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OPERATION HARDTACK, PHASE I

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TASK GROUP 7.5

RADIOLOGICAL SAFETY SUPPORT

OPERATION HARDTACK, PHASE I

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INTRODUCTION

This report has been prepared, primarily, to document the radiological support furnished by Holmes & Narver, Inc., the AEC Contractor, during Operation HARDTACK, Phase I. A secondary function of the report is to provide Rad-Safe information to be used in the planning of possible future operations.

The primary mission of the H&N Rad-Safe organization during the Operation was to protect TG 7.5 personnel from unnecessary exposure to radiation, to prevent the spreading of contamination, and to assist TG 7.1 in providing overall Rad-Safe support.

SUMMARY

The Rad-Safe organizational arrangement for this Operation - the Rad-Safe personnel of TG 7.5 functioning as an independent Rad-Safe organization for TG 7.5 - proved satisfactory and demonstrated that the AEC Contractor could adequately supply radiological safety service for TG 7.5.

In previous operations the AEC and its Contractor Rad-Safe personnel were integrated into TG 7.1, TU-6, and the CTU-6 became the Rad-Safe Officer for TG 7.5.

I. ORGANIZATION AND RESPONSIBILITY

1.1 Organization

1.1.1 General

The Rad-Safe personnel of AEC and its Contractor, Holmes & Narver, Inc., functioned as an independent Rad-Safe organization for Task Group 7.5. TU-6, the Rad-Safe organization for TG 7.1, acted as the overall Rad-Safe organization during the operational period; however, to keep radiation exposure to a minimum, TG 7.5 maintained control over services and operations as they affected TG 7.5 personnel.

Close liaison was maintained between CTG 7.5 and CTG 7.1 on all Rad-Safe matters of mutual interest. Facilities were shared, and work on common problems, such as dosimetry, decontamination, and equipment repair, was accomplished by agreement between the two TG Commanders.

An operational chart of the TG 7.5 Rad-Safe activities is shown in Figure 1.1.

1.1.2 H&N Rad-Safe Personnel

The Holmes & Narver Rad-Safe organization maintained a complement of 14 persons during the operational period. The personnel assigned to each atoll were:

Eniwetok		Bikini	
1	Rad-Safe Officer	1	Assistant Rad-Safe Officer
1	Senior Rad-Safe Technician	1	Senior Rad-Safe Technician
1	Rad-Safe Electronic Technician	1	Rad-Safe Electronic Technician
5	Rad-Safe Technicians	3	Rad-Safe Technicians

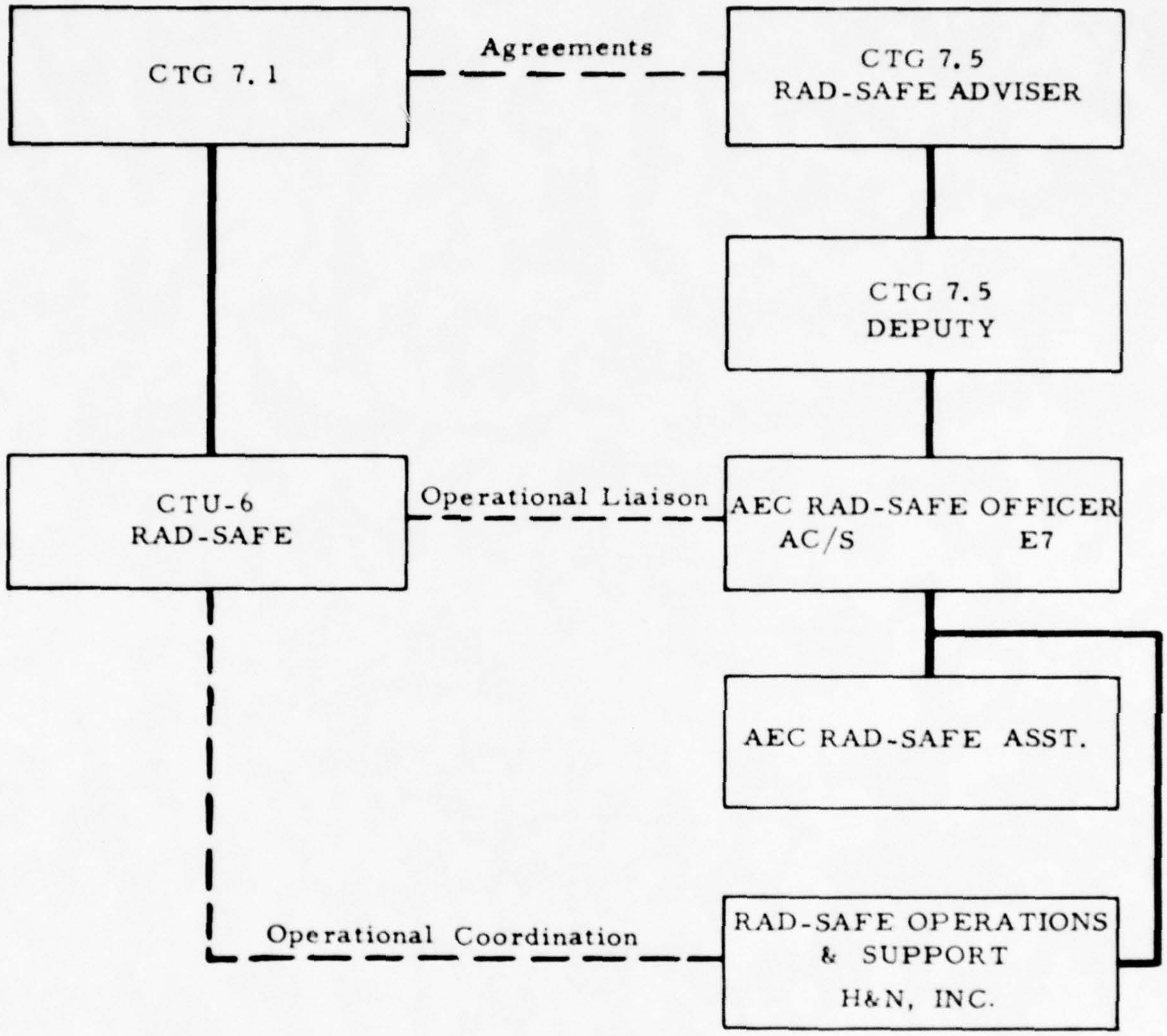

Figure 1.1 TG 7.5 RADIOLOGICAL SAFETY ORGANIZATION

1.2 Responsibility

1.2.1 Overall

At the beginning of Operation HARDTACK, the Commander, Joint Task Force Seven assumed overall responsibility for the radiological safety of all Task Force personnel.

