings 25 ft above ground in milliroentgens per hour.

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Table 10.1—ALICE (BOGALLUA)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
1 Nov.	1300		2,500	1,500 ft, east side
			1,200	1,500 ft, west side
			7,000	1,500 ft, center
			400	1,500 ft, lagoon
2 Nov.	0700		14,000	
3 Nov.	0800	22,000		
	1230	18,000		
4 Nov.	0830		10,000	Island center
			6,000	Inner reef
5 Nov.	0830	10,000	3,000	
6 Nov.	0815	5,000		Island center
7 Nov.	0800	3,900	1,500	Island center
8 Nov.	0815	3,500	1,400	Island center
9 Nov.	0805	2,800	1,300	Island center
10 Nov.	0815	2,200	800	Island center
11 Nov.	0815	1,700		Island center
12 Nov.	1630	2,100	800	Doubtful values
14 Nov.	0830	1,400	800	Island center
15 Nov.	0815		850	Radiation spotty at this time
16 Nov.	1230		750	King day
	1630		500	
17 Nov.	0830	1,400	440	
18 Nov.	0810	1,000	500	
19 Nov.	0900		210	
21 Nov.	1000	810		
1953				
3 Jan.		150		
9 Feb.		10–100		Radiation varies with location, weathering causes changes in concentration

*3 nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings of greater than 2300 r/hr would have existed at H + 1 hr. Limited recovery (10 min) could commence at H + 36 hr.

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Table 10.2—BELLE (BOGOMBOGO)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0700		16,000	Island center
3 Nov.	0757		8,000	Island center
4 Nov.	0827		10,000	Island center
5 Nov.	0827	10,000	3,800	Island center
6 Nov.	0812	7,000		
7 Nov.	0757	4,500	1,500	Island center
8 Nov.	0812	3,600	1,400	Island center
9 Nov.	0802		1,400	Island center
10 Nov.	0812	2,400	1,000	Island center
11 Nov.	0812		700	Island center
12 Nov.	1627	1,950	900	Island center
14 Nov.	0827		1,000	Island center
15 Nov.	0812		900	Island center
16 Nov.	1227	1,200	900	Island center
17 Nov.	0827		500	Island center
18 Nov.	0807	1,000	450	Island center
19 Nov.	0857		260	Island center
21 Nov.	0957	800		Island center
1953				
3 Jan.		180		Island center
9 Feb.		80–90		Island center

*2¼ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 2500 r/hr would have existed at H + 1 hr. Limited recovery (10 min) could commence at H + 38 hr.

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Table 10.3 — CLARA (RUCHI)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0657		16,000	Island center
3 Nov.	0754		9,000	Island center
4 Nov.	0824		9,000	Island center
5 Nov.	0824		3,400	Island center
6 Nov.	0809		4,000	Island center
7 Nov.	0754		1,400	Island center
8 Nov.	0809		1,600	Island center
9 Nov.	0759	2,500	1,300	Island center
10 Nov.	0809	2,600	800	Island center
11 Nov.	0808		425	Island center
12 Nov.	1624		700	Island center
14 Nov.	0822		1,000	Variable radiation levels on island
15 Nov.	0808		800	Variable radiation levels on island
16 Nov.	1224		400	Variable radiation levels on island
17 Nov.	0824		420	Variable radiation levels on island
19 Nov.	0854		180	Variable radiation levels on island
21 Nov.	0954	700		Variable radiation levels on island
1953				
3 Jan.		150		Variable radiation levels on island
9 Feb.		10–90		Variable radiation levels on island

*1½ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 2500 r/hr would have existed at H + 1 hr. Limited recovery (10 min) could commence at H + 38 hr.

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Table 10.4—DAISY (COCHITI)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
3 Nov.	0751		8,000	Island center
4 Nov.	0821		10,000	Island center
5 Nov.	0820		6,000	Island center
6 Nov.	0806	7,000		Island center
7 Nov.	0751	5,700	2,000	Island center
8 Nov.	0805	4,500	1,800	Island center
9 Nov.	0756	3,300	1,500	Island center
11 Nov.	0806		800	
12 Nov.	1623	2,200	700	Island center
14 Nov.	0820		1,000	Radiation varies with location
15 Nov.	0804		1,000	Radiation varies with location
16 Nov.	1235	1,400	800	Radiation varies with location
17 Nov.	0820		700	Radiation varies with location
19 Nov.	0850		700	Radiation varies with location
21 Nov.	0950	900		Radiation varies with location
1953				
3 Jan.		200		Radiation varies with location
7 Feb.		10–200		Radiation varies with location

*1 nautical mile from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 2500 r/hr would have existed at H + 1 hr. Limited recovery (10 min) could commence at H + 38 hr.

[redacted]

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Table 10.5—EDNA (SAN ILDEFONSO)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
4 Nov.	0816	26,000	6,000	Island center
5 Nov.	0817	20,000		Island center
8 Nov.	0800		6,000	Island center
9 Nov.	0751		3,300	Island center
10 Nov.	0805	8,000	3,000	Island center
11 Nov.	0801		3,800	Island center
14 Nov.	0815		2,200	Island center
15 Nov.	0800		2,200	Island center
16 Nov.	1230		2,000	Island center
17 Nov.	0810	2,800	1,200	Island center
21 Nov.	0945	1,700		Island center
1953				
3 Jan.		500–1600		Island center
7 Feb.		100–1000		Island center

*$^3/_4$ nautical mile from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 4500 r/hr would have existed at H + 1 hr. Limited recovery (10 min) could commence at H + 75 hr.

Table 10.6—FLORA (ELUGELAB)*†

Date	Time	Surface reading, mr/hr	Air reading, mr/hr	Remarks
1952				
3 Nov.	0813		8000	50 ft over water
5 Nov.	0813		14	25 ft over water
7 Nov.	0748		20	25 ft over water
8 Nov.	0754		10	25 ft over water
9 Nov.	0748		20	25 ft over water
16 Nov.	1630	7	2	25 ft over water
18 Nov.	0804		1	25 ft over water
19 Nov.	0847		2	25 ft over water

*Ground zero.

†Crater began to fill shortly after detonation; thus radioactivity of the crater bottom began to diminish because of decay, flushing, and burial.

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Table 10.7—GENE (TEITEIR)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
3 Nov.	0810		36,000	Island center
4 Nov.	0813		18,000	Island center
5 Nov.	0810		12,000	Island center
7 Nov.	0745		8,000	Island center
8 Nov.	0751	18,000	6,000	Island center
9 Nov.	0745	8,000	3,400	Island center
10 Nov.	0806		3,500	Island center
11 Nov.	0803	3,600		Island center
12 Nov.	1620		1,400	Island center
14 Nov.	0830		1,200	Island center
16 Nov.	1230		2,400	King day
	1630		1,900	Island center
17 Nov.	0806		1,600	Island center
18 Nov.	0800	2,500	1,000	Island center
21 Nov.	0942	2,000		Island center
1953				
3 Jan.		340–1,000		
9 Feb.		100–1,000		

*½ nautical mile from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 8500 r/hr would have existed at H + 1 hr. Limited recovery (10 min) could commence at H + 130 hr.

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[redacted]

Table 10.8—HELEN (BOGAIRIKK)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
3 Nov.	0805		13,000	Island center
5 Nov.	0807		8,000	Island center
7 Nov.	0742		2,200	Island center
8 Nov.	0748		1,800	Island center
9 Nov.	0742		1,700	Island center
11 Nov.	0800	2,400		Island center
12 Nov.	1616		800	Island center
15 Nov.	0801		1,600	Doubtful value
16 Nov.	1230		1,000	King day
	1623		700	Island center
17 Nov.	0803		600	Island center
18 Nov.	0757		600	Island center
19 Nov.	0844		340	
21 Nov.	0939	1,200		
1953				
3 Jan.		280		

*¾ nautical mile from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 1700 r/hr would have existed at H + 1 hr. Limited recovery (10 min) could commence at H + 36 hr.

[redacted]

[redacted]

Table 10.9—IRENE (BOGON)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
1 Nov.	1245		10,000	500 ft above blockhouse
			1,000	1,500 ft above blockhouse
3 Nov.	0802	27,000	10,000	25 ft above island
4 Nov.	0210	14,000		Blockhouse
5 Nov.	0804		8,000	Blockhouse
6 Nov.	0803	8,000	4,000	Blockhouse
7 Nov.	0739	7,800–10,000	2,500	General levels
8 Nov.	0745	5,000	1,800	General levels
9 Nov.	0738	3,800	2,000	General levels
10 Nov.	0803	4,200		General levels
11 Nov.	0757	2,700		General levels
12 Nov.	1613	2,400	1,000	General levels
14 Nov.	0827	2,400	1,000	General levels
15 Nov.	0758	2,200		General levels
16 Nov.	1220	1,600	1,200	General levels
	1630		900	General levels
17 Nov.	0800		800	General levels
18 Nov.	0754	1,500	500	General levels
19 Nov.	0841		490	General levels
21 Nov.	0936	1,200		General levels
1953				
3 Jan.		200		General levels
9 Feb.		8–80		General levels

*1¼ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 500 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 50 hr.

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[redacted]

Table 10.10—JANET (ENGEBI)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
1 Nov.	1240		>50,000	150 ft above island center
2 Nov.	0656		19,000	Island center
3 Nov.	0758	12,000	6,000	Island center
4 Nov.	0806		3,300	Island center
5 Nov.	0800	10,000	3,000	Island center
6 Nov.	0759	2,800–3,900		2,800, south tip 3,900, north tip
7 Nov.	0735	3,900	1,400	
8 Nov.	0740	2,400		Northwest tip
		2,200		South tip
			1,400	Northeast tip
9 Nov.	0734	2,500	1,400	Island center
10 Nov.	0800	2,400		Northwest tip
		2,000		Northeast tip
		1,400		South tip
11 Nov.	0753		800	Northeast tip
12 Nov.	1609	1,500	900	Northeast tip
14 Nov.	0823		800	Northwest tip
15 Nov.	0754	1,400	600	Center
16 Nov.	1216		480	South tip
	1626	1,100	450	Center
17 Nov.	0757	900	430	Center
18 Nov.	0753	850	310	Center
19 Nov.	0836	500	200	Northeast tip
21 Nov.	0930	800		Center
1953				
3 Jan.		150		Center

*2¾ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 200 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 26 hr.

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[redacted]

Table 10.11—KATE (MUZIN)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0654		13,000	Island center
3 Nov.	0736		4,400	Island center
4 Nov.	0806		2,200	Island center
5 Nov.	0758	4,000	1,800	Island center
7 Nov.	0734		800	Island center
8 Nov.	0738		700	Island center
9 Nov.	0734		900	Island center
10 Nov.	0758		500	Island center
11 Nov.	0750		400	Island center
12 Nov.	1607		300	Island center
14 Nov.	0821		460	Island center
15 Nov.	0752		400	Island center
16 Nov.	1230		330	Island center
	1630		280	Island center
17 Nov.	0755		310	Island center
18 Nov.	0748		220	Island center
19 Nov.	0834		110	Island center
21 Nov.	0927	630		Island center
1953				
3 Jan.		120		Island center

*3¼ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 200 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 26 hr.

[redacted]

[redacted]

Table 10.12--LUCY (KIRINIAN)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0652		13,000	Island center
3 Nov.	0754	12,000	3,200	Island center
4 Nov.	0804		2,000	Island center
5 Nov.	0756		1,400	Island center
6 Nov.	0752		1,800	Island center
7 Nov.	0731	2,000	800	Island center
8 Nov.	0736	1,600	800	Island center
9 Nov.	0732		800	Island center
10 Nov.	0756		500	Island center
11 Nov.	0748		375	Island center
12 Nov.	1605		360	Island center
14 Nov.	0819		410	Island center
15 Nov.	0750	900	200	Island center
16 Nov.	1227		340	King day
	1624		240	Island center
17 Nov.	0754		260	Island center
18 Nov.	0746		280	Island center
19 Nov.	0832		100	Island center
21 Nov.	0925	430		Island center
1953				
3 Jan.		110		Island center

*3¾ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 200 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 26 hr.

[redacted]

[redacted]

Table 10.13 — MARY (BOKON)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1953				
2 Nov.	0649		12,000	Island center
3 Nov.	0751	9,000	2,800	Island center
4 Nov.	0801		2,300	Island center
5 Nov.	0756		1,500	Island center
6 Nov.	0748	2,000	1,000	Island center
7 Nov.	0728	1,800	400	Island center
8 Nov.	0733	900	420	Island center
9 Nov.	0729		700	Island center
10 Nov.	0752	1,500	410	Island center
11 Nov.	0745		260	Island center
12 Nov.	1602	600	240	Island center
14 Nov.	0816		280	Island center
15 Nov.	0747	440	110	Island center
16 Nov.	1224		280	King day
	1621		140	Island center
17 Nov.	0751	410	190	Island center
18 Nov.	0743	200	130	Island center
19 Nov.	0829		50	Island center
21 Nov.	0922	320		
1953				
3 Jan.		80		

*5 nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 175 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 18 hr.

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Table 10.14—NANCY (YEIRI)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0647		10,000	
3 Nov.	0749		2,200	
4 Nov.	0759		1,400	
5 Nov.	0746		1,100	
6 Nov.	0726		800	
7 Nov.	0725		400	
8 Nov.	0731		250	
9 Nov.	0726		700	Doubtful value
10 Nov.	0742	1,000	300	
11 Nov.	0742		255	
12 Nov.	1559		160	
14 Nov.	0814		240	
15 Nov.	0747		110	
16 Nov.	1221		160	King day
	1619		120	
17 Nov.	0749		130	
18 Nov.	0741	400	100	
19 Nov.	0827		40	
21 Nov.	0919	230		
1953				
3 Jan.		70		

*$5\frac{1}{2}$ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings greater than 130 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 15 hr.

