WT-938

OPERATION CASTLE — PROJECT 4.1 ADDENDUM

Report to the Scientific Director

EXPOSURE OF MARSHALL ISLANDERS AND AMERICAN MILITARY PERSONNEL TO FALLOUT

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ABSTRACT

The final report of Project 4.1 contained detailed information concerning the clinical observations and therapy, the external lesions, the hematological studies, and the internal radioactive contamination of the 82 native inhabitants of Rongelap and Ailinginae atolls who were exposed to radioactive fallout following the detonation of Shot 1 at Bikini on 1 March 1954. Eighteen natives who were temporarily residing or visiting at Sifo Island (Ailinginae Atoll) 1 - 3 March are also listed.

This addendum report contains the following supplementary data regarding these exposed Marshallese: (1) a detailed sketch of Rongelap Village; (2) a brief description of the islanders' homes and their food and water supplies; (3) the various family groups and the location of their dwellings; (4) events during fallout: (5) the evacuation and decontamination procedures; and (6) readings of the external radioactive contamination of these individuals.

The majority of this material was obtained after the Marshallese were evacuated from their home islands (while they were under medical observation at Kwajalein). Additional information was obtained when either one or both authors accompanied radiological survey teams to Rongelap. These survey trips were made 26 March, 3 April, and 21 – 23 April 1954. Due to language interpretation difficulties, some of the material is incomplete or inaccurate and is subject to correction and revision by future survey teams.

Twenty-eight American Military personnel stationed on Eniwetak Island, Rongerik Atoll, were exposed to radioactive fallout following the detonation of Shot 1 at Bikini on 1 March 1954. The onset of visible fallout material was observed at approximately 1400 – 1430 hours, 1 March. An ATN/3a Recording Dosimeter, located on the island (Eniwetak), gave first positive indication that fallout particles were radioactive. This instrument went off scale at 100 mr/hr at H plus 6 hours and 48 minutes.

Authorities at Eniwetok were notified of fallout via dispatch. Personnel of Rongerik were evacuated by plane to Kwajalein at 1245 and 1800 hours, 2 March. Following decontamination procedures the men were sent to the infirmary at Eniwetok for clinical observation and preliminary clinical study. On 16 March, they were returned to Kwajalein and placed under care of the personnel of Project 4.1. The details of the clinical studies are presented in the final report of Project 4.1.

The exposure of these individuals afforded a unique opportunity to study the effects of radiation in man and it was considered desirable to supplement the clinical studies with as much information as possible concerning the period of exposure. Accordingly, these men were interviewed individually and asked to describe the fallout, their activities during the fallout, foods and liquids consumed, their clothing and housing, the disposition of film badges, etc. Insofar as possible, this information is recorded verbatim in the present report. The report also includes a summary of these interviews, film-badge readings, and readings of the external radioactive contamination of the men before and during the decontamination procedures.

PREFACE

The authors are indebted to CHGUN L. G. Barr, the Radiological Safety Officer for the Naval Air Station, Kwajalein and to the members of the radiation survey and decontamination teams of Squadron VP–29 for the radiological survey data obtained from 3 March until the arrival of the personnel of Project 4.1 on 9 March.

The Trust Territory representatives, J. E. Tobin and Marion Wilde, established and maintained a close liaison between the Marshallese and the personnel of Project 4.1. They also rendered an invaluable service as interpreters.

The authors wish also to express their gratitude to the Marshallese people, whose understanding of their predicament, together with their patience regarding the many clinical laboratory tests to which they were subjected and their willingness to be of help, greatly facilitated the collection of subject data. The services of John (village magistrate), Billiet (school teacher), Jabwe (village doctor), and Niktimos were especially helpful.

The aid of Harold J. Coolidge and F. Raymond Fosberg of the Pacific Science Board (National Research Council) in supplying specific publications pertinent to the various aspects of the present report is most sincerely appreciated.

The authors are, in addition, especially grateful to the following individuals for specific contributions made in either furnishing or aiding in the collection of material: CHGUN L. G. Barr, the Radiological Safety Officer, NAS, Kwajalein (in charge of the decontamination procedures); the radiological survey team of Squadron VP–29 (made all original readings of the external radioactive contamination of the Rongerik personnel); CDR W. S. Hall, MC, USN, and LT J. S. Thompson, MC, USN, of the U. S. Naval Dispensary, Kwajalein (collected dosimetry readings and made them available); and M/Sgt R. E. Pletsch and CWO J. A. Kapral, stationed at Rongerik (rendered continuous aid and cooperation in the collection of factual data concerning the period of fallout at Rongerik).