1.2.2 TG 7.5

The CTG 7.5 held Rad-Safe responsibility for the personnel of TG 7.5. The CTG 7.5's Rad-Safe Adviser was responsible for staff direction on all TG 7.5 Rad-Safe policies.

The AEC Rad-Safe Officer was designated the Assistant Chief of Staff, E-7, with responsibility to the TG 7.5 Deputy Commander for supervising the Rad-Safe operations and recommending protection measures.

The Contractor's Rad-Safe Officer functioned as the Operations Officer and provided the necessary support. During periods when neither the Rad-Safe Adviser or the Assistant Chief of Staff, E-7 was at EPG, the AEC Rad-Safe Assistant acted as Assistant Chief of Staff, E-7.

1.2.3 Facilities

On 1 April 1958, the CTG 7.5 relinquished to CTG 7.1 the operational control of the Rad-Safe facilities operated during the non-test periods by the AEC Contractor, H&N. This control was returned to CTG 7.5 on 3 September 1958, 15 days after the last detonation.

II. EQUIPMENT AND SUPPLIES

2.1 General

Prior to the Operation a complete inventory of all Rad-Safe protective clothing, decontamination materials, equipment and instrumentation at EPG was submitted to CTU-6, TG 7.1, the organization responsible for providing the Rad-Safe supplies.

The dosimetry and records and the instrument repair facilities at the Rad-Safe Center on Site Elmer were remodeled and air conditioned, and the vehicle and personnel decontamination centers were activated. A Rad-Safe laundry barge was put into operation to provide facilities for emergency personnel decontamination during the last phase of the Operation.

At Site Nan the Rad-Safe Center and the personnel and vehicle decontamination centers were put into operable condition, and new facilities were provided for the dosimetry and instrument repair section in the Communication Center, Building 204.

2.2 Repair and Maintenance

The care and maintenance of all radiological instrumentation was a joint function of the TG 7.5 Rad-Safe organization and TU-6, TG 7.1. They were responsible for furnishing repair services on the portable instruments and equipment in the photodosimetry room and the radiochemistry trailers at both atolls.

2.3 Equipment List

The electronic equipment utilized during the Operation included portable survey instruments, air sampling equipment, dosage instruments, background monitoring detectors with recorder units, various types of test equipment, and radiation analysis instrumentation.

THE FOLLOWING LIST REFLECTS THE TYPE AND DISTRIBUTION OF EQUIPMENT AND INSTRUMENTS DURING THE MAJOR PORTION OF THE OPERATION:

INSTRUMENTS

Manufacturer	Model	Type	Eniwetok	Bikini
Tracerlab Inc.	Radiac Set AN/PDR-39	Gamma Survey Meter	122	80
Tracerlab Inc.	Radiac Set Modified to 500 r AN/PDR-39	Gamma Survey Meter	4	2
Admiral Corp.	Radiac Set AN/PDR-27	Beta Gamma Survey Meter	36	4
Tracerlab Inc.	Radiac Set AN/PDR-18	Gamma Scintillation Survey Meter	12	8
Chatham Electronics	Radiac Set CDV-700	Beta Gamma Survey Meter	60	40
Instrumentation assembled and installed by Kewaunee Mfg. Co.	AN/MDQ-1	Radiochemistry Trailer	1	1
Designed by Los Alamos Lab.		Cumulative Dosage Alarm Instrument Dosimeter	5	5
Victoreen Instrument Co. Modified by LASL	Thyac	Alpha Scintillation Survey Meter	3	1
Beckman Instrument Co.	MX-5	Beta Gamma Survey Meter	21	2
Eberline Instrument Co.	PAC-3-G	Alpha Proportional Survey Meter	3	3
Eberline Instrument Co.	AM-1	Beta Gamma Continuous Air Monitor	1	2

Manufacturer	Model	Type	Eniwetok	Bikini
N. Y. Health and Safety Lab., USAEC (Recorder portion Mfg. by Evershed and Vignoles Ltd.)	TN-4D	Off-Site Gamma Background Monitor	33	2
Eberline Instrument Co.	FS-11	Film Badge Densitometer	2	1
Eberline Instrument Co.	FD-2	Densitometer	1	1
Jordan Instrument Co.	PRAM-5	Gamma Aerial Survey Instr.	2	1
Riggs Electronics	UW-1	Gamma Underwater Instr.	4	2

TEST EQUIPMENT

Manufacturer	Model	Type	Number
Simpson Instrument Co.	TS-183	Battery Tester	2
Phaostron Co.	TS-352	Multimeter	2
Rutherford Electronics	300	Pulse Generator	1
Tektronics Instrument Co.	315D	Oscilloscope	1
Weston Electric Co.	981	Tube Checker	1
Industrial Instruments Mfg.	MB	Megabridge	1
Sensitive Research Instrument Corp.	5000 Volt	Electrostatic Voltmeter	1
Sensitive Research Instrument Corp.	2000 Volt	Electrostatic Voltmeter	1
---	TE-113	Tool Kit	6
---	TS-297	Multimeter	6
---	OS-8C	Oscilloscope	2
---	TS-505	Vacuum Tube Voltmeter	6
---	TV-7	Electron Tube Test Set	2

2.4 Functioning of Equipment

2.4.1 AN/PDR-39

The AN/PDR-39 continued to be an excellent portable, rugged field monitoring instrument that required little maintenance. There was no moisture or "sweat" problem, and in general the accuracy was good with little or no drift with age or use. The range resistors were checked with a vibrating reed electrometer bridge circuit. Defective high range resistors were replaced at the beginning of the operation and checked periodically thereafter. The instruments, modified to record up to 500 r/hr, were used considerably for aerial surveys and responded excellently.