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[redacted]

Table 10.15—OLIVE (AITSU)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0645		10,000	Island center
3 Nov.	0747		2,400	Island center
4 Nov.	0756		1,500	Island center
5 Nov.	0744		1,200	Island center
6 Nov.	0723		1,000	Island center
7 Nov.	0722	1,000	500	Island center
8 Nov.	0728		340	Island center
9 Nov.	0723		700	Island center
10 Nov.	0739	900	340	Island center
11 Nov.	0739		215	Island center
12 Nov.	1556	440	180	Island center
14 Nov.	0811		280	Island center
15 Nov.	0744		160	Island center
16 Nov.	1218	310	220	King day
	1616		140	
17 Nov.	0747		150	Island center
18 Nov.	0738		85	Island center
19 Nov.	0824		40	Island center
21 Nov.	0916	260		Island center
1953				
3 Jan.		45		

*6 nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings of greater than 130 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 14 hr.

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Table 10.16—PEARL (RUJORU)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0642		10,000	Island center
3 Nov.	0744	8,000	2,700	Island center
4 Nov.	0754	4,000	1,500	Island center
5 Nov.	0741		1,200	Island center
6 Nov.	0720		900	Island center
7 Nov.	0719	1,600	500	Island center
8 Nov.	0725	800	390	Island center
9 Nov.	0720		600	Doubtful value
10 Nov.	0736	900	380	Island center
11 Nov.	0735		265	Island center
12 Nov.	1554	480	200	Island center
14 Nov.	0809		190	Island center
15 Nov.	0741		110	Island center
16 Nov.	1215		150	King day
	1614		100	
17 Nov.	0744		50	Island center
18 Nov.	0735	260	80	Island center
19 Nov.	0821		45	Island center
21 Nov.	0913	240		Island center
1953				
3 Jan.		50		

*6½ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings of greater than 130 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 14 hr.

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Table 10.17—RUBY (EBERIRU)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0640		4000	Island center
3 Nov.	0741		2100	Island center
4 Nov.	0751	4000	1000	Island center
5 Nov.	0739		800	Island center
6 Nov.	0717		700	Island center
7 Nov.	0717		360	Island center
8 Nov.	0722		200	Island center
9 Nov.	0717	600		
10 Nov.	0733		260	Island center
11 Nov.	0732		200	Island center
12 Nov.	1551		140	Island center
14 Nov.	0806		190	Island center
15 Nov.	0739		110	Island center
16 Nov.	1212		150	King day
	1611		100	
17 Nov.	0741		50	Island center
18 Nov.	0732		45	Island center
19 Nov.	0818		45	Island center
21 Nov.	0910	240		Island center
1953				
3 Jan.		60		

*7½ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings of greater than 130 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 14 hr.

[redacted]

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Table 10.18—SALLY (AOMON)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0638		3800	Island center
3 Nov.	0739		2600	Island center
4 Nov.	0749	2600–4800	1000	Island center
5 Nov.	0737		1100	Island center
6 Nov.	0715	1200		Island center
7 Nov.	0714		400	Island center
8 Nov.	0720		240	Island center
9 Nov.	0715		700	Island center
10 Nov.	0731		300	Island center
11 Nov.	0730		260	Island center
12 Nov.	1549		110	Island center
14 Nov.	0804	280	150	Island center
15 Nov.	0737		120	Island center
16 Nov.	1210	200	120	King day
	1609		140	
17 Nov.	0739		160	Island center
18 Nov.	0730		80	Island center
19 Nov.	0816		48	Island center
21 Nov.	0908	240		Island center
1953				
3 Jan.		60		Island center

*7¾ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings of greater than 130 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 14 hr.

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Table 10.19 — TILDA (BIIJIRI)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0636		3000	Island center
3 Nov.	0737	2800	1800	Island center
4 Nov.	0747	2000	1000	Island center
5 Nov.	0735		800	Island center
6 Nov.	0713		600	Island center
7 Nov.	0712	600	240	Island center
8 Nov.	0718		240	Island center
9 Nov.	0713	600	200	Island center
10 Nov.	0729	480	200	Island center
11 Nov.	0728	340		
12 Nov.	1547		110	Island center
14 Nov.	0802	280	150	Island center
15 Nov.	0735	270	130	Island center
16 Nov.	1208	200	120	Island center
	1507	210		
17 Nov.	0737	200	90	Island center
18 Nov.	0728	200	90	Island center
19 Nov.	0814	100	40	Island center
21 Nov.	0906	160		
1953				
3 Jan.		40		Island center

* 8 nautical miles from ground zero.

† Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings of greater than 90 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 12 hr.

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[redacted]

Table 10.20—URSULA (ROJOA)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0634	12,000	2,000	Island center
3 Nov.	0735	3,000	1,200	Island center
4 Nov.	0745	1,600	800	Island center
5 Nov.	0733		600	Island center
6 Nov.	0711	600	440	Island center
7 Nov.	0710	400	200	Island center
8 Nov.	0716	400	200	Island center
9 Nov.	0711	400	180	Island center
10 Nov.	0727	340	140	Island center
11 Nov.	0726	240		
12 Nov.	1545	200	90	Island center
14 Nov.	0800	210	110	Island center
15 Nov.	0733	190	90	Island center
16 Nov.	1206		100	King day
	1605		70	
17 Nov.	0735	150	70	Island center
18 Nov.	0726	140	50	Island center
19 Nov.	0812		26	Island center
21 Nov.	0903	100		Island center
1953				
3 Jan.		30		Island center

*$8\frac{3}{4}$ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings of greater than 55 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 8 hr.

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Table 10.21—VERA (AARAANBIRU)*

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0632		1600	Island center
3 Nov.	0733		800	Island center
4 Nov.	0743		280	Island center
5 Nov.	0731		230	Island center
6 Nov.	0709		260	Island center
7 Nov.	0708		100	Island center
8 Nov.	0714		120	Island center
9 Nov.	0709		120	Island center
10 Nov.	0725		100	Island center
11 Nov.	0724		55	Island center
12 Nov.	1543		90	Island center
14 Nov.	0758		60	Island center
15 Nov.	0731		31	Island center
16 Nov.	1203		48	King day
	1602		31	
17 Nov.	0733	80	34	Island center
18 Nov.	0724		24	Island center
19 Nov.	0809		18	Island center
21 Nov.	0900	80		Island center
1953				
3 Jan.		20		Island center

*8¾ nautical miles from ground zero.

[redacted]

[redacted]

Table 10.22—WILMA (PIIRAAI)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
1 Nov.	0800		8000	Island center
2 Nov.	0630	4200	1400	Island center
3 Nov.	0731	1700	700	Island center
4 Nov.	0740		220	Island center
5 Nov.	0729		220	Island center
6 Nov.	0707		210	Island center
7 Nov.	0705		100	Island center
8 Nov.	0711		200	Island center
9 Nov.	0706		100	Island center
10 Nov.	0722		60	Island center
11 Nov.	0721		42	Island center
12 Nov.	1541	90	40	Island center
14 Nov.	0753		40	Island center
15 Nov.	0729		26	Island center
16 Nov.	1200		40	King day
	1601		27	
17 Nov.	0731	70	28	Island center
18 Nov.	0721	80	21	Island center
19 Nov.	0806		12	Island center
21 Nov.	0857	45		Island center
1953				
3 Jan.		12		

*9 nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings of greater than 35 r/hr would have existed at H + 4 hr. Limited recovery (10 min) could commence at H + 5 hr.

[redacted]

[redacted]

Table 10.23 — YVONNE (RUNIT)*

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
1 Nov.	0745	1200	300	Center
	0747		5000	North tip
	0743		5	South tip
2 Nov.	0627	45	20	South tip
	0628	180		Center
	0629	1000	165	North tip
3 Nov.	0726	25–180		South-North
4 Nov.	0736	25–120		South-North
5 Nov.	0725	30		Center
6 Nov.	0707	25–90		South-North
7 Nov.	0700	50	15	North tip
8 Nov.	0705		18	Center
9 Nov.	0701		12–16	South-North
10 Nov.	0717	0–24		South-North
11 Nov.	0716			North tip
12 Nov.	1536	16	4	North tip
14 Nov.	0749	10	8	North tip
15 Nov.	0724	1.2	5	Center
16 Nov.	1155		0–3800	South-North
	1555		0–450	South-North
17 Nov.	0726	1–100		South-North
18 Nov.	0716	30	2	Center
19 Nov.	0801	0–4		South-North
21 Nov.	0852		8	South-North
1953				
3 Jan.		0		

*$11\frac{3}{4}$ nautical miles from ground zero.

[redacted]

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Table 10.24—LEROY (RIGILI)*†

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0725	[illegible]0	120	Island center
4 Nov.	0820	95		Island center
5 Nov.	0816		30	Island center
7 Nov.	0800		14	Island center
8 Nov.	0805		10	Island center
10 Nov.	0801	17	4	Island center
16 Nov.	1700	27		Island center
17 Nov.	0822	9	5	Island center
18 Nov.	0816	8		Island center

*13¾ nautical miles from ground zero.

†Assuming that radiation decay follows a $T^{-1.2}$ law, extrapolation indicates that radiation readings of greater than 2.5 r/hr would have existed at H + 4 hr.

Table 10.25—KEITH (GIRIINIEN)*

Date	Time	Ground reading, mr/hr	Air reading, mr/hr	Remarks
1952				
2 Nov.	0735	14	4	Island center
4 Nov.	0830	0		Island center
16 Nov.	1710		1.6	King day
17 Nov.	0832		1.3	Island center
		JAMES (RIBAION)†		
1952				
2 Nov.	0737		3	M + 1 day
16 Nov.	1700		1.2	King day
		IRWIN (POKON)‡		
1952				
2 Nov.	0739		2	M + 1 day
16 Nov.	1702		1.0	King day

*17½ nautical miles from ground zero.

†18 nautical miles from ground zero.

‡18½ nautical miles from ground zero.

[redacted]

Table 10.26—LAGOON CONTAMINATION*

Date	Station† A S	A SS	B S	B SS	C S	C SS	D S	D SS	E S	E SS	F S	F SS	G S	G SS	H S	H SS	Remarks
1 Nov.	0	0	0	0	0	0	1,110	945	1,405	3,350	980	945	22,125	27,150	0	0	Small amount of gamma at G
2 Nov.	0	0	0	0	197	298	1,435	940	1,698	1,535	4,180	4,455	12,100	12,150	0	0	All beta contamination
3 Nov., A.M.	0	0	0	0	0	0	0	0	1,065	1,380	520	775	83,500	90,500	0	0	
3 Nov., P.M.	0	0	0	0	0	0	240	306	452	485	500	610	96,750	98,500	0	0	
5 Nov.			0	0	0	0	0	583	249	378	2,963	906	13,428	833			Small amount of gamma at E, F, G
6 Nov.	111	0	92	261	118	123	277	0	708	6,740	788	442	20,000	12,550	0	9	Wind variations
7 Nov.	0	0	0	0	0	0	0	0	363	262	0	0	91	2,785	227	8.0	
8 Nov.	0	0	0	0	0	0	0	0	240	125	460	500	1,865	17,025			
9 Nov.			0	0	0	0	0	0	240	187	860	720					
12 Nov.	0	0	0	0	0	0	0	0	225	264	1,620	1,975	1,440	760			
17 Nov.	81	0	0	0	343	137	960	298	448	685	1,080	1,080			168	173	Day following King shot

*All measurements are expressed as counts/minute/milliliter of beta radiation.
†S denotes surface sample; SS denotes subsurface sample.

Table 10.27—DECAY ANALYSIS OF AIR FILTER SAMPLE 21A144
(1 to 18 November 1952)

Run No. 1 — Operating voltage, 1250
Instrument No. 4A — Window thickness, 1.9 mg/cm²
G-M tube No. 4A — Air thickness, 2.07 mg/cm²

Date	Time (GMT)	Gross count	Counting time, min	Total counts/min	Background	Coincidence	Net counts/min	Standard factor	Corrected counts/min	Remarks
1 Nov.	0900	163,840	1.73	94,800	28	30,084	124,856	0.98	122,000	
1 Nov.	1010	163,840	3.31	49,600	28	8,166	57,738	0.98	56,500	
1 Nov.	1110	81,920	2.06	39,700	28	5,243	44,915	0.98	44,000	
1 Nov.	1210	81,920	2.52	32,500	28	3,521	35,993	0.98	35,200	
1 Nov.	1400	81,920	3.06	26,790	28	2,356	29,118	0.98	28,500	
1 Nov.	1502	81,920	3.43	23,440	28	1,825	25,237	0.98	24,750	
1 Nov.	1600	81,920	3.71	22,100	28	1,618	23,690	0.98	23,200	
1 Nov.	1700	81,920	3.98	20,550	28	1,401	21,923	0.98	21,500	
1 Nov.	1800	81,920	4.18	19,550	28	1,263	20,785	0.98	20,325	
1 Nov.	2220	40,960	2.62	15,600	28	810	16,382	0.98	16,050	
2 Nov.	0717	40,960	3.84	10,650	30	398	11,018	0.99	10,930	
2 Nov.	1420	40,960	5.02	8,350	30	231	8,551	0.99	8,460	α = 30.4 dis/min
2 Nov.	2230	40,960	6.32	6,480	30	143	6,593	0.99	6,520	α = 0.70 dis/min
3 Nov.	0705	40,960	7.90	5,200	35	8	5,173	0.015	5,240	
4 Nov.	0810	40,960	13.05	3,140	42		3,098	1.013	3,135	
4 Nov.	1430	6,192	2.92	2,800	42		2,758	1.013	2,795	α = 86.0 dis/min
5 Nov.	1015	20,480	10.74	1,907	43		1,864	1.12	2,080	α = 0.0 dis/min
6 Nov.	1140	5,000	3.47	1,440	75		1,365	0.973	1,330	α = 0.43 dis/min
7 Nov.	1000	4,096	3.20	1,283	46		1,237	1.000	1,237	α = 0.00 dis/min
7 Nov.	1510	4,096	3.34	1,185	46		1,139	1.000	1,139	
8 Nov.	1140	4,096	20.00	947	79		868	1.000	868	α = 0.00 dis/min
9 Nov.	1045	0	5.30	0	3/60		0		0	α = 0.00 dis/min
9 Nov.	1110	4,096	5.26	772	68		707	1.03	730	
9 Nov.	1115	4,096	4.33	778	68		707	1.03	730	
10 Nov.	1000	4,096	6.28	651	45		606	1.01	612	α = 0.00 dis/min
10 Nov.	1010	4,096	6.28	651	45		606	1.01	612	α = 0.00 dis/min
11 Nov.	1310	4,096	7.34	550	48		502	1.02	511	
12 Nov.	0940	4,096	9.64	425	46		379	.995	378	
13 Nov.	1000	4,096	9.98	410	45		365	1.025	367	
13 Nov.	1015	4,096	10.40	399	45		354	1.025	356	
15 Nov.	1505	4,096	13.91	294	50		244	1.03	254	
16 Nov.	0915	2,048	7.18	286	42		244	1.01	246	
17 Nov.	1200	1,000	246 sec	244	71		173	0.985	171	Scaler 4B
18 Nov.	0955	2,000	532 sec	231	72		159	0.980	156	