CONTENTS

PART I MARSHALLESE

Chapter I

OBJECTIVES

The objectives of this study were to: (1) present factual and pictorial data describing and illustrating the environmental surroundings of the inhabitants of Rongelap and Ailinginae atolls; (2) supplement data for clinical records with information concerning family group membership and activities of the Marshallese during fallout; and (3) supplement physical dosimetry studies with readings of the external radioactive contamination of the inhabitants of Rongelap and Ailinginae atolls, including an account of the evacuation and decontamination procedures.

Chapter 2

ENVIRONMENT on RONGELAP and AILINGINAE ATOLLS

2.1 RONGELAP VILLAGE

Rongelap Island is located at the southeastern edge of Rongelap Atoll. A sketch of the native village and its location on Rongelap Island are presented on the following page (Figure 2.1).[1]

2.2 DWELLINGS[2]

The majority of the natives' homes were pole and palm-leaf construction (Figures 2.2 and 2.3). A few houses were partially constructed of lumber (Figure 2.4). The average home had a coral "pebble" floor, either bare or covered in part with palm-leaf mats. A few houses had a connecting shed or lean-to type of roof with facilities for cooking "indoors" during rainy weather (Figure 2.5). Strips of burlap or canvas were hung at windows and doorways. There was little screening. Doors and windows were left open most of the time. Several houses had a partially elevated floor or storage loft. A few natives had cots; however, most of them slept on palm-leaf mats on the floor.

Out-buildings, i.e., cook houses (see Figure 2.6), chicken houses, copra drying-sheds, and storage sheds, were usually shared by one or more families who lived as a group (see also References 1, 3, 5, and 6).

2.3 FOODS

Coconuts and starch-foods comprised the bulk of the native diet. Coconut meat was eaten fresh or dried (copra). Coconut milk served as an important supplement to the scanty water supply during the dry months. Coconut sprouts are edible. Babies are breast-fed by the mother for a short time and then fed the freshly collected sap of the coconut tree (jekaro). When allowed to ferment, jekaro is a potent alcoholic beverage.

The principal starch foods eaten were rice, taro, arrowroot (a potato-like edible root), and starch tubes (mokmok, made from arrowroot, is similar to macaroni). (See Reference 7, page 172 for preparation of mokmok.) Taro root is powdered, then moistened, and compressed into cakes or balls, approximately a foot in diameter. It can be kept indefinitely in this form. Taro is used for making bread and doughnuts.

Various sea foods comprise the next most important part of the native diet. Fish are plentiful and are eaten fresh or dried, raw or cooked. Clams, oysters, crabs,

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[1] Maps showing location of Marshall Islands included in References 1–6.

[2] The key to Holmes and Narver, Rongelap Map, Misc. 254, contains the dimensions and type construction of each building.