2.4.2 AN/PDR-27H

The AN/PDR-27H, a beta-gamma survey meter, was a good low range personnel monitoring instrument that had rugged qualities and good stability.

2.4.3 AN/PDR-18

The AN/PDR-18, a gamma scintillation survey meter, was used occasionally, and proved to be rugged. It operated with six easy to obtain flashlight-type batteries.

2.4.4 CDV-700

The CDV-700 beta-gamma survey meter did not perform satisfactorily in this high moisture climate, for the following reasons:

a. Frequent power supply failures due to dead batteries, fragile terminal connections, etc.

b. Leakage of tar-like substance from headset jack, resulting in shorts across the printed circuit board underneath calibration potentiometer.

c. Substandard printed circuit board with difficulties in unsoldering and resoldering component connections such as tubes, capacitors, resistors, etc.

d. Calibration drift over a period of a few days.

2.4.5 Integrons

The Integrons were not used to a large extent. They calibrated and checked easily, and were relatively rugged.

2.4.6 Thyac

The Thyac alpha scintillation survey meter was gamma responsive in a radiation field above 500 mr/hr. However, for normal personnel or equipment monitoring, the instrument worked adequately.

2.4.7 MX-5

The Beckman MX-5 beta-gamma low range personnel monitoring instrument performed very well, though many were not used due to the lack of spare parts. The instrument was rugged, had good stability and was easy to calibrate. This instrument is no longer in production.

2.4.8 PAC-3-G

The Eberline PAC-3-G alpha proportional survey meter was an adequate monitoring instrument but required a daily check-out and re-adjustment of the gas-flow system. The probe assembly was easily damaged in the field. However, if the monitor utilizing the instrument were carefully instructed, with emphasis placed upon handling care, adequate field monitoring could be accomplished.

2.4.9 AM-1

The Eberline beta-gamma continuous air monitors functioned adequately during the entire Operation. However, the background monitoring probes did not perform properly. It was thought that the probe assembly had a high voltage ground, but the probe could not be dismantled to remedy the situation.

2.4.10 TN-4D

The TN-4D background monitor and recorder was used by the U.S. Public Health Service to record off-atoll radiation levels. It possessed a sensitive electronic circuit that caused trouble, primarily due to failure of the recorder. The Evershed recorder, Mark II, drive motor gears stripped frequently, and it was necessary to replace the motor and enclosed main drive gear box. Only a few spare motors were available.

2.4.11 FS-3

The Eberline film badge evaluation and recording system, FS-3, required the attention of a technician several hours daily to clean contacts, check tubes, and make miscellaneous adjustments. During the early phase of the operation the high voltage power supply caused trouble, until filtering was improved.

The maximum, and only, voltage that could be obtained from the power supply was approximately 1275 volts. It is felt that 1400 volts would produce a stronger signal from the photomultiplier tube, which would result in faster servo response.

The tachometer feedback circuit also warranted component changes to eliminate feedback voltage. Optimum operation resulted with the "feedback pot" in the fully counter-clockwise (off) position.

The light source strength was also a critical item. The best operation resulted with a General Electric 300 watt PH/300 TIOP-120 volt projection lamp which had a lifetime of only 30 operating hours.

The red-light (GE-328) indicator on the microswitch push button of the densitometer did not operate satisfactorily, due to the red bulb's lifetime of from only two to three days.

The Mosely servo-voltmeter performed excellently, requiring only occasional cleaning and oiling. The correct reference voltage was obtained with an Eveready No. E502 mercury-type battery.

The Mosely curve follower also performed excellently. The X-axis potentiometer had to be swabbed out with carbon tetrachloride every other day. The correct X-axis reference voltage was obtained with a Mallory RM-12R mercury-type battery.

2.4.12 PRAM-5

The Jordan aerial survey instruments, PRAM-5, did not function properly and were deadlined at the start of the Operation. Considerable circuit checking and recalibration was performed to no avail.

2.4.13 UW-1

The UW-1 underwater instruments functioned excellently. When check calibrated, they were found to retain accuracy with no drift.

2.4.14 Rad-Chem Trailer Equipment

The radiation measuring equipment in the Rad-Chem trailers functioned adequately. The Berkley Model 2000 scalers presented some trouble, but were generally accurate and reliable. These units were calibrated and tested with a Rutherford Model 300 pulse generator using a 0.25 volt, 1 ms rise time, 2 ms duration, negative pulse.

The best GM tube was the Tracerlab TGC-2 with a window thickness of less than 2 mg/cm^3, which gave counting efficiencies of from 20 to 30 percent.

The alpha counter head and amplifier-power supply system functioned well for low level alpha counting, providing good discrimination against beta and gamma pulses.

The laboratory monitor, SU-3B, was used to monitor bench tops and miscellaneous items.

Initially the voltage regulation at the Site Elmer trailer was poor, due to a defective Sorenson voltage regulator. The voltage regulation stability was carefully examined with a fast trigger oscilloscope, and line disturbances were damped out by careful tuning to resonance.

III. DOSIMETRY AND RECORDS

3.1 General

Upon arrival at EPG each person was issued an addressograph identification plate and film badge. The identification plate of H&N employees was embossed with an eight digit serial number that designated the individual's task group, task unit, department and payroll number.

The identification plate and the film badge were attached to and worn with the security badge. The film badges were exchanged on a bimonthly basis or on return from a mission into a RADEX area.