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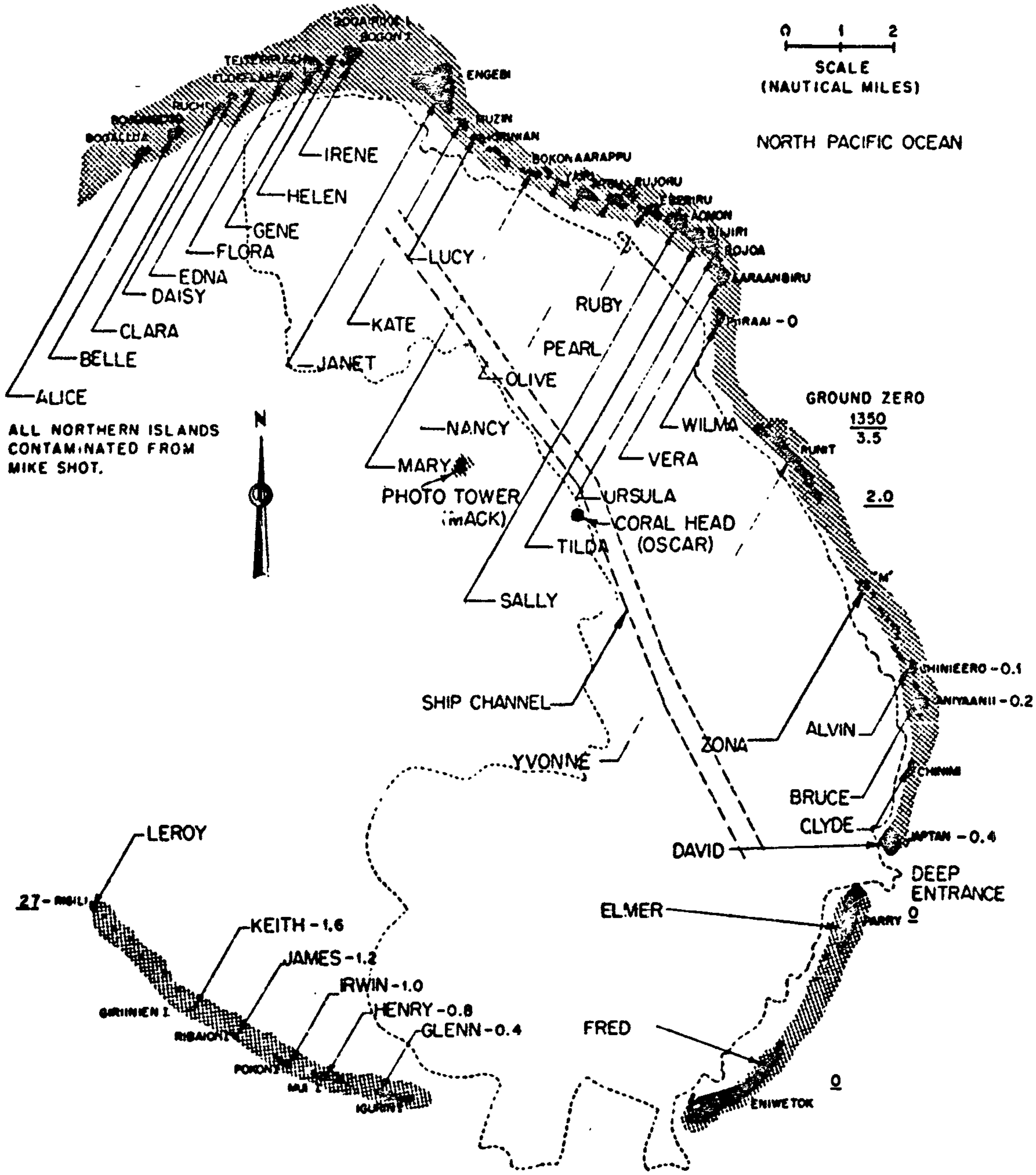

Fig. 10.2— King shot, H + 5 hr. Underlined readings are ground values in milliroentgens per hour; other readings are helicopter readings 25 ft above ground in milliroentgens per hour.

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days, after which time water leaching became stabilized and radioactive decay became predominant. Radioactive decay approximated the $T^{-1.2}$ law in the longer periods and was determined from laboratory counting of an air-filter dust sample collected 40 min after shot time from a point $7\frac{1}{4}$ miles south of ground zero (Table 10.17).

10.1.3 Lagoon Contamination

Lagoon-contamination surveys were conducted from TG 132.3 water-sampling helicopters. These helicopters could hover over water positions A, B, C, D, E, F, G, and H (Fig. 10.1) and sample water at the surface and at 30-ft depths. These samples were returned to the radiological laboratory for evaporation and counting. No attempt was made to correlate counts/minute/milliliter and milliroentgens/hour. The purpose of this survey was to use counts/minute/milliliter as an indication of diffusion of radioactive material throughout the lagoon and as an indication of possible ship contamination in the Eniwetok anchorage (Table 10.26).

Results of these lagoon surveys illustrate the nature of diffusion in the upper lagoon and the currents that move from east to west on the surface and from west to east in the subsurface in conformance with the surface trade-wind directions.

10.2 KING SHOT

Location: Reef—northeast of north end of Runit Island, Eniwetok Atoll.
Height of burst: 1480 ± 20 ft.
Yield: 570 ± 30 Kt.
Time fired: 1130, Nov. 16, 1952.

10.2.1 Cloud Disposition

Fall-out pattern predictions indicated strong easterly winds below 35,000 ft. Upper-level winds just below the tropopause were toward the southeast quadrant after shot time. Surface radex was from 210° true to 290° true from H hour to H + 3 hr. Air radex was concentrated in the west-southwest sector.

The atomic cloud rapidly dispersed owing to strong wind shear at several altitudes; therefore no consequent heavy fall-out was observed.

10.2.2 Ground Contamination

The residual contamination from Mike shot obscured residual contamination from King shot in the northern islands. Runit and the southwestern islands revealed material increases in radiation readings after King shot (Fig. 10.2). Contamination of Runit Island from King shot had decayed to negligible amounts by K + 5 days (Table 10.23).

10.2.3 Lagoon Contamination

Aerial sample collection was completed by H + 3 hr, and no material increase of radioactivity was noted in lagoon and anchorage stations.

10.3 POTABLE WATER SUPPLIES

Samples of distant-atoll water supplies were analyzed in the radiochemical laboratory before and after each shot. No radioactivity above background was noted in any potable water supplies. Samples were obtained from springs and cisterns of Kusaie, well-water stores from Majuro, untreated storage water at Ponape, drinking water and cistern storage at Kwajalein, drinking water at Bikini, fresh water at Ujelang, and drinking water of Parry and Eniwetok islands.

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CHAPTER 11

CONCLUSIONS AND RECOMMENDATIONS

The Rad-Safe program for TG 132.1 was successfully accomplished with a minimum number of exposures under a condition of extensive residual contamination following Mike shot. Certain items of unit operation could be accomplished more efficiently if the following conclusions were considered and the recommendations were adopted.

11.1 CONCLUSIONS

1. Rad-Safe facilities at Parry Island are inadequate in space requirements. The nature of operations requires peak periods for equipment issue and decontamination during early morning and late afternoon hours. This building houses supply, administrative, control, laboratory, and decontamination facilities, although there is actually only enough space for adequate laboratory, decontamination, and administrative functions.
2. Procurement of test-operation Rad-Safe equipment under the present system is not economical because of the number of agencies involved. Six separate government agencies loaned equipment to TG 132.1 for Operation Ivy. This caused duplication of effort, transportation cost, and maintenance facilities.
3. Procurement of personnel to fill the various specialities became a major problem of the initial planning phase owing to the number of personnel offices in the procurement channel. Since the personnel were procured from four services, six or more personnel offices required specific information on qualifications desired. It was only by constant follow-up that the unit was able to obtain information such as names, stations, organizations, and serial numbers in order to initiate Q clearance.

11.2 RECOMMENDATIONS

1. Additional office and control-center space should be constructed adjacent to the Rad-Safe Building in order to provide a control-center briefing and ready room.
2. Rad-Safe equipment should be procured on a permanent-issue basis and left in the Parry Island Rad-Safe Building for use by the AEC field engineer and his Rad-Safe organization between operations.
3. A small military Rad-Safe support unit should be established to furnish a cadre of key personnel for each operation. This cadre could be supplemented by personnel of the several services to meet the requirements of test-operation needs.

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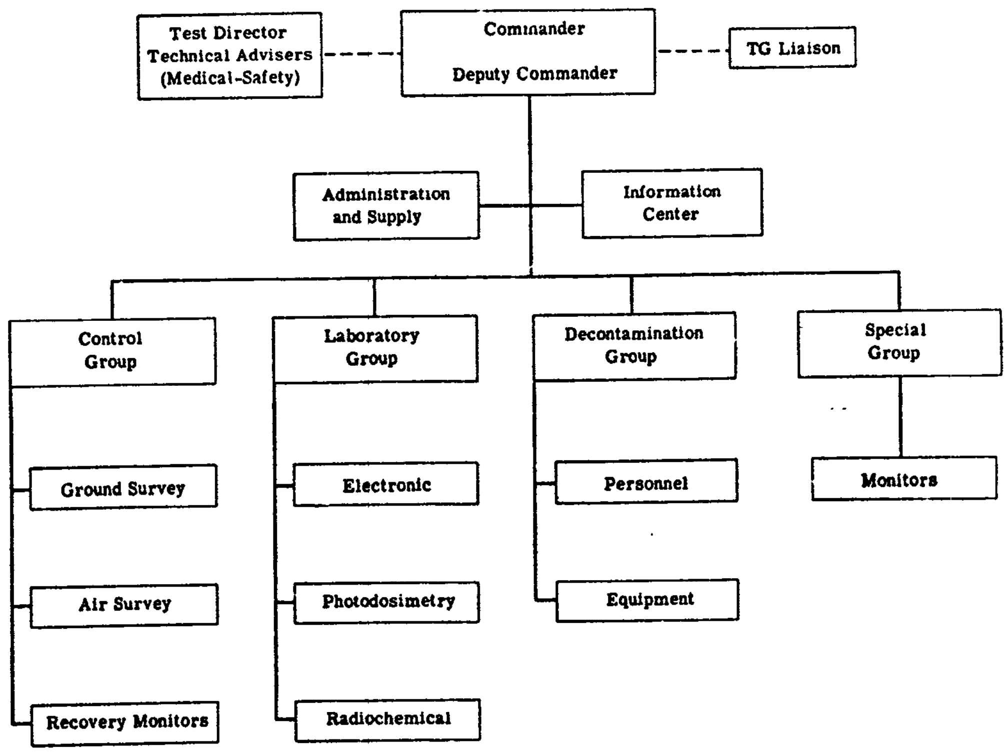
APPENDIX A

TASK UNIT 7



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APPENDIX B

STANDARD OPERATING PROCEDURE FOR EQUIPMENT ISSUE

B.1 AFLOAT

B.1.1 Instruments

1. Instruments have been assigned all monitors aboard the USS Rendova, and a name has been placed on each instrument. Monitors are responsible for taking their instruments aboard.

2. Instruments will be stored at the instrument-repair shop (hangar deck). Prior to any mission requiring instruments, monitors will procure their instruments from this shop.

3. On return from a mission the instruments will be left on the flight deck at a point prescribed by the ship's officer in charge of decontamination. Instrument-repair personnel will return the instruments to the repair shop, and they will be available again for use by the monitors.

4. In case of instrument failure or special cases, other instruments may be assigned by instrument-repair personnel.

B.1.2 Dosimeters and Film Badges

1. Prior to each mission the monitors will procure dosimeters and film badges from the photo laboratory trailer on the hangar deck for all personnel of the recovery party on the mission. A list of names, film-badge numbers, and dosimeter numbers will be furnished.

2. Dosimeters and film badges will be collected on the flight deck after return from the mission.

B.1.3 Protective Clothing

1. A list of all persons involved in a mission will be turned in to the supply sergeant or officer as far in advance as is possible by the senior monitor for the mission. The list must give the time of the mission and the desired time of clothing procurement. It is desired that clothing be procured the evening before the mission.

2. Clothing will be made up in bundles for each individual on the mission and may be obtained by the individual in the vicinity of the laboratory trailer on the hangar deck at a time designated by the supply sergeant. It is the responsibility of the senior monitor to notify mission personnel to procure clothing.

3. For special clothing or equipment, or for deletion of any item, notify the supply sergeant.

4. Respirators will be issued with the clothing and will be marked by name. Each individual is responsible for changing filters in his respirator. Filters will be available at the time of issue.

5. Clothing will be turned in to decontamination personnel on the flight deck. "Cold" clothing and respirators will be returned to supply by supply personnel for reissue.