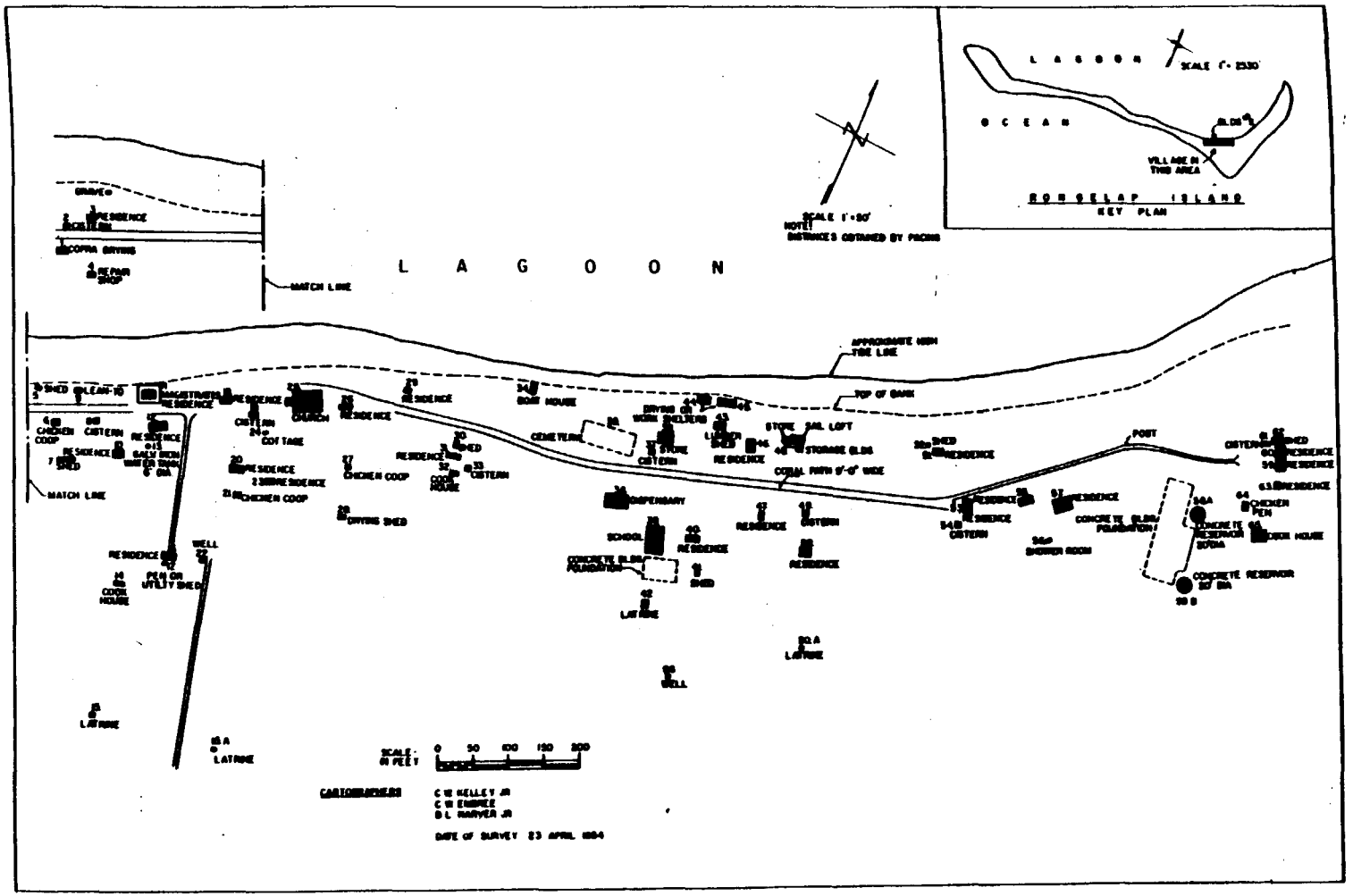


Figure 2.1 Rongelap Village.

octopi, and langouste (tropical lobster) are also eaten, when obtainable. The killer clam (Tridacna gigas) is easily obtained and frequently eaten by the natives.

Although the climate seemed ideal for many types of melons and tropical fruits, only pandanas, papayas, and pumpkins were observed on the island. There were no breadfruit or banana trees. Wild bud was mentioned as a food; however, it was not identified, because the natives failed to find specimens when they revisited Rongelap with the survey teams.

There were approximately 150 chickens on Rongelap on 26 March. In comparison with various sea foods, chickens were eaten rather infrequently. Eggs were eaten raw and considered a great delicacy. The natives made frequent trips to Enialo for eggs. This island is approximately 5 miles north of Rongelap. It is a nesting place for terns and gulls.

There were 12 swine on Rongelap, i.e., a boar, a sow and ten 6-weeks old pigs. Swine were eaten only on festive occasions.

Reference 7 is an excellent study of nutrition in the Marshall Islands (see also Reference 6, pages 149–154).

2.4 WATER SUPPLY

The main water supply was obtained from eight concrete cisterns. These were 6 to 8 feet square, with galvanized metal sheeting for the catchment areas (Figure 2.2). The cisterns were 4 to 5 feet deep and, during the latter part of March and April, each contained about 6 to 10 inches of water. There was one well 2 by 2 feet square and approximately 12 feet deep (Figure 2.7). It contained about 18 inches of water. For many weeks prior to 1 March, the natives had been rationed to one pint cup of water per individual per day.