The Dosimetry and Records Section of TU-6, TG 7.1, was responsible for providing the film badges for all personnel during the Operation. The section was also responsible for the processing of film badges and the evaluation and recording of radiation dosages. H&N Rad-Safe personnel assisted TU-6 in the issuing, collecting and processing of film. Dosage records were maintained for all TG 7.5 personnel with IBM dosage cards, obtained daily from TU-6.

3.2 Procedures

During the Operation, the Eberline film badge evaluation and recording system, FS-3, was used for the first time. Two units were installed at Site Elmer and one at Site Nan.

When the equipment was operating efficiently, approximately 2000 films could be read and recorded within a few hours. All film badge data at Site Nan was transmitted to the IBM section at Site Elmer by an IBM data transceiver. An IBM 704 was used for storage and dosage print-out rosters.

The bulk of the workload was on the 1600 to 2400 hour shift. Film badge processing commenced at 1900 hours, and the IBM dosage cards were sent to the IBM 704 for information storage at approximately 2300 hours. A print-out dosage roster was prepared each night for the previous day's film badges, and an extra deck of dosage cards was printed for the TG 7.5 dosage file. Over 12,000 film badges were processed for TG 7.5 personnel.

The Dupont Film Packet, Type 559, with component films (502 for low range and 834 for high range) proved excellent for the Operation. The ceresin wax dip and vinyl plastic holder protected the film from the effects of handling and high humidity.

The films were calibrated on a "constant time, variable distance" range, and the calibration curves were checked for accuracy approximately every two weeks. During the initial calibration a density inversion was noted. The area under the lead strip had a darker appearance than the rest of the film. Investigation indicated that this occurred only when the back of the film was exposed to the calibration source. A further check, however, showed that the optical density under the lead strip remained the same when the films were exposed both "foreward" and "backward."

The Cobalt 60 calibration source strength was 8.67 r/hr at 50 cm, as of 25 April 1958.

3.3 Radiation Exposure Guides

The total cumulative exposure guide for JTF-Seven personnel during the Operation, as authorized by CJTF-Seven directive, was:

a. Gamma - a maximum of 3.75 roentgens per any consecutive 13 week period, with a maximum of 5.0 r during the Operation.

b. Exceptions - on an individual basis and approved by CTG 7.5 and the CJTF-Seven.

The gamma exposure criteria for TG 7.5 personnel was further restricted to 5.0 r for the calendar year.

3.4 Dosage Records

A summary of the dosages received by TG 7.5 personnel from 1 April through 4 September 1958 follows.

Dose in mr	No. of Persons	Percent
No dosage	676	19.5
1 - 499	493	14.2
500 - 999	378	10.9
1000 - 1999	1330	38.4
2000 - 2999	472	13.6
3000 - 3750	78	2.3
3751 - 5000	37	1.1
Over 5000	0	0
Total	3464	100.0%

The 48-hour fallout at Site Elmer that followed the Fir and Koa events contributed significantly to the radiation dose of TG 7.5 personnel, as much as 1500 mr for persons remaining at Site Elmer for the duration of the Operation. Therefore, it was necessary to request that the guide of 3750 mr per 13 week period be increased, and also, the 5000 mr dose for the Operation be increased to 10,000 mr for 35 key employees.

Upon completion of the Operation only four of these 35 employees actually exceeded the 3750 mr guide, and none exceeded the 5000 mr limit.

IV. MONITORING

4.1 Preoperational Training

Prior to Operation HARDTACK a radiological safety course to train Rad-Safe monitors was conducted by the H&N Rad-Safe Officer, with the assistance of the AEC Rad-Safe Assistant.

The basic training course, given to H&N personnel of various departments and divisions, totaled 24 hours, and was conducted at Site Elmer from 24 through 28 February, and at Site Nan from 3 through 7 March 1958. Instruction was given in elementary radiation theory, with emphasis on recovery party operations, use of protective clothing, decontaminaion and operation of radiation detection instruments.

At the completion of the course 53 H&N personnel were qualified monitors and were listed in a monitors pool.

In addition a two-hour Rad-Safe indoctrination lecture was presented to H&N supervisory personnel at all sites on Eniwetok and Bikini Atolls to acquaint them with Rad-Safe principles, maximum permissible exposures, and their responsibilities as work party leaders in RADEX areas.

4.2 General Procedures

Task Group 7.5 monitors accompanied nearly all work and recovery parties involving TG 7.5 personnel. These monitors were briefed prior to departure into FULL RADEX areas, and were provided with an access permit listing the accumulated dosages of all personnel going on the mission.

A Summary Sheet of the D-day, D+1, and D+2 day missions which were accompanied by trained TG 7.5 Rad-Safe monitors during Operation HARDTACK is shown in Figure 4.1.

Month	Number of Access Permits Issued		Number of Persons in H&N Parties		Number of H&N Monitors	
	Eniwetok	Bikini	Eniwetok	Bikini	Eniwetok	Bikini
April						
D-Day	-	0	-	0	-	0
D+1	-	0	-	0	-	0
D+2	-	0	-	0	-	0
May						
D-Day	138	8	260	34	20	2
D+1	130	38	216	154	22	17
D+2	114	25	240	82	22	7
June						
D-Day	86	29	170	113	12	15
D+1	84	35	221	156	15	26
D+2	95	46	286	153	13	26
July						
D-Day	61	13	90	33	7	4
D+1	146	19	386	116	22	10
D+2	75	31	234	138	6	19
August						
D-Day	61	-	205	-	15	-
D+1	13	-	34	-	6	-
D+2	21	-	86	-	6	-

Figure 4.1 Summary of Missions Accomplished by Trained TG 7.5 Rad-Safe Monitors.

TG 7.5 monitors also manned checkpoints on Site Elmer when H&N workers were leaving or returning at irregular work hours.

4.3 Underwater Monitoring

The use of underwater monitors during this Operation was an innovation in Rad-Safe monitoring procedures. The underwater monitors performed radiation surveys prior to work required of H&N divers.