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B.2 ON-SHORE SUPPLY

After the unit has returned to Parry Island, all supplies will be issued from the Rad-Safe Building.

B.2.1 Instruments

Instruments may be obtained from the supply room by the monitors, who will take only those instruments bearing their name. Special cases may be arranged with supply personnel. Instruments will be turned in to decontamination personnel and will be available in the supply room for reissue on the next mission.

B.2.2 Dosimeters and Film Badges

Dosimeters and film badges for all members of the party will be obtained from dosimetry personnel by the senior monitor. These will be turned in at the decontamination center.

B.2.3 Clothing

At any time prior to a mission, each person (including monitors and the recovery party) will obtain necessary clothing at the clothing-issue counter in the Rad-Safe Building. Monitors must notify personnel of his party of these facts. Clothing will be taken up by decontamination personnel. Clothing bundles can be made up when names and sizes of individuals are given in advance of a mission, or they may be made up on the spot at the issue counter at any time.

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APPENDIX C

STANDARD OPERATING PROCEDURE FOR RADIOLOGICAL-SAFETY CONTROL GROUP

C.1 PURPOSE

The purpose of this Standard Operating Procedure is to establish operational procedures for the Rad-Safe Control Group.

C.2 COMMAND

While the recovery and reentry programs are in progress, the Control Group Officer or the Assistant Control Group Officer will normally be present in the Rad-Safe Control Center during peak hours. In addition, a Rad-Safe Duty Officer will be assigned to the Rad-Safe center when directed by the Control Group Officer. The Rad-Safe Control Center will be located in the forward ready room, USS Rendova, while afloat, and in Building 57, Parry Island, when ashore.

C.3 DUTIES OF CONTROL GROUP OFFICER PRIOR TO DAILY OPERATIONS

1. Consult the Scientific Program Director as to requirements for the following day.
2. Check with Operations, J-3, as to projected operations for the following day. Check the availability and location of transportation.
3. Post a schedule of operations for the following day on the Rad-Safe center bulletin board (see Sec. C.11).
4. Provide the USS Rendova Rad-Safe Officer (while afloat) with a schedule of operations (for decontamination purposes).
5. Keep CTU 7 informed as to projected operations.
6. Brief the senior monitors just prior to departure (see Sec. C.12).

C.4 DUTIES OF CONTROL GROUP OFFICER DURING DAILY OPERATIONS

1. Exercise general supervision of activities in the Rad-Safe Control Center.
2. Meet returning parties and pass survey data to RIC. Interrogate senior monitors on return.
3. Recommend Rad-Safe requirements to parties desiring entrance to contaminated areas.

C.5 DUTIES OF RAD-SAFE DUTY OFFICER

The Rad-Safe Duty Officer shall be responsible for up-to-date maintenance of information concerning the radiological situation. In this regard he shall perform the following duties:

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[redacted]

1. Maintain contact with the Rad-Safe Information Officer.

2. Maintain an up-to-date radiological-situation map in the Rad-Safe Control Center which is based on information from RIC.

3. Maintain a file of all pending recovery and/or reentry trips.

4. Maintain a file of all recovery or survey parties in the field. This shall include names of all personnel, area in which operating, type of transportation, time of departure, and expected time of return.

5. Maintain a check-off list of projects to show progress of recovery.

6. Keep Supply and Laboratory groups informed as to anticipated future demands.

7. Maintain a rough log which shall describe briefly, in chronological order, all events of importance. Entries in this log may be used to demonstrate the efficiency of Control Group operations.

C.6 DUTIES OF SENIOR MONITORS PRIOR TO TRIP

1. Notify senior member of recovery or reentry team as to time of departure, means of transportation, and requirements and location of Rad-Safe protective clothing. Request the senior member to assemble his personnel at the time and place desired, dressed and ready to depart. Notify the Supply Group as to protective clothing required.

2. Obtain film badges and dosimeters as required for all personnel in the party, including pilots and boat and vehicle operators. When issuing film badges, check names against security passes.

3. Check the previous exposure record for all personnel in the party.

4. Obtain maps, photographs, grids, and survey forms necessary for the trip.

5. Obtain necessary survey instruments.

6. Check the known radiological situation from available data.

7. Present himself at the Rad-Safe Control Center for final briefing.

C.7 DUTIES OF SENIOR MONITORS DURING AN OPERATION

1. Maintain contact, if possible, with RIC at frequent intervals. Use prescribed survey and communications procedures (see Secs. C.13, C.14, and C.15).

2. Require proper use of protective clothing and equipment.

3. Exercise all reasonable precautions to avoid contamination of means of transportation.

4. Keep civilian scientific personnel fully advised as to the Rad-Safe situation, and recommend nonentry or withdrawal when, in his judgment, the situation warrants.

C.8 DUTIES OF SENIOR MONITORS AFTER AN OPERATION

1. Give survey notes to the Control Officer or the Rad-Safe Duty Officer for further transmittal to RIC.

2. Place film badges, dosimeters, and instruments in a container provided by the Laboratory Group.

3. Ensure that all trip personnel go through required decontamination procedures.

4. Report to the Control Group Officer or the Rad-Safe Duty Officer for interrogation.

C.9 ALLOWABLE-RADIATION-LEVEL GUIDES

The total permissible dose for personnel participating in Operation Ivy is 3.9 r (measured gamma only). No limitation is placed on the rate of accumulation so long as the rate is sufficiently low to permit adequate control.

[redacted]

[redacted]

C.10 CONTROL OF ENTRY INTO CONTAMINATED AREAS

Subsequent to both Mike and King events, daily reports of contaminated islands will be disseminated throughout the Task Force by RIC. Control of entry to such contaminated islands shall be a function of the Control Group Officer. He shall make recommendations as to non-entry, limited access, or full access, and shall further prescribe, as required, the wearing of a film badge and the presence of a monitor.

Where only portions of an island are contaminated above a tolerable limit, the Control Group Officer shall have "Danger" signs posted, delineating the contaminated area.

C.11 SCHEDULE OF OPERATIONS FOR RECOVERY TRIP

1. Monitor:
2. Trip number: Call sign: Flatiron
3. Scheduled: ____________ (Time Date) Transportation:
4. Destination: ____________ (Station or coordinates) ____________ (Island)
5. Mission:
6. Project personnel:
7. Pilot:
8. Copilot:
9. Monitor responsibility:
   a. Protective clothing and bootees.
   b. Film badges and dosimeters.
   c. Notification and briefing of project personnel.
   d. Previous exposure record of all personnel making trip.
   e. Meters, codes, grids, photographs, map, data sheets.
   f. Estimated radiological situation (time in area).
10. Remarks:
    a. Time of departure.
    b. Estimated time of return.
    c. Time of return.

C.12 FINAL BRIEFING CHECK LIST

1. Trip number.
2. Monitor.
3. Destination.
4. Means of transportation.
5. Mission.
6. Project personnel.
7. Radiological situation.
8. Estimated time allowed in area.
9. Survey equipment.
10. Project equipment.
11. Protective clothing.
12. Film badges.
13. Dosimeters.
14. Previous exposure record.
15. Survey maps and report forms.

[redacted]

16. Grid.
17. Call signs.
18. Island code.
19. Radiation intensity code.
20. Mae West.
21. Ditching.

C.13 STANDARD OPERATING PROCEDURE FOR GROUND SURVEY

C.13.1 Purpose and Scope

Radiological ground surveys are necessary to assess the radiological hazard to personnel involved in recovery operations and to clear the islands for reentry. The purpose of this Standard Operating Procedure is to establish procedures for the following types of ground surveys at Eniwetok Atoll:

(a) Initial Recovery Survey. This is a survey made at each recovery station prior to commencement of recovery operations at the station.

(b) Recovery Survey. This is the survey made by the monitor accompanying the recovery party.

(c) Reentry Survey. This is a survey made of an island to clear it for reentry.

C.13.2 Initial Recovery Survey

(a) General. When the radiological intelligence indicates that recovery operations may be initiated at a station or stations, the Control Officer will send a monitor to make a ground survey there. From these data the Control Officer will be able to advise the recovery party of the radiological hazard.

(b) Personnel and Equipment. The initial recovery survey will be made by a monitor using a helicopter for transportation. Intensity readings will be taken with a T1B survey meter. The monitor will be provided with a map or aerial photograph and with a special overlay grid of the island or islands concerned. A duplicate set will be retained at RIC for interpretation of the coded data reports.

(c) Procedure. The initial recovery monitor will determine the most practical route of entry to the station. He will direct the helicopter pilot to land as close to the station as possible. Upon landing the monitor will dismount from the helicopter and approach the station. If the station is reached, he will report the intensity at the station to RIC. If a station cannot be approached, this fact will be reported together with the intensity at the point of nearest approach. The monitor will complete the survey expeditiously and leave the contaminated region. He will not undertake to make a more extensive survey than that required for accomplishment of the recovery.

C.13.3 Recovery Survey

Each recovery party will be accompanied by a monitor with a T1B survey meter. The same general instructions for the initial-recovery monitor apply. The recovery monitor must be prepared to advise the recovery party of any new or previously undetermined radiological hazards encountered. He will report radiological information to RIC as prescribed.

C.13.4 Reentry Surveys

(a) Elmer. The ground survey monitor and an assistant will leave the USS Rendova, when directed, for the air strip on Elmer. They will carry two T1B survey meters and appropriate aerial photographs and grid overlays. A $\frac{1}{4}$-ton 4 by 4 truck will be parked at the Rad-Safe Building (Building 57) for their use. The ground-survey monitor will proceed to survey

[redacted]

the whole of Elmer in the following manner: The assistant will drive along the roads while the monitor holds a survey meter over the side of the vehicle at seat level. The monitor will record readings at road junctions, intersections and corners, principal structures, and at such other points deemed necessary. If there is indication of local hot spots, the monitor will make such off-street surveys considered necessary to locate them. Upon completion of the survey a general radiological-condition report will be made to RIC via helicopter radio. This survey will be repeated daily until Elmer is reentered. Post reentry surveys will be made as directed.

(b) Fred. A survey similar to that on Elmer will be made daily on Fred until reentry. The $^1/_4$-ton truck will be furnished by CTG 132.2 and will be parked at the airstrip. Upon reentry on Fred the radiological responsibility of that island returns to CTG 132.2.

(c) Other Islands. Reentry surveys of other islands will be made on a priority basis, which is dependent on the need to reenter. Instructions as to transportation, nature and extent of survey, and means of communication will be given the monitor at the time the mission is dispatched by the Control Officer.

C.13.5 Records and Reporting

All ground monitors will record their data on record forms (Sec. C.11). The data will be reported to RIC at the earliest practicable time. Normally, Rad-Safe reports will be transmitted via helicopter or boat-pool radio networks until telephone communication is restored. Where a combination of water and vehicular transportation is required, such as an LCU (or LCM) and a DUKW (or truck), two SCR 300's will be used for vehicle-to-boat communications. Data will be relayed from shore to boat to RIC only in emergencies. Reports transmitted by radio will be made in the approved brevity code for TU 7. To minimize exposure, monitors will normally complete the survey and transmit reports on leaving the contaminated area. A record sheet will be turned in to the Control Officer on completion of the trip.

C.13.6 Protective Clothing

All personnel entering contaminated areas will wear the prescribed protective clothing consisting of coveralls, shoes, socks, bootees, gloves, and cap. A respirator will be covered and worn when dusty conditions are likely to be encountered. Collars and cuffs will be buttoned, and gloves will be pulled over the cuffs. Contaminated bootees will not be worn aboard the helicopter. As the monitor enters the helicopter, he will remove the bootees and discard them. Sufficient bootees will be carried to provide a clean pair for each time a person must step on the ground.

C.14 STANDARD OPERATING PROCEDURE FOR AERIAL SURVEY

C.14.1 General

It is contemplated that aerial surveys of the ground contamination on all the islands of Eniwetok Atoll will be made very soon after the Mike and King shots and at frequent intervals thereafter. The results of these surveys will determine when ground-survey and recovery teams may safely enter each island. An additional purpose in making the aerial surveys is to develop, under Project 5.4b, a practical system for making rapid aerial surveys of ground contamination which can be used by troops in the field.

C.14.2 Personnel and Equipment

The aerial survey will be made from a helicopter with a T1B survey meter for measuring radiation intensities. The aerial-survey officer will sit next to the pilot, and an instrument man will sit in the passenger space below. Each will carry a clip board with mimeographed data-recording sheets. The survey officer will carry aerial photographs of all islands to be surveyed.

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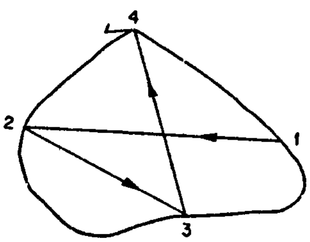
Communications between the survey officer and the instrument man will be by the regular interphone system of the helicopter. Communications with RIC will be by the established helicopter radio net.

C.14.3 Flight Plan and Location of Position with Respect to Ground

The position of the helicopter with respect to the ground at all times will be made with the aid of aerial photographs. Prior to making the first aerial survey, the survey officer will, from a careful examination of photographs of each island, pick out and number several points which can be easily located both on the photograph and on the ground. Straight lines will be drawn between these points so that each island is crossed in different directions by these lines. An illustration of a photo marked in this manner is given below.

Direction of Chain



Line 1–2 will always be the line in the direction of the chain of islands. One copy of each marked photo will be carried by the Survey Officer; a duplicate copy of each will be retained by RIC. Using the aerial photo, the survey officer will direct the pilot to fly accurately over each line at a constant speed of about 20 mph at an altitude of 25 ft when possible. The instrument man will take a series of readings at equally spaced points above each line using the procedure given below.