Sump pools were observed in the lower parts of the island and in old bomb craters. The water in these was apparently ample for the dogs, chickens, and swine (see Reference 8, page 328; and Reference 9).

Figure 2.2 Examples of buildings in Rongelap Village. At left: Cistern No. 37 on Figure 2.1. At right: Village store (No. 39 on Figure 2.1).

Figure 2.3 Interior of dispensary (No. 36 on Figure 2.1) showing details of pole-and-palm-leaf construction. This was best constructed building on island. Note canvas window covering and air spaces between palm-leaf tiers along eaves.

Figure 2.4 House partially constructed of lumber.

Figure 2.5 Typical dwelling, illustrating open-type construction, lean-to roof, and an area for preparing meals "indoors" during rainy weather.

Figure 2.6 Cookhouse (No. 14 on Figure 2.1). This building had wire screening along two sides.

Figure 2.7 Well (No. 22 on Figure 2.1). This well was approximately 2-by-2-ft square and 12 ft deep. The sides were cased with coral masonry.

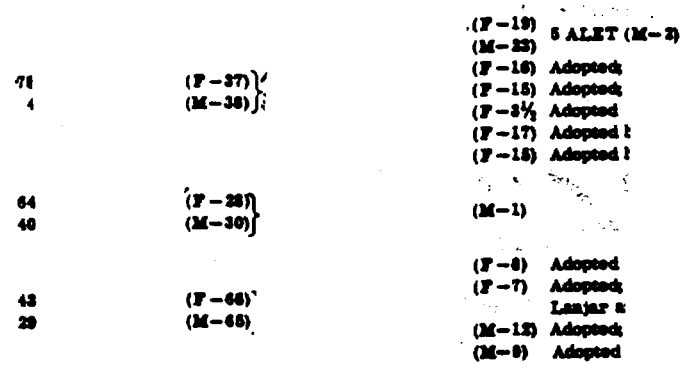
Chapter 3

FAMILY GROUPS: ACTIVITIES, OBSERVATIONS, and FOODS DURING FALLOUT

The natives of Rongelap lived in groups, comprised of one or more families, constituting a matriarchic unit (see References 6, Chapters 5 to 8; 10; and 11). Each family group usually occupied one or more houses and shared several out-buildings.

The family groups are presented on the following pages. Information concerning the location of families, foods eaten 1–3 March, and descriptions of the fallout are included. Each native's name is preceded by the clinical number assigned by Project 4.1, and followed by the sex and age of the individual. Married couples are indicated by brackets. Solid lines indicate direct descendants. Broken lines indicate adoptions.

3.1 GROUP ONE



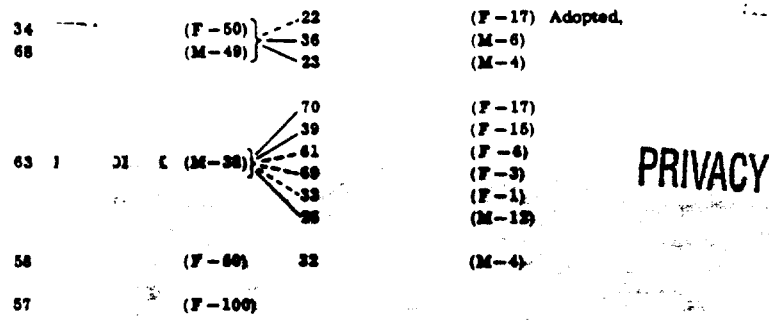
Living Area. the village magistrate, and family lived in house No. 12. the school teacher, and family lived in house No. 11. Other families lived in the same general area. were at Ailinginae 1–3 March.

Activities. On 1 March, walked on reef to Jaboan (island near west end of Rongelap) and returned to Rongelap after sundown. Later went on a picnic and ate only coconuts. said coconut meat tasted sour.

Food and Drink. Fresh fruit, bread, rice, fresh coconut milk and meat, starch tubes (mokmok), copra, jekaro, water, and coffee. Told to stop drinking water at 1500 (1 March), but did not do so.

Fallout. Began in afternoon of 1 March. The group who went to Jaboan said the fallout particles ranged in appearance "from flour to salt." Fallout material was visible on their skin and "like dust in their eyes." It caused itching and "felt like mosquitoes were biting."