Three H&N Rad-Safe personnel were checked for physical fitness and swimming ability, and then were given instruction in the use of the Scott Aqua-Lung. Also, the AEC Rad-Safe Assistant, having previous skin diving and swimming experience, became a member of this team.

During the Operation the underwater monitors made 52 dives to depths varying from 15 to 85 feet. Radiation intensities in some areas of the lagoon bottom were found to be in excess of 50 roentgens per hour. The Rad-Safe divers were instrumental in detecting and recovering a radioactive source that had been dropped from one of the shot barges into 85 feet of water.

The underwater survey instrument utilized, (UW-1), designed by Riggs Nucleonics Corporation of Burbank, California, has a range of 0.05 r/hr to 50 r/hr. Figure 4.2 shows this instrument and other diving equipment used by the underwater monitoring team.

Figure 4.2

Instruments and Diving Equipment Used by the Underwater Monitoring Team

V. FALLOUT

5.1 14 May 1958 Fallout

At 0715 hours on 14 May 1958, the continuous air monitor and background monitor at the Site Elmer Rad-Safe Center recorded readings that were appreciably higher than those of the previous day.

The recorder chart showed that the background had started to rise at 0300 hours. At 0715 hours the radiation levels both inside and outside the Rad-Safe Center were 10 mr/hr. At 0900 hours a survey of the tent and barracks areas showed readings of 15 mr/hr both inside and outside the buildings. At 1600 hours radiation levels ranged from 20 to 25 mr/hr.

At 0730 hours on 15 May the radiation levels were from 10 to 15 mr/hr. Thereafter, the levels began to decrease less rapidly until a steady reading of from 2 to 2.5 mr/hr was reached on 19 May.

Two film badges were placed outside the Rad-Safe Center at 0845 hours, 14 May, and were removed at 0950 hours on 18 May. The badges recovered dosages of 1790 mr and 1360 mr.

On 15 May air samples were taken with a model AD-440 Gast Pump for 1 hour with a flow rate of 17.5 liters per minute. The background in the Site Elmer Rad-Chem trailer was too high to count these samples, therefore the samples were sent to the Site Nan Rad-Chem trailer for counting and determination of decay rate. Figure 5.1 represents the time vs. dose-rate curve for this fallout.