C.14.4 Procedure for Taking Readings

The instrument man will sit in the seat next to the door of the helicopter and will hold the T1B survey meter between his knees. The survey officer will give the instrument man prior warning of readings to be made by giving the code name of the island, line number, and altitude. As the helicopter passes over the beginning of the line the survey officer will say "Read." The instrument man will make the reading and report it over the interphone. Both will record the reading. The survey officer will continue to say "Read" at intervals until the end of the line is reached, each reading being recorded by both the survey officer and the instrument man.

When the intensity is low or is uniform over the whole island, as is expected in most cases, the above procedure can be simplified. The helicopter should first fly over line 1–2 of the island at a speed of about 30 mph. If the intensity is uniform along that line, only one reading need be reported by the instrument man and recorded. If there is a marked variation of intensity along the line, a series of readings should be taken along each line according to the procedure given above.

For that M-day survey which will be made before conditions have become stabilized, the simplified procedure will be used. Only the maximum reading along line 1–2 of each island will be recorded.

In both procedures correction of readings to ground intensity will be as described in Sec. C.14.5.

C.14.5 Correction to Ground Intensity

Measurements made of residual contamination from Greenhouse shots show that intensities measured from an H-19 helicopter at an altitude of 25 ft vary from one-third to one-

[redacted]

[redacted]

fifth of the intensity as measured with a survey meter 3 ft above the ground. However, the relation between air and ground intensities may differ considerably from this after the Mike and King shots. In order to determine the correct relation, one ground measurement of intensity will be made near the center of at least five different islands on which the maximum reading is less than 500 mr/hr. These readings should be made 3 ft off the ground and at least 50 ft away from the helicopter. From these readings RIC can correct all readings to ground intensity.

In order to avoid tracking contamination materials into the helicopter, the instrument man will, after making each ground reading, sit in the doorway of the helicopter, remove his bootees, and discard them before reentering the helicopter. For this purpose extra pairs of bootees will be carried in the helicopter used in making the survey.

After the completion of the survey, a background reading will be made and recorded at a point distant from the contaminated area.

C.14.6 Data To Be Sent to RIC

Immediately after the survey of each island is completed, the following data will be sent in code by radio to RIC:

1. Time (not encoded).
2. Island.
3. Maximum reading over island.
4. Ground reading (if any).

Completed aerial-survey forms will be turned in to the Control Group Officer immediately after return from the survey trip.

Intensity and island codes will be furnished the Survey Officer by the Control Group Center prior to the survey trip (see Sec. C.15).

C.14.7 Maximum Radiation Levels and Accumulated Doses (Initial Survey)

The helicopter making the survey will proceed up the chain of islands toward ground zero until an instrument reading of 3000 mr/hr is reached. At this point the helicopter will halt, proceed to Alice, making a wide detour around ground zero, and again move toward ground zero until 3000 mr/hr intensity is reached.

C.15 COMMUNICATIONS

C.15.1 Afloat

From M day to Mike entry (ME) day, RIC will be aboard the USS Rendova (Air Intelligence Office), and all messages from survey officers and monitors will be directed there. The following communications circuits will be available for Rad-Safe traffic:

1. AN/TRC radiotelephone from RIC (USS Rendova) direct to CDR Maynard (USS Estes).
2. Helicopter radio net from Combat Information Center (CIC), USS Rendova, to all helicopters to be used during the operation. The frequency 120.06 Mc will be used by these helicopters, except that for special missions (i.e., aerial survey) 142.56 or 143.28 Mc may be used as arranged with CIC, USS Rendova.
3. TU 7 is a member station in the 132.1 command net through an SCR 508 located in CIC, USS Rendova, and, as such, is in communication with the USS Estes, USS Shanks, USS Collins, USS Curtiss, USS Oak Hill, and USS Leo [this would be an alternate route of communication for traffic between RIC (USS Rendova) and CDR Maynard (USS Estes), 27.2 Mc].
4. SCR 300's will be furnished to monitoring parties as requested for point-to-point radio communications not in excess of 3 to 4 miles (44.5 Mc).

[redacted]

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5. A Rad-Safe operations net will be operated on 25.4 Mc from CIC, USS Rendova, for communications to LCM's or LCU's on Rad-Safe missions.

6. Messages up to and including Secret may be sent by blinker-light communication systems (approved by J-5, JTF 132).

7. Communication with Lt Col Collison, TG 132.2, will be effected through the command net on 27.2 Mc (SCR 508, CIC, USS Rendova).

8. Mr. Fussell will be aboard the USS Rendova with a Motorola walkie-talkie for communication with the USS Estes. He will keep in touch with Maj Servis.

C.15.2 Parry-based Operations

1. All helicopters will operate on 120.06 Mc, and TU 7 will furnish Parry Air Operations a man to copy Rad-Safe messages over the helicopter net. A direct landline telephone connects Parry Air Operations with Building 57, Parry.

2. An SCR 508 installed in Building 57 will take over the function of the SCR 508, CIC (USS Rendova), described in 3 and 5, Sec. C.15.1.

3. A direct landline telephone from Building 57 to CDR Maynard (Compound) will replace the AN/TRC radiotelephone circuit.

C.15.3 Messages

1. The code given below for reporting radiation intensities and island names will be used on low-frequency radio nets. For VHF circuits (AN/TRC, SCR 508, SCR 300, helicopter radio) and telephones, it is not necessary to encode the name of the island beyond the Restricted code, e.g., Alice, Belle, Clara, etc.

It will be the responsibility of the monitor originating the message to ensure that a message using the names Alice, Belle, etc., will not be sent via low-frequency radio (i.e., Motorola and ship c-w circuits). Note that this would occur only in the event that our normal VHF radio channels failed and it became necessary to send the message through a communications center not under our control.

2. A typical message for VHF circuits then would be made up as follows:

Time	Island	Map	Coordinates	Scale, Intensity
1430	Janet	3	60-75	W 15
		1	15-22	T 35
		2	22-20	T 40

The above message gives several locations and their intensities. The number under "Map" indicates the photo number since in some cases more than one aerial photo is necessary to cover the island. The headings for the groups are not transmitted. Thus a message would be sent as follows:

1430	Alice	16-24	W 15

In this case, where only one photo is used to cover the island, it is not necessary to give a map number after the code name for the island.

If the grid coordinates are omitted, the reported intensity will be assumed to be relatively uniform throughout the island.

The coordinates for a given location will be determined by placing an overlay over the photo and reading first to the right and then up in normal fashion, i.e., "read right up."

The following revised code will be used to report radiation intensities and location by TU 7 Rad-Safe personnel.

[redacted]

[redacted]

ISLAND DESIGNATIONS

VHF	Low frequency	VHF	Low frequency
Alice	CX	Tilda	MB
Belle	RP	Ursula	AA
Clara	FH	Vera	SS
Daisy	LY	Wilma	VL
Edna	NW	Yvonne	RJ
Flora	DZ	Zona	MD
Gene	TU	Alvin	NB
Helen	JC	Bruce	AE
Irene	UT	Clyde	GT
Janet	WV	David	WF
Kate	YR	Elmer	QY
Lucy	ND	Fred	NK
Mary	EQ	Glenn	SV
Nancy	PK	Henry	XG
Olive	BG	Irwin	HF
Lagoon	AZ	James	LN
Pearl	XJ	Keith	UC
Ruby	HM	Leroy	PE
Sally	QN	Mack	CH

The phonetic alphabet shown below will be used in all communications where references to letters of the alphabet are required.

A—Able	N—Nan
B—Baker	O—Oboe
C—Charlie	P—Peter
D—Dog	Q—Queen
E—Easy	R—Roger
F—Fox	S—Sugar
G—George	T—Tare
H—How	U—Uncle
I—Item	V—Victor
J—Jig	W—William
K—King	X—X-ray
L—Love	Y—Yoke
M—Mike	Z—Zebra

Note that the AN/PDR-T1B meter face from zero to full-scale deflection is marked off in five major divisions with five subdivisions each. This will be thought of as 0 to 50, with 0, 10, 20, 30, 40, and 50 indicated by the larger divisions and 2, 4, 6, 8, etc., being indicated by the smaller markings. The range scale utilized in taking the reading will be indicated by choosing one of the appropriate letters listed below. This letter will be followed by the two digits representing the meter readings; thus A38 would represent 380 mr/hr.

When reporting intensities (normally using the T1B) the letters shown below will designate the scale in use.

0 to 5 mr/hr	X or M	0 to 5K mr/hr	H or P
0 to 50 mr/hr	T or W	0 to 50K mr/hr	E or K
0 to 500 mr/hr	S or A	0 to 500K mr/hr	N or F

[redacted]

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APPENDIX D

STANDARD OPERATING PROCEDURE FOR PHOTODOSIMETRY AND RECORDS SECTION

D.1 MISSION

The mission of the Photodosimetry and Records Section is to determine and record, by photodosimetric methods, the radiation exposure of personnel connected with the operations of JTF 132.

D.2 RESPONSIBILITIES

1. Issue, receive, process, and interpret all photographic film badges.
2. Issue, receive, read, and record all TG 132.1 personnel dosimeters.
3. Maintain records of exposures which will be available to proper authorities.
4. Forward photodosimetry reports to the appropriate service surgeon or civilian laboratory at the completion of the operation.
5. Forward processed film to AFSWP for final storage at the completion of the operation. A record of exposures will accompany this shipment.
6. Forward all film records to the Division of Biology and Medicine, AEC.

D.3 ORGANIZATION

Processing: Two enlisted men and one supervisor.

Records: Two enlisted men and one supervisor.

Note: It is expected that individual duties will cover all aspects of photodosimetry and records work.

D.4 EQUIPMENT

1. The main item of equipment is the photodosimetry trailer, which is practically a self-contained unit for processing and interpreting film. The trailer is air conditioned and is equipped to maintain bath temperatures constant.
2. Photodosimetry facilities exist in the Rad-Safe Building on Parry Island, providing more space and greater processing capacity.
3. Three densitometers are available, two Ansco and one Weston. The Ansco is the primary instrument for this operation.
4. A survey meter will be used to check contamination on incoming film and dosimeters.
5. A Kardex file will be used for individual exposure records.

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D.5 MATERIAL

1. The standard film packet to be used is Du Pont packet 558 containing one piece of 508 emulsion (range 15 mr to 6 r) and one piece of 1290 (range 5 to 750 r) with a 20-mil-thick lead strip ½ in. wide covering about one-half the length of the packet on both sides. The lead is held on the paper-wrapped packet by an adhesive. The entire packet with lead strip is enclosed in a heat-sealed envelope of 2-mil polyethylene. The standard badge will be identified by an embossed number.

2. In addition, extra badges and films will be worn by one group. These films will be in Du Pont packet 553 consisting of one piece of 502 (range 30 mr to 15 r), one piece of 510 (range 5 to 50 r), and one piece of 606 (range 10 to 300 r). The holders for this packet will be of two types: the Los Alamos holder, made of 20-mil sheet brass with two windows on both sides of the holder, one open to the air and one covered with 20 mils of cadmium, and the Bureau of Standards holder, which has no windows but completely encases the film in layers of bakelite, tin, and lead. These films will be identified by X-rayed numbers.

3. Processing chemicals —Ansco Liquadol developer (concentrated liquid), glacial acetic acid, and Ansco Liquafix fixer (concentrated liquid).

D.6 PROCEDURE

D.6.1 Location

Film processing and densitometry will be done in the photo trailer aboard the USS Rendova or in the Rad-Safe Building on Parry Island. When all personnel are evacuated, operations will necessarily be conducted aboard ship. When conditions on Parry Island permit, operations may be moved ashore.

D.6.2 Film Storage

Prior to issue film will be kept in a locked refrigerator set between 40 and 50°F. Frost will not be allowed to accumulate, and a desiccant will be used to keep the air dry.

D.6.3 Calibration

Film will be calibrated by accurately timed exposure at a fixed distance from a known amount of radium or Co^{60}. A set of these standards will be processed, and a calibration curve will be plotted. Included in a set of calibrated film is a control (unexposed) film. The amount of fog on the unexposed film is subtracted from the calibrated film to obtain the net density; gross densities are never used.

The formula for exposure time is as follows:

$$t = \frac{d^2 \times 60 \times r}{7.8 \times s}$$

where t = time in minutes
d = distance in centimeters
r = roentgens
s = source strength in milligrams

The constant 7.8 is used only if the radium source is enclosed in a platinum capsule of 1-mm wall thickness. For ½-mm platinum wall thickness, this constant is 8.4. For 1-mm monel metal, this constant is 8.5. For Co^{60} of known source strength, the constant is 13.6.

Dosimeters are leak tested to detect possible discharge. Leak testing consists in charging the dosimeter to zero, setting it aside for a 24-hr period, and then rereading. If the chamber discharge is greater than 10 per cent of full scale, the chamber is declared inoperative.

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Calibration of the dosimeter is similar to film calibration. The dosimeters are mounted in a circle at a 40-cm radius from the source and exposed to an r value of roughly ¾ full-scale deflection (i.e., a 200-mr dosimeter exposed to 150 mr). After the exposure is completed, the resultant reading is recorded, and a correction factor is taped on the dosimeter body.

$$\text{Correction factor} = \frac{\text{calculated r values}}{\text{dosimeter reading}}$$

D.6.4 Issue and Receiving

A personnel-exposure data sheet prepared from loose-leaf paper will be used for issuing and receiving purposes. The form will have space for the following information:

1. Date of issue.
2. Film-badge number.
3. Issued to.
4. Person wearing badge.
5. Project.
6. Wearer's home station.
7. Date returned.
8. Dosimeter number.
9. Dosimeter reading.

In so far as possible the monitor assigned to each recovery or working party will draw film badges for the entire party. He will sign for all films and will be given an extra form so that he may record the names of the persons who receive them. Certain elements of the Task Force will be issued film badges on a block basis to be reissued to individuals at the discretion of the group Rad-Safe officers. Personnel-exposure data sheets should be filled out in duplicate and returned with used badges. For military personnel, rank or rate and serial number should be given also. One copy of the exposure form will be retained by the Photodosimetry and Records Section, and the other will be returned to the appropriate Rad-Safe officer. With each group of returned badges one or more control (unexposed) badges should be included. When the film badge and dosimeter are returned, the dosimeter will be read, and the reading will be recorded. Film badges will be sent to the Processing Section for developing and interpretation. Processed film will be kept in a combination-locked safe file until properly declassified.