3.2 GROUP TWO



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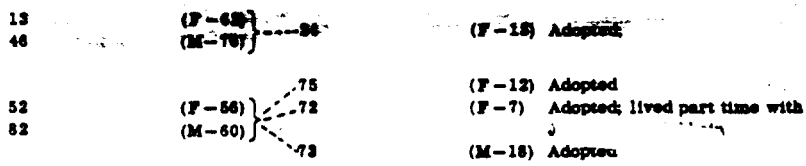
Living area. and family lived in house ? and family lived in house (no information obtained regarding his family). Other families probably lived in houses

3.3 GROUP THREE



Living Area. and family lived in house No. and family lived in house No lived in house No.

Activities.

Food and Drink. Rice, bread, fresh coconut meat, wild bud, copra, fresh crab, fresh fish, starch, cooked pumpkin, papaya (peeled), doughnuts, tea, jekaro, and water. Drank water after told them not to.

Fallout. Began afternoon of 1 March. " Blackened the sky as if night was approaching. Children's lips turned black." " Rained a little" during afternoon of 1 March.

Fallout material which looked like " white powder" turned yellow and dissolved when wet. Reappeared when dry. Powder tasted like cement. Made people sneeze and cough.

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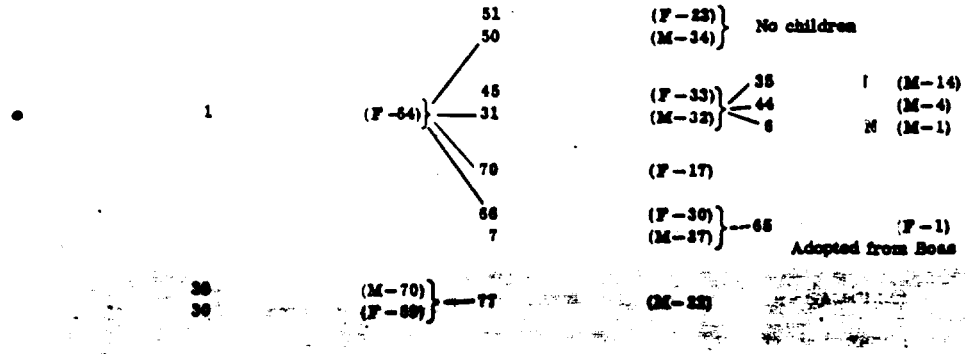
PRIVACY ACT MATERIAL REMOVED

3.4 GROUP FOUR



Living Area. lived in house No. (at Ailinginae 1–3 March). lived in house No. lived in house No. House No. also occupied by a family of this group. were at Ailinginae 1–3 March.

Activities.

Food and Drink. Rice, bread, crabs, fish, wild bud, copra, coffee, water, jekaro, and coconut milk. Fresh coconut milk and meat were the only things not exposed to fallout.

Fallout. Began in afternoon of 1 March. " Looked like table salt."

3.5 GROUP FIVE

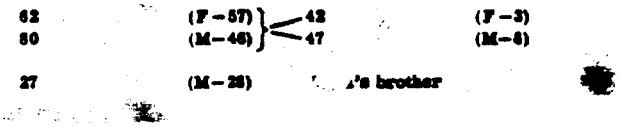
Living Area. lived in house No lived in house No.

Activities.

Food and Drink. Rice, bread, fresh coconut meat, wild bud, copra, fresh crab, fresh fish, starch, cooked pumpkin, papaya (peeled), doughnuts, tea, jekaro, and water. Drank water after old them not to.

Fallout.

3.6 GROUP SIX



Living Area. lived in house No. village doctor, lived alone at the dispensary, Building No.

Activities. A few of the events which occurred 1–3 March are briefly summarized in the interview with the village doctor:

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5007036

" I was asleep at time of flash" but was awakened in time to hear " seven echoes" of blast. Felt shock wave. " Was almost knocked down. Pushed me back, then forward. "

" Fallout began at 1300" on Monday, 1 March. It looked like " taro powder or chalk dust. Water turned yellow shortly after fallout began. Fallout lasted for about seven hours. "

At 0800 (1 March) a group of people left Rongelap to fish at Ailinginae.

Ate breakfast and lunch (1 March). Had evening meal at about 2000. This latter meal consisted of rice, coffee, and dried fish. (Coffee kept in a can; rice in bags, fish was taken from an outside drying rack).