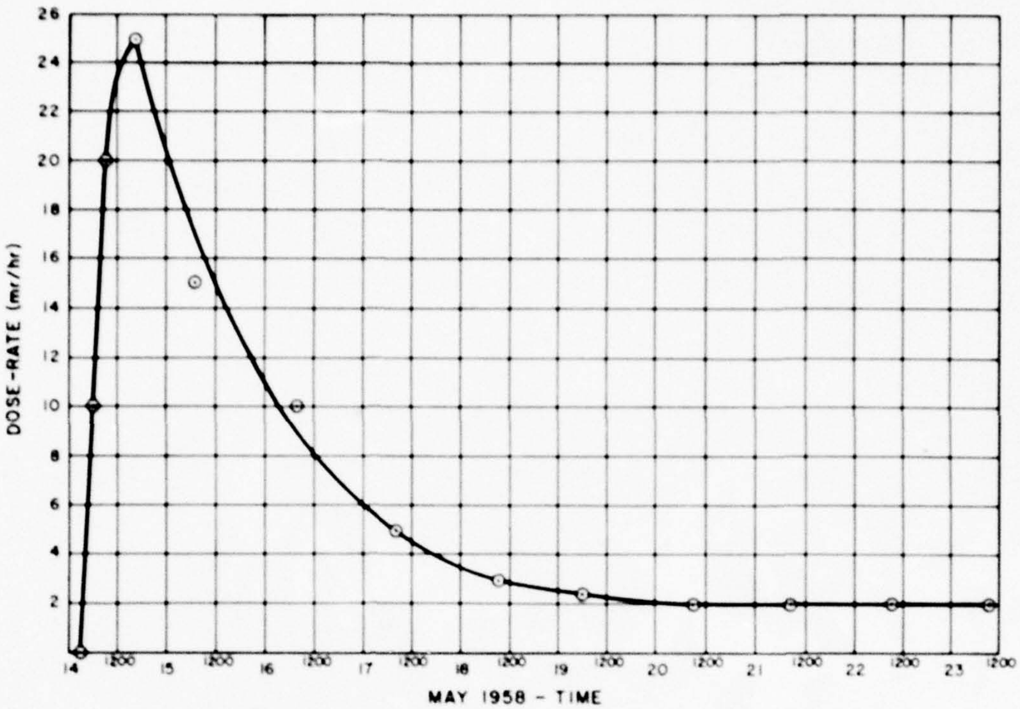

Figure 5. 1 Site Elmer Background Radiation Intensity Curve

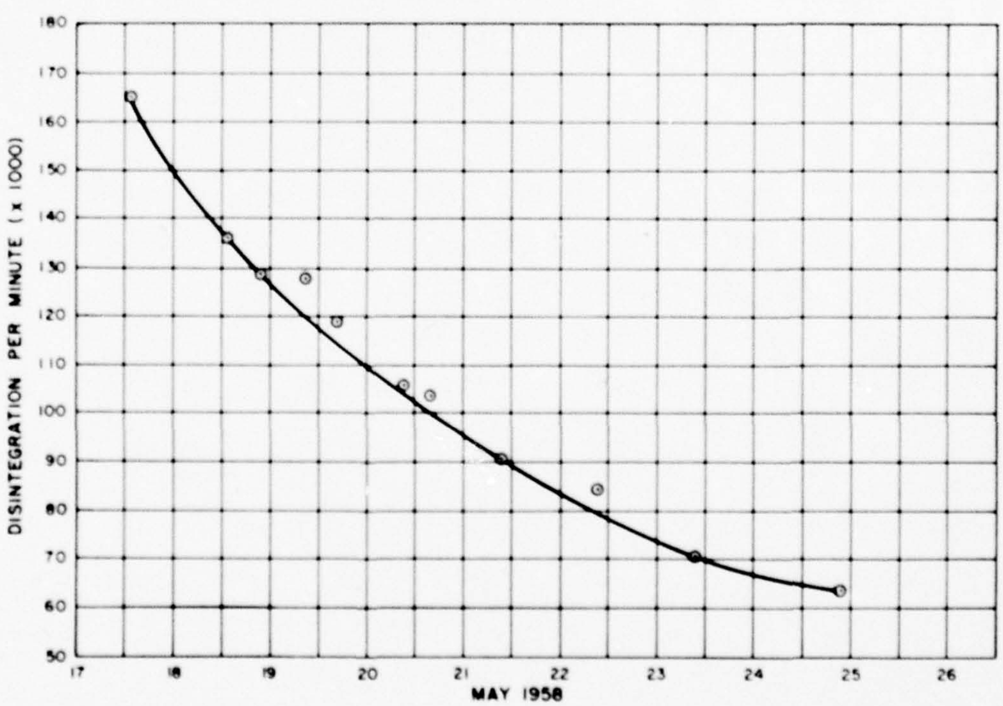

Figure 5. 2 Fallout Tray Sample Decay Curve

The air filter tape was removed from the continuous air monitor, and 2-inch diameter samples were cut from the tape at areas of maximum radiation intensity, as indicated by the recorder chart. These samples also were sent to Site Nan for counting, due to the high background at Site Elmer.

A fallout tray was placed outside the Rad-Safe Center at 1500 hours, 15 May, and samples were collected at 1400 hours, 17 May. The initial gross beta count, at 1600 hours, was 165,000 $d/m/m^3$ and was taken with a Geiger-Muller counter (Tracerlab Inc.) and a model CP-139/PD decimal scaler (Berkeley Instrument Corp).

Figure 5.2 represents the fallout tray sample decay curve.

The emergency evacuation procedures were not implemented, as potential radiation dose savings to personnel did not warrant a long period evacuation. Air and ground radiation intensities were equal and dose rates virtually were the same inside and outside the buildings.

5.2 28 June 1958 Fallout

On 28 June 1958 a shot was detonated at Eniwetok Atoll at 0630 hours. Rain started at 1600 hours and continued for approximately three hours. The background at Site Elmer at waist level was 0.7 mr/hr. A puddle of water behind the Rad-Safe Center showed a radiation intensity of 2 mr/hr. Rain samples collected at 1630 and 1830 hours showed beta intensities of 600 d/m/ml and 17,000 d/m/ml, respectively.

5.3 29 June 1958 Fallout

On 29 June 1958 a shot was detonated at Bikini Atoll at 0730 hours. At 1945 hours it began to rain and the background intensity at Site Nan began to rise slowly. A peak intensity of 2.5 mr/hr was reached at 2130 hours, and then subsided.

5.4 3 July 1958 Fallout

On 3 July 1958, following an event at Bikini Atoll, the background at Site Nan began to rise after a rainshower at 1500 hours. The background rose from 4 mr/hr at 1500 hours to 12 mr/hr at 1645 hours, and then began to decline, as follows:

0300 hours July 4 . . . . 5 mr/hr

1200 hours July 4 . . . . 3 mr/hr

1000 hours July 5 . . . . 1 mr/hr

5.5 13 July 1958 Fallout

On 13 July 1958 a slight rise in the background and the continuous air monitor was noticed at 0030 hours at Eniwetok Atoll. The background monitor reached a high of 1.8 mr/hr and the air monitor showed 20,000 c/m at 0345 hours and then declined to 1.5 mr/hr and 2000 c/m at 0630 hours.

5.6 18 July 1958 Fallout

At 1420 hours, 18 July 1958, the background monitor at the Site Elmer Rad-Safe Center began to rise sharply. At 1430 hours the background had risen to 20 mr/hr and reached a peak intensity of 34 mr/hr at 1449 hours. The increase in background was noticed shortly after rain began to fall. Another rain squall started at 1452 hours and the background intensity dropped sharply and continued to decrease to 0.3 mr/hr at 1630 hours.

A survey of Site Elmer showed intensities up to 4 mr/hr at 1530 hours. The tent areas showed readings of 3 mr/hr and the interiors of the tents showed

2 mr/hr. The northern end of Site Elmer showed intensities of from 3 to 4 mr/hr, and water puddles showed 4 mr/hr.

A rain sample was collected during the fallout, 1430 to 1625 hours. Filterable particles, collected on a micropore filter, showed an intensity of 10 cpm/ml at 1830 hours.

VI. DECONTAMINATION

6.1 General

The decontamination activities of the TG 7.5 Rad-Safe organization were divided into two sections, the Personnel Decon Section and the Equipment Decon Section.

6.2 Personnel Decon Section

All personnel returning from RADEX areas were monitored at the check points. If contaminated, they were processed through the Personnel Decon Station adjacent to the Rad-Safe Center. Their protective clothing was deposited into receptacles in the "hot" side of the decon center. After showering they were monitored again, and if found uncontaminated, proceeded to the "clean" side of the decon center to dress.

Personnel decontamination was exercised when levels were greater than 7 mr/hr (beta + gamma) or 500 c/m/55 cm^2 (alpha) for outer clothing, or 1 mr/hr (gamma) or 100 c/m/55 cm^2 (alpha) on skin or underclothing.

6.3 Equipment Decon Section

The equipment and vehicle contamination tolerances were 7 mr/hr (gamma + beta) or 500 c/m/55 cm^2 fixed alpha. (When no change in alpha contamination level could be observed by checking the swipe of a 100 cm^2 area, it was referred to as fixed alpha.) Respiratory protective devices were maintained at a contamination level of less than 1 mr/hr (beta + gamma) or 100 c/m/55 cm^2 (alpha).