D.6.5 Developing

The loose-leaf form used by the Processing Section will contain the following information:

1. Badge number.
2. Gross density.
3. Net density.
4. Exposure.
5. Date.
6. Batch number.
7. Lot number.

All film in the packet will be processed, but only the appropriate one for the exposure received will be interpreted.

The solution will be maintained at 68°F. A suitable concentrated liquid X-ray developer and fixer will be used. The stop bath will be distilled water with 1.5 per cent acetic acid. Process solutions are changed after running through approximately 2500 films, or sooner, if deemed advisable. Unwrapped film is always handled by the edges to avoid finger marks on either surface.

D.6.6 Timing

1. Developing solution is agitated with paddle.

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2. At zero time the timer is started, and the film is placed in developer and let stand for 3 min.

3. Film is removed and allowed to drain for not more than a few seconds.

4. At +3 min, the film is immersed in stop bath and agitated for 10 sec.

5. Film is placed in fixer for 10 min.

6. Film is placed in wash for 30 min.

7. Film is placed in dryer until completely dry.

At least one control and one calibrated film will be processed with each batch.

D.6.7 Densitometry

1. Instrument is turned on and warmed up for 10 or 15 min until pointer becomes stable.

2. Operator positions himself so that the meter is at about eye level and in the center of his field of vision.

3. Densitometer calibration is performed by the use of a calibrated-density step-wedge. The original step-wedge readings should be duplicated on future calibrations with a drift of ±2 divisions or less.

4. Instrument must be checked for drift after reading film with densities in the range 4 to 6.

5. Prior to reading, film should first be visually analyzed for light streaking or contamination. In the event of uneven densities an average should be recorded.

6. Only density readings under the double thickness of lead will be taken and recorded on the film-processing form.

7. The densitometer is always turned to the off position when not in use. This prolongs the life of the light source.

8. Films are filed in numbered and dated paper envelopes, which in turn are placed in cardboard filing boxes.

D.6.8 Recording

Densities appearing on the processing sheet will be interpreted in milliroentgens from the calibration curve. The exposure will then be recorded on the personnel-exposure data sheet and on the individual's exposure record.

Individual exposure records will be kept on 5 by 8 cards in a Kardex file. These cards will contain the following information:

1. Name.
2. Project.
3. Home station.
4. Date.
5. Badge number.
6. Exposure.
7. Accumulated dose.
8. Dosimeter reading.

Cards will be made up as far in advance as is possible for each person likely to receive any exposure.

D.6.9 Reports

It is contemplated that the following reports will be made daily after shot time: (1) accumulated exposure of monitors and helicopter pilots and (2) all persons whose exposure exceeds 2 r.

Upon completion of the operation a master list of all exposures will be prepared. The final repository for film records will be the Division of Biology and Medicine, AEC; the final repository for all films will be AFSWP. It will be necessary to forward reports of exposures to the home station of each civilian film-badged.

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APPENDIX E

STANDARD OPERATING PROCEDURE FOR RADIOLOGICAL FIELD LABORATORY

The mission of the Radiological Field Laboratory is to perform radiological assays of liquids, solids, and airborne particulate matter for the Rad-Safe Officer in connection with the health-physics program of Operation Ivy. The following discussion will indicate how this mission will be accomplished.

Samples will be received aboard the USS Rendova, where the field laboratory is stationed. These will be monitored, and representative samples will be taken for assay. The techniques to be followed will vary with the data desired and the type of sample submitted. The standard operating procedures described in detail in the "Manual for the Radiological Field Laboratory" will be adhered to. Expected samples include salt water from the Eniwetok Lagoon, fresh water from the effluents of drinking-water purification plants, soil taken at various distances from ground zero, and airborne material collected on filter paper and cascade-impactor slides.

The field laboratory will determine, as required, the activity of alpha, beta, and gamma radiations; the energy of beta and gamma radiations; and the decay rates of the various activities. Beta and gamma measurements will be taken primarily by means of end-window G-M tubes coupled to either decade or binary scalers. Rough and rapid gamma activities can also be obtained by dip counting using a Marinelli type beaker coupled to a scaler. Alpha activities will be measured with a scintillation counter plus a scaler.

Beta energies will be obtained by Feather analysis using aluminum absorbers; gamma energies will be determined with lead absorbers. Decay rates will be primarily determined by manual counting at definite time intervals. Rapidly decaying activities will, however, be followed with a counting rate meter and automatically recorded.

The accuracy of the data will be ensured by calibration against standard sources. The operation of each counting setup will be checked by the daily determination of standard factors and periodic determination of chi-square values. The nine-tenths error of the raw counts will be maintained at a level below 1 per cent. The over-all precision of the results will be held to a maximum spread of ±5 per cent. Results will be reported on standardized forms to RIC.

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APPENDIX F

STANDARD OPERATING PROCEDURE FOR DECONTAMINATION GROUP

F.1 MISSION

The mission of the Decontamination Group of TU 7, TG 132.1, is to reduce unnecessary personnel exposure to radiation effects by the operation of the necessary decontamination stations.

F.2 RESPONSIBILITIES

The responsibilities of the Decontamination Group are to

1. Operate a personnel-decontamination station in Building 57 (Rad-Safe Building).
2. Operate an equipment-decontamination station north of the personnel pier on Parry Island.
3. Operate an aircraft-decontamination station in the vicinity of the flight operations building, Parry Island airstrip.
4. Operate two entry and exit control points: one in the vicinity of the flight operations building and one on the north side of the personnel pier.
5. Operate and safeguard a contaminated-equipment storage area immediately to the north of the Rad-Safe Building.

F.3 ORGANIZATION

Personnel Decontamination: One supervisor and one enlisted helper.

Equipment-decontamination Station: One supervisor plus the decontamination team.

Aircraft-decontamination Station: One supervisor plus the decontamination team.

Decontamination Team: Three enlisted men, one of whom must be capable of driving vehicles (i.e., possess a license) to the parking and/or storage area from decontamination areas. The team is to operate at both decontamination stations on instructions from respective officer supervisors.

Check Points: Officer supervisors at both stations will act as check-point supervisors also.

Contaminated Storage Area: No personnel required. On storage of equipment the area will be adequately posted with the proper signs.

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F.4 PROCEDURES

Aircraft: Prior to the departure of aircraft for the site, all passenger compartments will be lined with paper. Areas to be covered will include the deck, sides, seats, and any other pertinent sections of the interior which are subject to body contact and/or recovery-equipment contact.

Prior to the departure of aircraft from the site area, all passengers will be instructed to discard bootees and gloves at the site area after each recovery or entry and subsequent re-entry into the aircraft.

On return of the aircraft to the control check point at the airstrip, the supervisor will check the craft for contamination above the prescribed limits and log the necessary information in the control-check-point log sheet. If the contamination check indicates levels above the permissible amounts, the following steps will be taken in order until the radiation level is reduced to the permissible limits:

1. Remove all paper liners.
2. Remonitor.
3. Vacuum interior and exterior surfaces of craft.
4. Remonitor.
5. Notify Decontamination Group supervisor if allowable limits still have not been reached.

Vehicles: Prior to the departure of vehicles for the site areas, all passenger compartments will be lined with paper. Areas to be covered will include seats, bed, sides, and any other pertinent sections of the vehicle subject to contamination by contact of personnel or recovery equipment.

Prior to the departure of the vehicle from the site area, all passengers will be instructed to discard bootees and gloves at the site area.

On return of the vehicle to the control check point at the landing area north of the personnel pier, the supervisor will check the vehicle for contamination above the prescribed limits and log the necessary information in the control-check-point log sheet. If the contamination check indicates levels above the permissible amounts, the following steps will be taken in order until the radiation level is reduced to the allowable limits:

1. Remove paper liners and sweep out interior portions of the vehicles.
2. Remonitor.
3. Scrub surfaces indicated with soap and water using suitable brushes; follow by a fresh-water flushing using the power-driven decontamination apparatus.
4. Remonitor.
5. Escort the vehicles to the contaminated-equipment storage area if levels still have not been reached.

If the vehicle is checked out as clean, either before or after the decontamination procedures have been applied, the decontamination-team driver will drive the vehicle to the parking area adjacent to the Rad-Safe Building.

Boats: The same methods will be used for small boats as for vehicles, with the exception that paper liners will not be installed prior to departure and the contaminated-equipment storage area will not be on land north of the Rad-Safe Building.

Personnel: Prior to the departure of personnel for the site areas, they will assemble at the Rad-Safe Building for a briefing of decontamination procedures and for issuance of the following protective clothing and equipment:

1. Shoes and bootees.
2. Socks.
3. Coveralls.
4. Gloves (type suitable for the operation involved).
5. Fatigue cap.
6. Necessary personnel dosage devices.
7. Dust respirator.

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Prior to the departure of personnel from the site area, they will discard bootees and gloves when notified by the group monitor.

On arrival of personnel at either check point, they will be directed by the supervisor and by appropriate signs to the personnel-decontamination station.

On entering the personnel-decontamination station, each person will obtain one paper bag for valuables storage and will then proceed to disrobe as indicated by the signs in the station. Clothing will be discarded, as removed, into the appropriately marked containers. Personnel will then enter the shower room, place their valuables (in paper bags) on the appropriately marked shelf, and proceed to wash themselves thoroughly using soap and water. Personnel will be instructed to pay particular attention to the folds and creases of the body as well as the hairy portions of the body. When the shower is completed, personnel will enter the drying room, dry themselves thoroughly with a towel, discard the towel in an appropriately marked container, and be monitored. If passed, personnel will then retrieve their valuables and proceed to the dressing room, where their passage through the station will be recorded by the supervisor on the appropriate personnel-decontamination log sheet. If necessary, first aid for minor cuts and bruises will be furnished after leaving the drying room.

Personnel not passing the monitor at the drying room will reenter the shower room for another shower, obtain another towel, and be remonitored.

Personnel not passing the monitor for the second time will be referred to the supervisor, who will take necessary action.

F.5 RADIOLOGICAL DECONTAMINATION OF HELICOPTERS (MODELS HRS, H-19, OR S-55)

F.5.1 Purpose

This project was undertaken to determine an expeditious helicopter-decontamination method which would allow high availability in contaminated areas and would be especially applicable for shipboard operations.

F.5.2 Preparation

The aircraft were monitored with an MX-5 beta-gamma radiac meter for contamination at 30 reference points, with readings being noted before and after each type of decontamination process was employed. In some cases the aircraft was stripped of cowling, and in others, only partially. The main rotor blades were removed in all cases, and the starter and magnetos were covered. After the first method used, it was found necessary to seal the radio compartment to prevent water or steam from damaging this equipment.

F.5.3 Methods Employed

Steam: This method is especially good for cleaning grease and oil from metal surfaces. However, the extreme care which must be exercised around seals, electrical and radio wiring, ignition harness, and moving parts makes it impractical to use. Although this method is the most practical for shipboard use, its damaging effects preclude its use.

Tide Slurry and Fresh Water: A mixture of Tide detergent and water in a 1 to 1 ratio was applied by means of a suction spray gun; this was followed by scrubbing with a brush and washing with fresh water. This process removed grease and oil, did not harm internal or moving parts, and was relatively fast as well as effective.

Kerosene and Water: This method was applied by spraying kerosene over the contaminated object and letting it remain for 15 min before washing with fresh water. This process removed grease and oil and did not harm moving parts. However, after the rinse a film of oil remained, which could be the means of collecting further contamination.

Fresh Water: This is effective against loose dirt but will not remove grease or oil, which holds the majority of contamination.

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Trichloroethylene: This is a very effective method which removes paint and grease; it is toxic and otherwise dangerous to personnel using it.

Cleaning Compound (Gunk)–Kerosene and Steam: The cleaning compound was mixed with kerosene in a 4 to 1 ratio, was applied by spray, and then was removed by steam. The amount of oil and grease removed was less than that removed by kerosene and water; the use of steam around the ignition system precluded a thorough steaming.

Liquid Soap and Water Under Pressure: This method was applied by mixing soap and water in a standard Army decontamination vehicle (400 gal), applying under pressure, and following by a rinse of fresh water under pressure. The method was effective on all dirt but did not thoroughly remove grease and oil.

F.5.4 Precontamination and Predecontamination Requirements

The following requirements should be adhered to before entering contaminated areas and when attempting to decontaminate helicopters.

1. Prior cleaning and waxing of the helicopter will tend to hold contamination to a minimum.
2. Seats used by personnel entering and departing contaminated areas should be of a nonporous material or covered by disposable material.
3. The deck areas should be smooth surfaces which can readily be vacuum cleaned, or may be covered with a disposable material.
4. Bootees or shoes and gloves worn in contaminated areas must be removed and discarded before entering the helicopter.
5. Radio and baggage compartments should be sealed to prevent dust and water from entering.
6. Competent helicopter personnel should be employed to prepare the helicopter and to direct decontamination.
7. Component replacement parts should be available to replace items which become internally contaminated and are impossible to clean in the field.
8. All parts that require greasing should be greased before and after the decontamination process.
9. For shipboard decontamination a large square section of painted canvas raised along the edges by sandbags to form a hollow square with one corner draining into scuppers may be used as a decontamination area.
10. For land-based decontamination an area of concrete with a drain in the center may be employed.
11. The use of salt water is not feasible on helicopters.

F.5.5 Conclusions

It is noted that kerosene and water on the engine and Tide slurry and water and steam on all the other components produce a very good slope of reduction in contamination.

It is noted that liquid soap and water applied under pressure and pressure rinsed and even Tide slurry and water reduced the contamination to not below 10 mr/hr. This is probably because the contamination is internal and impossible to reach with the methods used and without taking the components apart piece by piece. This is a time-consuming project and is not feasible if a high availability rate is to be maintained while operating in contaminated areas.