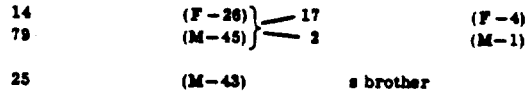
On Tuesday (2 March), told people not to drink water, but most of them continued to do so.

" Sixteen people left in a plane about 1000, " Wednesday, 3 March. " The rest left on a destroyer. "

Food and Drink. Bread, rice, copra, cooked fresh fish, fresh coconut milk, coffee, and jekaro.

Fallout. Started about 1300, 1 March. Was like flour. Caused skin irritation and sneezing. Food tasted strange. was nauseated after breakfast and most of day (1 March).

3.7 GROUP SEVEN



Living Area. Houses No. , and

Activities. Tima fished from a canoe from 1000 to 1600, 1 March. He ate no lunch.

Food and Drink. Bread, rice, copra, cooked fresh fish, fresh coconut milk, coffee, and jekaro.

Fallout.

3.8 GROUP EIGHT

Living Area. Entire group at Ailinginae 1-3 March.

Food and Drink. Bread, rice, fresh coconut meat, wild bud, copra, fresh crab, fresh fish, starch, cooked pumpkin, papaya (peeled), doughnuts, tea, jekaro, and water. Drank water after told them not to.

Fallout.

PRIVACY ACT MATERIAL REMOVED

3.9 LIST OF NATIVES AT SIFO ISLAND, AILINGINAE ATOLL, 1–3 MARCH

The following individuals were either temporarily living at Ailinginae to make copra, or had gone there to fish for a few days. All had permanent homes on Rongelap.

Clinical No.	Name	Clinical No.	Name
1		44	
6		45	
8		48	
16		50	
28		51	
29		53	
31		59	
41		70	
43		81	

3.10 LIST OF MARSHALLESE NOT CONTACTED DURING INTERVIEWS

No information was obtained for these individuals regarding family group membership, activities during fallout, foods eaten, etc.

Clinical No.	Name	Sex	Age
3		M	1
15		F	7
37		M	19
55		M	75
56		F	75
60		F	63
67		F	14
71		F	25
74		F	18

PRIVACY ACT MATERIAL REMOVED

Chapter 4

EVACUATION and DECONTAMINATION

4.1 EVACUATION OF INHABITANTS OF RONGELAP AND AILINGINAE ATOLLS

Sixteen (16) Marshallese were evacuated by plane from Rongelap at 1000, 3 March (H + 51 hours).

Forty-eight (48) Marshallese were evacuated from Rongelap by destroyer at the same time (H + 51 hours).

The eighteen (18) Marshallese who were living on Sifo Island, Ailinginae Atoll, were evacuated by destroyer at H + 54 hours.

The Marshallese were allowed to take with them little more than the clothing they wore.

The survey team with the evacuation party reported readings of 1.0–2.3 r/hr throughout Rongelap Village at the time of evacuation.

4.2 DECONTAMINATION OF MARSHALLESE

The 16 Marshallese evacuated from Rongelap by plane arrived at Kwajalein at noon on 3 March. These individuals showered and bathed several times in an emergency decontamination area, which consisted of a shower room and two adjacent buildings for storing contaminated clothing and possessions. The decontamination area was enclosed by burlap sacking material (Figures 4.1 and 4.2).

The 66 Marshallese evacuated by destroyer (48 from Rongelap and 18 from Ailinginae) arrived late in the evening of 3 March (10–12 hour trip from Rongelap via destroyer). These individuals had taken numerous showers and prolonged washings with salt-water-hose sprays while aboard the destroyer. Clothing was not removed for showers and washings.

On 4 March, showers and baths were repeated.

The personnel of Project 4.1 arrived at Kwajalein on 9 March. The Rongelap and Ailinginae natives were monitored on 11 March (Figure 4.3).

The instruments used by Project 4.1 personnel were the ANPDR/39A and the ANPDR/27c (standard military issue, in general use). Due to the lack of a high-range, beta-sensitive instrument, clothing and body surveys had to be made with the ionization chamber type meter if the activity of the contamination exceeded 5 mr/hr. In most cases, after extensive decontamination, the probe of the 27c instrument was adequate for this purpose. The instruments used had been recently calibrated at the Naval Medical Research Institute (NMRI) against a Co^{60} standard and were considered to be accurate and in good operating condition. They were hand-carried from NMRI to Kwajalein.