The Vehicle and Equipment Decon Section was responsible for the decontamination of all contaminated vehicles and equipment to levels less than the permissible tolerances. In a few instances when steam and chemical cleaning failed, sandblasting was utilized to bring the radioactive contamination to the permissible level.

A list of the major equipment which was processed through the decon lot follows:

	Eniwetok	Bikini
Trucks	20	18
Jeeps	10	7
DUKW's	17	14
Cat's	9	1
Skip-loaders	2	0
Generators	4	1
Trailers	1	1
Vacuum Cleaner	1	0
Air Samplers	3	0
Vacuum Pumps	2	0
LCM's	3	

Also, a great many miscellaneous articles and materials were decontaminated and returned to service. Materials which could not be decontaminated were placed in barrels, filled with concrete, and dumped at sea.

6.4 Decontamination of Mack Tower

Mack Photo Tower was subjected to radioactive fallout from several shots during the Operation, and many attempts were made to lower its radiation intensity.

On 16 May the tower showed gamma radiation levels up to 5000 mr/hr. Using a fire truck mounted on a LCU, the fire department attempted to lower the radiation level to a permissible tolerance by pumping approximately

20,000 gallons of water over the tower. However, the dose rate could not be reduced to less than 1000 mr/hr.

On 22 May another decontamination attempt was made. This time 60,000 gallons of water were pumped over the tower, but the east side of the tower still showed gamma readings of 1000 mr/hr.

On 1 June the tower was washed down with water and scrubbed with brushes, and the maximum reading on the east side was 450 mr/hr.

To protect the tower from fallout a disposable canvas cover was placed over the top cab of the tower and a tent over the generators on the lower platform. On subsequent shots the gamma intensities were reduced somewhat; however, the Scaevola event contaminated both the lower and upper cabs with alpha.

At the close of the Operation the tower was again washed down and the radiation intensities were 80 mr/hr gamma and 50,000 c/m/55 cm^2 alpha.

For future operation it is recommended that the tower be covered with a disposable canvas cover prior to each event.

6.5 Alpha Decontamination

6.5.1 General

Due to a low yield event on Site Yvonne a considerable area was heavily contaminated with alpha. The same GZ area had to be used for a subsequent event, and it was necessary to partially decontaminate the area.

The area between Stations 1310 and 1610 on Site Yvonne was designated as a FULL RADEX alpha area. The Rad-Safe check point set up near the personnel pier is shown in Figure 6.1. Two decon trucks,

Figure 6. 1

Rad-Safe Check Point Near Personnel Pier

Figure 6. 2

Decon Trucks Located at the Check Point for Personnel Decontamination shown in Figure 6.2, were located at the check point and provided facilities for the decontamination of personnel returning from the contaminated area. In addition, the Rad-Safe barge was moored off-shore to provide showering for personnel and a laundry for the decontamination of protective clothing.

6.5.2 Procedures

An access was bladed with a road grader from the check point to GZ. Then, a parking area 75 x 25 feet was bladed on the upwind, or oceanside of GZ.

Approximately three to five inches of contaminated topsoil was removed, picked up by a skip-loader, and transported to an area on the west, or lagoon side of the island. Finally an area approximately 60 feet square was bladed at GZ to a depth of 3 inches, and the soil was transported to the contaminated disposal site. All contaminated equipment and debris within the GZ area also was discarded at the disposal site.

The "decontaminated" area still indicated alpha activity in excess of 20,000 c/m, as measured by PAC-3G instruments. To prevent personnel from wandering into more highly contaminated areas, this area was roped off, as shown in Figure 6.3.

During the course of the work 69 nose swipes were taken of personnel working in the area. None of the swipes showed detectable alpha activity. Urine samples were collected from seven H&N heavy equipment operators and sent to Los Alamos for analysis. All results of the urine analysis were negative.

Figure 6.3

Ropes prevented personnel from wandering into the more highly contaminated areas.

A tent was erected at GZ to protect the instrumentation for the subsequent shot from the elements. While project personnel were preparing the device for detonation, air samples were taken both inside and outside the tent. Although the air contamination inside the tent was much lower than outside, the wearing of respirators still was necessary at all times.

Alpha contamination in the air inside the tent ranged from a few $d/m/m^3$ up to 7000 $d/m/m^3$, and outside the air contamination was as high as 33, 000 $d/m/m^3$. To keep the air contamination inside the tent to a minimum the floor and sides of the tent were cleaned with a vacuum cleaner several times daily. All personnel working in the GZ area were monitored each time they returned through the check point. Their living quarters also were monitored, and alpha swipes were taken at the mess hall on Site Elmer. All swipes proved to be negative.

During this period and until recovery operations were completed after the last event, all vehicles and equipment entering the area north of the rope barrier at the check point were required to remain for monitoring and decontamination. Two jeeps and two weapons carriers transported personnel and equipment from the check point to the GZ area.

6.5.3 Result

Final decontamination of GZ is in progress, and a fully documented report will be forthcoming.

VII. SAMPLE COUNTING PROGRAM

7.1 General

The environmental testing and sample counting program was a joint function of the TG 7.5 Rad-Safe organization and TU-6 of TG 7.1. The facilities for sample preparation and counting were provided by two Rad-Chem trailers, one at Site Elmer and one at Site Nan. Most of the samples processed were counted for gross beta activity, and the remainder were counted for alpha activity.

7.2 Sample Counts

A summary of the samples which were processed and counted during the Operation follows.

Water Samples	374
Rain Water	22
Alpha Swipes	92
Fallout Tray Samples	23
Air Samples	13
Food	14
Soil	15
Urine (tritium)	20
Marine Specimens	6
Plant Specimens	3

7.3 Rad-Chem Trailer Equipment

Each Rad-Chem trailer was provided with the following equipment.