It is further noted that the main rotor-blade tips are contaminated owing to the drain holes and cannot be reduced by any of the methods used. The steam method cannot be employed because of factory limitations on washing the blades with nothing stronger than a mild soap and water, owing to the bonding process used in their construction. The leading edges of the blades were pitted, and it was assumed that emery cloth would smooth these pits and reduce the contamination; this was not true.

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The main rotor-blade hub was reduced to a zero reading following a Tide slurry and water bath which indicated that all the contamination was embedded in the grease at this point.

Kerosene followed by water on the engine was found to be the most effective method on this part of the helicopter. A more thorough cleaning prior to entry into a contaminated area would have decreased engine contamination considerably.

Tide slurry scrubbing and rinsing with water was exceptionally effective on the cabin, rotor head, and intermediate gear box. Steam was also effective, but it is harmful to the various portions of the head and engine.

Trichloroethylene was effective but cannot be used because of its volatility and toxic effects.

The radio equipment was not contaminated enough to be cleaned, but in event of contamination it should be immerred in carbon tetrachloride. However, dynamotors should be hand cleaned.

Oil was drained from the engine, gear boxes, and hydraulic system and monitored; no contamination was present.

The over-all results indicate that Tide soap and water in a 1 to 1 ratio, sprayed on, followed by brushing, and then rinsed with fresh water is considered to be the most effective method. However, if decontamination equipment is available to apply the slurry under pressure with a mixture of 400 gal to 10 boxes of Tide, it should be used and followed only by a pressure rinse. The amount of time involved is fairly constant, and it is believed that the entire operation of disassembly, washing, and reassembly can be done in 4 to 5 hr with four men, using the following system:

1. Remove the side transmission panels, engine intake ducts, fan cover, all loose gear in the cabins, and main rotor blades.
2. Purge all grease fittings with new grease.
3. Vacuum radio and baggage compartments, and seal with scotch electrical tape.
4. Cover starter and magnetos.
5. Apply Tide slurry and water rinse.
6. Regrease all fittings.
7. Check radio compartments for dryness.
8. Reassemble the helicopter.

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APPENDIX G

STANDARD OPERATING PROCEDURE FOR RAD-SAFE INFORMATION CENTER

G.1 MISSION

The RIC will be established aboard the USS Rendova on MX−1 day and will operate from this time until recovery operations need no longer be conducted from the ship.

The purpose of the RIC is to collect, analyze, and disseminate air- and surface-survey data for assisting CJTF in determining R hour. Information on the radiological situation is also necessary for the various commanders of task groups to properly carry out their mission.

G.2 SEQUENCE

Day	Hour	
M−1		Information on the surface radex forecast will be passed from CTU 7 via AN/TRC and will be placed on a maneuvering board in RIC.
M	H + 10 min to H + 2 hr	Information from helicopters performing survey missions in the atoll will be received by the TU 7 communicator in CIC, USS Rendova, and will be passed to RIC for decoding and plotting on detail charts of the atoll. This information will be copied in duplicate, the duplicate being held in RIC for pickup by the TU 7 Control Group. Information of immediate importance can be passed by intercom.
	H + 2 hr	Initial atoll survey reports will be relayed to CJTF via AN/TRC. Results of the initial survey of Eniwetok Island, necessary for entry of Air Force personnel manning airstrip facilities, will be passed as soon as possible.
	H + 11 hr	Information on the radiological situation will be passed to CTU 7 for inclusion in the report to CinCPac.
M + 1	Approx. 0900	Results of detailed atoll aerial-survey and any ground-survey data will be relayed to CTU 7. CTU 7 will also be advised of any significant dosage received by personnel.
M + 1	1730	CTU 7 will be advised of the general Rad-Safe picture with recommended status of atoll and lagoon areas subject to open or controlled operations.

There will be many other survey data passed to CTU 7 as the situation develops.

The Rad-Safe Office, Joint Operations Command (JOC), will relay to the Rad-Safe center certain significant information from outlying weather stations and certain operational information from AFOAT operations which are reported direct to JOC.

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APPENDIX H

STANDARD OPERATING PROCEDURE FOR RADIOLOGICAL SAFETY INVOLVED IN TRANSPORT OF RADIOACTIVE SAMPLES TO THE ZONE OF THE INTERIOR

H.1 PURPOSE

The purpose of this Standard Operating Procedure is to establish procedures and responsibilities in connection with the packaging, loading, transfer, and unloading of radioactive samples being transported to the Zone of the Interior (ZI).

H.2 GENERAL

The responsibility for radiological safety in connection with the transporting of radioactive samples to the ZI has been given to TG 132.1 (TU 7). The samples will be principally material collected during the tests. Adequate precautions will be taken to ensure the radiological safety of personnel involved in handling the samples during loading, transporting, and unloading operations.

H.3 MONITORS

A monitor will be required for each special sample courier aircraft traveling to the ZI. This monitor will be responsible for the radiological safety of all personnel in the aircraft until the sample is turned over to the using agency.

Program monitors will be responsible for radiological safety in connection with packaging and loading the samples of their program on the aircraft.

The TG 132.1 liaison officer with TG 132.4 at Kwajalein will be responsible for radiological safety in connection with the collection of the samples from test aircraft and the packaging and the loading of these on the MATS aircraft.

H.4 RADIOLOGICAL LIMITS

Each package will be shielded so that the maximum radiation will not exceed 0.1 r/hr at 1 ft. The radioactive material will be stored in such a location as to prevent personnel from being exposed to more than 0.1 r/hr and not to exceed a total dose of 3 r.

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H.5 INSTRUMENTS AND FILM BADGES

Each person aboard the aircraft will be issued a film badge and will wear it at all times.

Each aircraft monitor will, in addition, carry a 263B survey meter.

The aircraft monitor will return all the film badges issued to him via Air Mail to CTU 7, TG 132.1.

The film badges will be accompanied by a list giving each person's name, badge number, and home station address.

For flights terminating at Kirtland AFB, N. Mex., the 263B survey instruments will be consigned to H Division, LASL.

For flights terminating at Baltimore, Md., the 263B instruments will be consigned to Health Physics Division, Radiological and Chemical Laboratory, Army Chemical Center.

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APPENDIX I

STANDARD OPERATING PROCEDURE FOR LOW-ORDER DETONATION

I.1 PRIMARY HAZARDS INVOLVED

HE Only: An internal hazard due to the possibility of inhalation or ingestion of alpha emitters (Pu^{239}, U^{235}, U^{238}) and/or tritium, which is a soft beta emitter, will exist. There would be no external hazard from beta or gamma.

HE Plus Low-order Nuclear Detonation: An internal hazard will exist as described above. In addition, an external hazard would exist from beta and gamma radiation. The extent of the external hazard would be dependent on how far the fission reaction had progressed.

I.2 RESPONSIBILITY FOR REENTRY

The decision to reenter is the responsibility of CTG 132.1; no personnel will enter without his approval.

I.3 RAD-SAFE SURVEY

Upon notification from the CTG 132.1 of the decision to reenter, CTU 7 will take the following action.

A survey team composed of three control monitors will approach the compound for a gross survey; the survey will consist in gathering the following information:

1. One monitor will be equipped to determine the extent of the external hazard from beta and gamma radiation.
2. One monitor will be equipped to determine the extent of the internal hazard from alpha contamination.
3. The third monitor will have special equipment available to determine the hazard due to tritium.

Upon completion of the survey, the CTU 7 will advise the CTG 132.1 of the radiological hazards existing and the precautions to be taken.

I.4 PROTECTIVE CLOTHING AND EQUIPMENT

All personnel entering the area will wear full protective clothing and equipment, including respiratory equipment. On initial entry and until the extent of the hazard is determined, supplied air type respirators are desirable.

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I.5 DECONTAMINATION

All personnel and equipment leaving the area will be routed through a decontamination station which will be established by TU 7. Every effort will be made by the individual to limit the spread of contamination.

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APPENDIX J

RADIOLOGICAL-SAFETY REGULATIONS

J.1 REGULATIONS

The total permissible dose for personnel participating in Operation Ivy is 3.9 r (measured gamma only), based on a three-month operational period. No limitation is placed on the rate of accumulation of the total dose permitted for the operation so long as the rate is sufficiently low to permit adequate control. Special rules apply to sampling-aircraft pilots.

Individuals or groups working in contaminated areas, or with contaminated equipment, will be accompanied by Rad-Safe monitors. During recovery operations the Rad-Safe monitor 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 members of the recovery party to adhere to the limits established in this Appendix.

Names of all individuals who are expected to enter radioactive areas subsequent to a test will be submitted to CTG 132.1 in the form of an eligibility list two weeks prior to the test.

All islands in the atoll will be considered contaminated after each test until reported clear by CJTF 132.

No radioactive material will be removed from the test site, except as authorized in experimental program plans. Unauthorized entry into radioactive areas is prohibited.

Prior to entering a contaminated area, the monitor will issue appropriate equipment, consisting of film badges, dosimeters, and such protective clothing as may be required. Work parties will wear appropriate face masks if the radiological monitor deems it necessary. On leaving a contaminated area, all persons will return film badges and dosimeters to the monitor and will dispose of bootees and gloves. The monitor will check personnel for contamination and process those contaminated through the personnel-decontamination station.

All personnel working with radioactive materials will wear protective clothing and/or gloves as indicated. Safe handling of highly radioactive materials will be ensured by the proper use of additional protective equipment, such as tongs and remote-handling devices.

J.2 PERMISSIBLE CONTAMINATION LEVELS

Permissible contamination levels stated below are to be regarded as advisory limits for the general guidance of Rad-Safe personnel attempting control of contamination under average conditions. These limits may be adjusted upward or downward under special circumstances, as directed by CTG 132.1.

All readings of contamination levels are to be made with side-window G-M counters, the counter tube walls of which are not substantially in excess of 30 mg/cm^2, with the beta shield open. When possible the surface of the probe should be held 1 to 6 in. from the surface under

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observation. The larger distance is preferable for preliminary survey; the smaller distance is preferable for detailed survey of maximum contamination areas.

J.2.1 Personnel and Clothing

Skin: Complete decontamination by bathing is to be attempted. If a reading in excess of 1 mr/hr is obtained after repeated washings, the decontamination supervisor will be consulted for appropriate advice.

Underclothing and Body-contact Equipment (Interior Linings of Boots and Respirators): The permissible limit is 2 mr/hr.

Outer Clothing and Body-proximity Equipment (Outer Surface of Boots and Protective Clothing): The permissible limit is 7 mr/hr.

J.2.2 Aircraft, Vehicles, and Small Boats

The permissible limits are as follows: interior surfaces, 2 mr/hr; exterior surfaces, 7 mr/hr; and distant exterior surfaces, 20 mr/hr.

J.2.3 Air and Water

The following continuous levels of radioisotope content in air and water are generally considered to be safe:

	Beta or gamma emitter	Alpha emitter
Air	10^{-9} μc/cc	5×10^{-12} μc/cc
Water	10^{-7} μc/cc	10^{-7} μc/cc

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APPENDIX K

MIKE RECOVERY PROGRAM

K.1 AERIAL SURVEY

The aerial-survey officer with one assistant will leave the USS Rendova at H + 10 min by helicopter and go directly to Elmer. The helicopter will fly at an altitude of 50 ft and a ground speed of 20 mph over the center of each island in the chain in the direction of Flora. While flying over each island, the readings will be taken with a T1B survey meter, corrected to ground intensity, and sent by radio to the USS Rendova by prearranged code. The time and exact location will be sent with each reading.

When an instrument reading of 5 r/hr is reached, the helicopter will halt, make a wide detour around Flora, and proceed to Alice. The survey will then continue back toward Flora until a reading of 5 r/hr is again obtained. In order to obtain accurate isodose lines, flights will be made in several different directions over any island that shows a marked gradation of intensities.

The above survey will be repeated on M + 1 day and on following days, as the situation requires, and, in addition, surveys will be made of islands Glenn through Leroy.

K.2 GROUND SURVEY

General: Ground surveys of all islands requiring reentry will be made to confirm the results of aerial surveys and to assess the personnel hazard involved in reentry. Monitors will be required for all recovery parties until the island is cleared for reentry. Final clearance will be based on ground-survey results.

Initial Recovery Surveys: As soon as the aerial-survey data indicate that stations having high recovery priority may be safely approached, ground surveys will be made, using a helicopter to transport the monitor. Results will be reported to RIC by the most expeditious means available, preferably by radio in prearranged code. These data will constitute a preliminary ground survey. Monitors will not undertake more extensive survey operations than required for the accomplishment of the recovery missions. Recovery parties, accompanied by a monitor, if necessary, will then proceed only if the recovery can be made under existing radiological conditions.

M + 1 Day (Elmer and Fred): The ground-survey officer and one assistant will leave the USS Rendova by helicopter at 0630 (dawn) for Elmer. A $\frac{1}{4}$-ton 4 by 4 truck, located at the Rad-Safe Building, will be used for ground transportation. When the Elmer survey is completed, the party will proceed to Fred by helicopter and make a ground survey of that island. CTG 132.2 will provide a $\frac{1}{4}$-ton 4 by 4 truck at a prearranged location for ground transportation. Reports will be made to RIC by radio.

M + 2 through ME Days: Ground surveys of Elmer and Fred will be repeated as described above.

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K.3 WATER SURVEY

Eniwetok Atoll: The TG 132.3 Rad-Safe Officer will leave the USS Rendova by helicopter at about H + 4 hr to make a water survey of the lagoon and surrounding waters. Samples of water will be taken at various points and will be flown back to the USS Rendova for analysis. Additional water surveys will be made on M + 1 day and on following days as required.

Distant Atolls: Water samples will be taken from several distant atolls and islands. The passage of the radioactive cloud will determine the location and the time of the samples to be taken. Transportation will be by Navy PBM.