The most highly contaminated areas of the body were the head and hair and areas of skin not protected by clothing. Natural folds of the skin and areas of the skin where

prespiration accumulated served to trap and retain particles of the radioactive dust.

Since the Marshallese used a coconut-oil hair dressing, it required a good detergent and brush to adequately decontaminate the hair and head. When scrubbing with brushes caused tenderness and soreness to other parts of the body, decontamination was achieved by substituting cloth towels for washings.

Figure 4.1 Decontamination area, Naval Air Station, Kwajalein.

4.3 DECONTAMINATION OF CLOTHING AND OTHER PERSONAL POSSESSIONS OF THE MARSHALLESE

The Marshallese had received a change of clothing which was voluntarily contributed by the personnel at NAS, Kwajalein. Many individuals had, however, retained articles of their own clothing. When surveyed on 11 March, the contamination of the clothing and possessions, in use, was found to be spotty. The highest concentration of activity was found in the children's clothing, in trouser cuffs, seats of trousers (and areas of clothing which had obviously been in contact with the ground), shoes (inside and out), belts, and combs.

The clothing of the Marshallese (not in use) was monitored 10–12 March and separated into three categories. Clothing which read less than 1.0 mr/hr was returned for use. Clothing which read 1.0 to 5.0 mr/hr was laundered several times and returned to the natives on 17 April, when it read less than 1.0 mr/hr. The clothing which read more than 5.0 mr/hr 11 March was kept until 3 May, at which time it read less than 1.0 mr/hr. Prayer books and shoes were the last possessions returned for use.

The clothing of the 16 Marshallese who were evacuated by plane had not been laundered and still read approximately 100 mr/hr on 18 March. Repeated washings by the Kwajalein laundry failed to lower the counts appreciably. The addition of citric acid to laundry water facilitated decontamination.

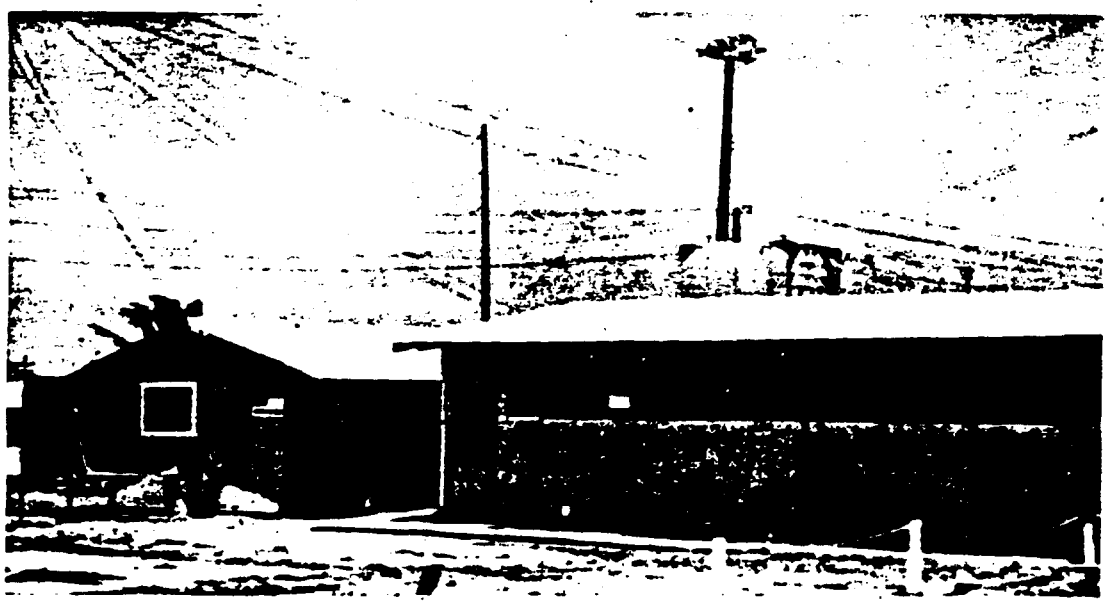


Figure 4.2 Decontamination area, Naval Air Station, Kwajalein. At right: shower room; at left: building for storing contaminated clothing.