No.	Manufacturer	Model	Type
5	Berkeley Instrument Corp.	Radiac CP-139/PD	Decimal Scalers
2	General Radio Company	Radiac CP-140/PD	Count Rate Meters
1	Industrial Nucleonics Corp.	DT-66(XE-2)/UD	Radiac Type Detector
1	Applied Physics Corp.	No. 30	Vibrating Reed Electrometer
1	Tracerlab Inc.	SU-3B	Laboratory Monitor

VIII. RADIATION LEVELS

The following chart shows the preoperational and postoperational radiation levels for Eniwetok and Bikini.

8.1 Eniwetok

Site	Preoperational High (31 March 1958)	(mr/hr) Avg	Postoperational High (31 August 1958)	(mr/hr) Avg
Alice	0.4	0.2	105	40
Belle	0.6	0.3	90	60
Clara	0.4	0.3	120	40
Daisy	0.3	0.2	100	40
Edna	0.6	0.2	30	12
Gene	7.0	3.0	-	-
Helen	4.0	3.0	30	14
Irene	8.0	4.0	8	4
Janet	0.2	0.1	10	2
Kate	0.2	0.2	2	2
Lucy	0.2	0.1	2	2
Mary	0.2	0.1	2	2
Nancy	.0	.0	2	2
Olive	0.5	0.2	2	2
Pearl	110 (metal)	5.0	2	2
Ruby	400 (metal)	3.0	100 (metal)	2
Sally	1.2	0.2	0.2	0.2
Tilda	0.1	0.1	0.2	0.2
Ursula	0.1	0.1	0.2	0.2
Vera	0.2	0.1	1.0	1.0
Wilma	0.1	0.1	1.0	1.0
Yvonne	2.0	0.7	800	5.0
Zona	.0	.0	0.2	0.2
Sam	.0	.0	0.2	0.2
Tom	.0	.0	0.2	0.2
Uriah	.0	.0	0.2	0.2
Van	.0	.0	0.2	0.2
Alvin	.0	.0	0.2	0.2
Bruce	.0	.0	0.2	0.2
Clyde	.0	.0	0.2	0.2
David	.0	.0	0.2	0.2
Elmer	.0	.0	0.2	0.1
Fred	.0	.0	0.1	0.1
Glenn	.0	.0	0.1	0.1

Site	Preoperational High (31 March 1958)	(mr/hr) Avg	Postoperational High (31 August 1958)	(mr/hr) Avg
Henry	.0	.0	0.1	0.1
Irwin	.0	.0	0.1	0.1
James	.0	.0	0.1	0.1
Keith	.0	.0	0.0	0.1
Leroy	.0	.0	16	12
Mack	.0	.0	80	30
			Alpha 50,000 c/m	10,000 c/m
Oscar	.0	.0	150	150
			Alpha 50,000 c/m	50,000 c/m

8.2 Bikini

Site	Preoperational High (31 March 1958)	(mr/hr) Avg	Postoperational High (31 August 1958)	(mr/hr) Avg
Able	4.0	3.0	3500	2000
Charlie	2.8	2.0	180	100
Dog	1.5	1.0	36	30
Easy	1.0	0.4	100	20
Fox	1.0	0.5	1000	1000
George	0.6	0.4	15	10
How	0.4	0.2	0.5	0.3
Item	0.2	0.2	0.5	0.3
Jig	0.1	.0	0.25	0.25
King	0.2	0.2	0.25	0.25
Love	.0	.0	0.25	0.25
Mike	0.1	0.1	0.25	0.25
Nan	.0	.0	0.25	0.25
Oboe	0.2	0.2	0.5	0.5
Peter	0.2	0.2	0.5	0.5
Roger	0.2	0.2	0.5	0.5
Sugar	0.2	0.2	0.5	0.5
Tare	0.5	0.2	1000	250
Uncle	0.3	0.2	140	80
Victor	0.2	0.2	800	600
William	0.6	0.4	1000	600
Yoke	0.6	0.5	360	300
Zebra	0.8	0.4	300	260
Alfa	0.8	0.3	300	250
Bravo	0.8	0.6	280	240

APPENDIX A

FALLOUT PROTECTION STUDY

After the fallout of May 1958, a study into the methods of reducing or minimizing the radiation dosages to personnel was considered advisable. Under mild fallout conditions, where evacuation of all personnel would not be practicable, it was believed that a washdown system on living quarters would reduce interior radiation intensity.

Upon completing the installation of the study's washdown equipment, no fallout occurred on Site Elmer. Therefore, although the efficiency of the new system could not be tested during this Operation, a description of the installed equipment and proposed procedures for the fallout protection study is presented herein.

Barracks 103 was selected as the fallout study structure and was provided with a sprinkler system that sprayed salt water over the entire roof. The water, washing down the slopes of the roof, would carry radioactive particulate matter into two different types of disposal systems on opposite sides of the longitudinal axis of the building.

One disposal system utilized a gutter and rain spout for carrying the wash water from the slope of the roof. The rain spout emptied into a catch basin which in turn emptied into the ocean.

The other disposal system, on the opposite side of the roof, was not provided with gutters and rainspouts. The water fell from the roof onto a 10-foot wide asphalt apron that sloped away from the barracks to a ditch running parallel to the building. Not only would the particles falling onto the roof of the barracks be washed away but also particles falling onto the asphalt apron near the building.

Photographs of the installed systems are shown in Figure A. 1.

Barracks 101 was designated as a control building for this study and was not provided with a washdown system. Both barracks were to be provided with a continuous background monitor.

In the event of a fallout Rad-Safe personnel were to place film badges at 129 identical locations inside of each building, so that the radiation dosages received at all interior points could be computed. Fallout trays would be placed around each of the buildings and samples would be collected and analyzed daily. Immediately upon determining that the fallout had ceased, a complete radiological survey would be made inside and outside the two buildings.

Results of the survey would be compared and the efficiency of the washdown system for reducing the dose rate would be computed. Also, the dosages received by the film badges in the two buildings would be compared, and the efficiency of the washdown system could be determined.

Figure A. 1

Installed Washdown Equipment