K.4 RECOVERY PLAN

Tables K.1 and K.2 list the projects, means of transportation, and islands to be visited. Table K.1 gives high-priority projects, essential to the success of the operation, which must be recovered as early as the radiological situation permits. Table K.2 lists all other projects. The time of recovery will depend on the radiological conditions on the islands to be visited and on the availability of helicopters for transportation. In cases where the recovery teams of different projects are composed of the same personnel or where different projects must visit the same islands, those projects are listed together.

The recovery program is based on the assumption that all recovery will be from the USS Rendova. When recovery is to be made by boat, helicopter transportation will be used to Elmer, where the boat will be picked up. The helicopter will then return to the USS Rendova for use by other recovery teams.

Radiological surveys will be made of islands to be visited before any recovery missions are scheduled for those islands.

K.5 COMMUNICATIONS

K.5.1 General

The principal communications requirement in the execution of the above plan is that of relaying radiological information from the monitors to RIC. Since the utilization of monitors will be for the most part prearranged, messages pertaining to the employment of these monitors will constitute only a small portion of the total volume of traffic. The design of this communication plan is thus directed toward a rapid transmission of information from the individual monitor to RIC, with only secondary consideration being given to communication between monitors.

From M until ME day RIC will be aboard the USS Rendova, and all messages from monitors will be directed there. On ME day both the RIC on the USS Rendova and the newly opened RIC in Building 57, Elmer, will be in operation until full control is assumed by the latter. At this time the Net Control Station on Elmer will notify all member stations of this change and will also report to the TG 132.1 command net (J-114) from the new location.

K.5.2 Provisions for Monitor-to-RIC Communication

General: Prearranged codes by which radiation intensities and location may be reported will be provided each monitor. These codes will be submitted to CTG 132.1 and CJTF 132 for approval in accordance with Operations Plan 1-52. Prior to ME day all communications will be via radio; after ME day landline telephone will be available to certain upper islands as an alternate means of communication.

Specific Missions: Aerial-survey monitors will report via helicopter radio to the Communications Center aboard the USS Rendova for delivery to RIC from M to ME day and, thereafter, direct to the Elmer Air Operations Office for delivery to RIC in Building 57, Elmer.

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Table K.1 — HIGH-PRIORITY RECOVERY

Project	No. of persons	Means of transportation	Islands visited and remarks
Aerial survey	3	Helicopter	All islands
W. E. Ogle	3	Helicopter	Damage survey; leave USS Rendova after completion of aerial survey
Utilities crew	5	Helicopter	EE; leave USS Rendova H + 20 min
3.1, 2.1, 8.2, 9.1, 5.3	7	2 helicopters	EE only; leave USS Rendova H + 20 min; 3 persons for 3.1; 2 for 8.2; 1 each for 2.1 and 9.1; none in 5.3; photo tower, Bldgs. 212, 232
4.1, 4.2	8	LCM, LCU, 2 DUKW's	D and E; 4 project personnel; 4 H&N, plus boat crews; 2 monitors
4.4	4	Helicopter	E
3.3, 3.4	4	Helicopter	A (Station 300)
2.1 to 2.4	8	2 helicopters	I (Station 200); possibly could use 1 helicopter; 2 trips
5.2	3	Helicopter	C (high priority); B, D, and E can be late recovery
8.2, 8.1, 8.3	6	Helicopter and DUKW with A frame	J and T; high priority; A, I, L, M, O, and EE can be late recovery; total of 400 lb to be picked up at J and T; 5 recovery personnel, 1 H&N, DUKW operator
5.4a	6	2 LCM's, helicopters	A, J, N, W, Y, BB, EE, and FF; 20 stations in lagoon; 6 recovery personnel, plus boat crews; 3 monitors
5.4b	4	Helicopter	A, B, C, I, J, K, L, M, N, O, P, R, S, T, U, V, W, Y, Z, BB, DD, EE, FF, JJ, KK, and MM; 2 persons collect samples; 2 remain on FF to prepare samples; 50 lb picked up at each station
6.2	1	Helicopter	Check to see that AA guns have fired (breech should be open); check can be made by a monitor
Program 1	3	Helicopter	If air-sampling program fails, must get hot samples of water immediately; also A (Station 300)
3.1	2	Helicopter	J; if yield is low, immediate recovery of film is necessary

Monitors accompanying recovery parties will communicate to RIC via helicopter radio or landing-craft radio, depending on what means of transportation is utilized. SCR 300's will be used when further communication is needed from the means of transportation to the recovery party.

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K.5.3 Requirements

One SCR 508 will be installed in the Rad-Safe Building (Building 57), Elmer, with preset channels 24.5 and 26.9 Mc.

Eight SCR 300's will be used by monitoring parties with preset channel 44.5 Mc.

One telephone landline (W/EE8) will be used, connecting the Air Operations Office, Elmer, to RIC, Building 57, Elmer.

Table K.2—OTHER RECOVERY PROJECTS

Project	No. of persons	Means of transportation	Remarks
1.3	2	Helicopter	A (Station 300)
3.1	2	Helicopter	J
3.2, 3.5	2	Helicopter	EE
5.1	3	Helicopter	A, B, C, D, E, F, G, H, I, and J
5.3	2	Helicopter	A, I, J, T, Y, EE, and LL
6.1, 6.3, 6.5, 6.7b	4	Helicopter	I, J, K, L, M, T, S, Y, and EE
6.2	2	Helicopter	J, T, U, Y, and EE
6.3	2	LCM, truck	J, L, M, and S
6.7a	3	LCM, truck	I; required only if cable goes up on beach
6.9	2	LCM, $\frac{3}{4}$-ton truck	J, L, M, and S
9.3	2	Helicopter	EE
TU 9	3	LCM	G and I
Removal of cameras	5	Helicopter	A (Station 300), I (Station 200), and G (Station 520); (Note: Film has been removed from these cameras in prior recovery)

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APPENDIX L

KING RECOVERY PROGRAM

L.1 GENERAL

This program is predicated on the assumptions that personnel will not be evacuated for King shot and that all recovery operations will be made from Elmer.

L.2 AERIAL SURVEY

The aerial-survey officer with one assistant will leave Elmer shortly after H hour by helicopter. The helicopter will fly at an altitude of 25 ft, with a ground speed of 20 mph, over the center of each island in the direction of Yvonne. From Yvonne the survey will continue along the chain to Alice. An aerial survey of Glenn through Leroy will be made subsequent to completion of the above operation and when danger of encountering gross fall-out is passed.

Readings will be taken in flight over each island with a T1B survey meter and will be sent by radio in prearranged code to Elmer airport and then to RIC, Building 57, by telephone. The time and exact location will be sent with each reading. This survey will be repeated daily.

L.3 GROUND SURVEY

L.3.1 General

Ground surveys of all islands requiring reentry will be made to confirm results of aerial surveys and to assess the personnel hazard involved in reentry. Monitors will be required for all recovery parties until the island is cleared for reentry. Final clearance will be based on ground-survey results.

L.3.2 Initial Recovery Surveys

As soon as the aerial-survey data indicate that stations having high recovery priority may be safely approached, ground surveys will be made, using a helicopter to transport the monitor.

Results will be reported to RIC by the most expeditious means available, preferably by radio in prearranged code. These data will constitute a preliminary ground survey. Monitors will not undertake more extensive survey operations than are required for the accomplishment of the recovery mission. Early surveys of this type are contemplated for Yvonne, Tilda, Ursula, and Bruce. Recovery parties, accompanied by a monitor, if necessary, will then proceed, but only if the recovery can be made under existing radiological conditions.

L.3.3 Ground Survey of Inhabited Islands

Elmer: One monitor will make periodic surveys on Elmer as required.

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Fred: CTG 132.2 will be responsible for the ground survey of Fred. Results will be reported by telephone to RIC on Elmer.

Ground surveys will be made and repeated on an island-priority basis as needed until all necessary islands are cleared.

L.4 WATER SURVEY

Eniwetok Atoll: At H + 4 hr the TG 132.3 Rad-Safe Officer will make a water survey of the lagoon and surrounding waters, using a helicopter. Samples will be taken at various points and sent to CTG 132.1 (TU 7 Radiochemical Laboratory, USS Rendova) for analysis. This survey will be repeated on K + 1 day and subsequently as required.

Distant Atolls: Water samples will be taken and ground monitoring will be accomplished on elected distant atolls and islands. The time and location will be determined by passage of the radioactive cloud. Transportation will be by Navy PBM and/or surface craft.

L.5 RECOVERY PROGRAM

Eniwetok Atoll: The recovery program shown in Table L.1 is a projected schedule of recovery events. The times indicated are for planning purposes and may be postponed as conditions dictate. It is assumed that the shot will be fired under optimum weather conditions so that the postshot radioactive contamination on inhabited islands of the atoll will be at a minimum. The Rad-Safe Control Officer will determine the actual departure times of all trips into areas north of Elmer until these areas are cleared for reentry. Recovery personnel and transportation will be ready at the scheduled time. The Rad-Safe Control Officer will clear the trips for departure when the radiological conditions permit. Recovery from stations on Elmer will not be scheduled since no monitor support is anticipated.

Kwajalein Atoll: Rad-Safe responsibility for TG 132.4 personnel on Kwajalein Atoll lies with CTG 132.4. CTU 7, TG 132.1, has the responsibility for supervising the Rad-Safe activities in connection with Projects 1.3, 5.4b, and 7.3. Specifically, CTU 7 is responsible for the radiological safety of all personnel while working in connection with the removal, processing, and reshipment of experimental material from sample-collection aircraft until the aircraft are released to TG 132.4.

The senior monitor from TU 7 at Kwajalein will procure, from TG 132.4, monitors sufficient to accompany all aircraft sample-removal teams. The monitors will monitor all removal, processing, packaging, and loading of radioactive material. The TG 132.1 (TU 7) representative is responsible for the release, to TG 132.4 for shipment, of all materials returning to the ZI.

L.6 COMMUNICATIONS

Landline telephone will be the principal means of communication for King shot. RIC (Building 57, Elmer) will be connected by direct lines to CDR Maynard, JOC; Air Operations, Elmer; Marine Dispatcher, Elmer; and the powerhouse, Yvonne.

The above lines are in addition to the existing local telephone system.

Communications with monitors in helicopters will be via the regular channel (126.18 Mc) to Air Operations, Elmer. This channel will also be monitored by a VHF receiver in RIC. A Rad-Safe operator will be stationed at the radio position, Air Operations, Elmer, to copy Rad-Safe messages and pass them to RIC.

Communications from monitors in boats will be established on the regular H&N boat-pool frequency (25.6 Mc) by means of the SCR 508 located in RIC. It will be the duty of the monitor in the boat to notify Rad-Safe of his boat voice call and number prior to departure from Elmer.

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At the higher level, CDR Maynard in JOC, Building 211 (TF Headquarters Building), will have either landline telephone or AN/TRC radio contact with the following:

Weather Central, Fred	Rad-Safe, TG 132.3
CTG 132.2, Fred	USS Rendova
CTG 132.3	CIC, USS Estes

Island and intensity codes are those used for Mike shot and are available to monitors at RIC.

Table L.1 — PROJECTED SCHEDULE OF RECOVERY OPERATIONS

Item	Time	Project	No. of persons (exclusive of crew)	Means of transportation	Approx. recovery time, hr	Destination and remarks
				K Day		
1	H + 30 min	Aerial survey	2	1 helicopter	2	All islands; will inspect rocket launchers of Project 6.13 on Y, Station 6140, for misfire
2	H + 1 hr	6.13	2	1 helicopter	1	In case of rocket misfire, dispose of dud
3	H + 1 hr	2.1b	3	1 helicopter	1	Y, Station 250
4	H + 1 hr	2.1, 3.2, 3.5, 3.6, 3.8, 6.13, 6.2	4	1 helicopter	2	EE, Station 301; Y, Station 307; U, Stations 305, 306, and 303.09 to 303.16
5	H + 1 hr	8.2, 8.3	4	1 helicopter	1	BB, Station 804; T, Stations 802 and 803; EE, Station 301
6	H + 1 hr	6.1, 6.3	3	1 helicopter	1	Y, Station 605
7	H + 1 hr	Programs 3 and 8	4	1 LCM		OO and MM
8	H + 4 hr	Damage survey	2	1 helicopter	2	

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Table L.1 — (Continued)

Item	Time	Project	No. of persons (exclusive of crew)	Means of transportation	Approx. recovery time, hr	Destination and remarks
			K + 1 Day			
9	0730	Aerial survey	2	1 helicopter	2	All islands
10	0730	Ground survey	2	1 helicopter	2	Y; other islands as required
11	0800	Water survey	2	1 helicopter	2	Lagoon
12	0900	4.1, 4.2, 4.4, 5.1, 5.2, 8.1		1 LCU, 2 DUKW's, 1¼-ton truck, 2¾-ton trucks, 1¾-ton truck with A frame	4	Y, Stations 412.01–4.2.24, 441, 511.01–511.26, 521.04–521.06, 810.09–810.11
13	0900	6.3	2	LCM ¾-ton truck	2½	T, Station 630.04
14	0900	6.2	3	LCM	2½	Lagoon to recover rafts
15	0900	5.4b	4	1 helicopter	8	A, B, C, I, J, K, L, M, N, O, P, R, S, T, U, V, W, Y, Z, BB, DD, EE, FF, GG, JJ, KK, LL, and MM
16	1600	Water survey	2	1 helicopter	2	Lagoon
			K + 2 Days			
17	0730	Aerial survey	2	1 helicopter	2	All islands
18	0730	Ground survey	2	1 helicopter	2	As required
19	0800	Water survey	2	1 helicopter	2	Lagoon
20	0800	5.4b				Continues from previous day
21	1600	Water survey	2	1 helicopter	2	Lagoon
			After K + 2 Days			
22	0800	5.3	2	1 helicopter	8	A, J, T, Y, BB, LL, EE, and FF

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