Figure 4.3 Personnel of Project 4.1 monitoring Marshallese. Left to right: HMC Strome, photographer and recorder; John, Rongelap Village magistrate and interpreter; CDR Conrad, examining skin (for clinical records); Kotar, Rongelap native (No. 4); and LTJG Sharp, monitoring skin, hair, clothing, etc.

Chapter 5

PHYSICAL MEASUREMENTS of RESIDUAL EXTERNAL CONTAMINATION

The 16 Marshallese who were evacuated from Rongelap by plane were monitored four times during the initial decontamination procedures on 3 March. The names of these individuals are preceded by an asterisk in Table 5.1.

A single reading was made at Kwajalein on 3 March of each of the 66 Marshallese who evacuated from Rongelap and Ailinginae via destroyer. These readings appear in the fourth column under 3 March in Table 5.1.

On 4 March decontamination procedures were continued and the external contamination of the Marshallese was reduced from 5.0 to 40.0 mr/hr to 2.0 to 10.0 mr/hr.

The readings made on 11 March and subsequently were made by Project 4.1 during the latter phase of the decontamination procedures.

TABLE 5.1 MEASUREMENT OF RADIOACTIVE CONTAMINATION OF RONGELAP NATIVES AS DETERMINED BY MONITORING WITH A RADIAC SET NO. AN/PDR-27c SURVEY INSTRUMENT

NAME	CLINICAL NUMBER ASSIGNED BY PROJECT 4.1	3 MARCH				4 MARCH		8 MARCH	11 MARCH		15 MARCH		3 APRIL
		BEFORE FIRST SHOWER	SECOND READING	THIRD READING	FOURTH READING	BEFORE SHOWER	AFTER SHOWER			GAMMA		GAMMA	
					22.0	4.0			2.5		1.0		0
						8.0	5.0		0		0		0
						6.0 (Sore on head)	8.0 (Hand)		1.0		0		0
									1.0		1.0		0
						8.0 (Hair)	6.0		2.0		0		
						7.0 (Hair)	6.0 (Hair)		0		0		0
					20.0	8.0	7.0 (Hair)		2.0		1.5	4.5 (Shoes)	0
					25.0	8.0		1.0	2.5		2.1		0
					20.0	6.0 (Back)	2.0		1.5	15.0 (Shoes)	0		0
					34.0	9.0	3.0	5.0	2.5		1.8		0
		200.0	30.0	12.0	10.0	5.0	4.0		2.0		1.5		0
		200.0	25.0	20.0	10.0	4.0 (Hair)	3.0		2.0		1.0		0
		80.0	70.0	45.0	40.0	3.0			3.5		2.0		
									5.0	2.9	4.5		0.2 (Hair - 1.0)
		80.0	30.0	20.0	10.0	11.0 (Hand)	3.0	3.0	1.0		0		0
											5.0*	1.3	0
									2.5		1.2		0
		200.0	80.0	40.0	30.0		4.0		3.8		4.5		0.2 (Hair - 1.0)
					27.0	7.0	4.0		0		0		0
									1.0		0		0
											1.0		0
						5.0	7.0 (Chest)		3.0		1.3		0.1 (Hair - 0.8)
						7.0	5.0		0		0		0
					10.0	5.0	5.0		5.0*	2.8	5.0*	1.0	0.1 (Hair - 1.5)
					27.0	6.0	5.0 (Hair)		5.0*	2.0	5.0*	1.5	0
						9.0	6.0 (Arms)	5.0	2.0		1.0		0.1 (Hair - 0.7)
		240.0	30.0		15.0	9.0 (Hair)	5.0 (Abdomen)		2.5		1.0		0
					25.0	7.0 (Back)	5.0		4.8		1.8		0
					15.0				1.5		0.9		0
		200.0	60.0	35.0	20.0		6.0		4.6		2.5		0

*In first group evacuated.

PRIVACY ACT MATERIAL REMOVED

TABLE 5.1 CONTINUED

NAME	CAL NUMBER ASIGNED BY PROJECT 4.1	3 MARCH				4 MARCH		8 MARCH	11 MARCH		15 MARCH		3 APRIL
		BEFORE FIRST SMOKER	SECOND READING	THIRD READING	FOURTH READING	BEFORE SMOKER	AFTER SMOKER			GAMMA		GAMMA	
					12.0						-		0
						6.0	5.0 (Hair)		0		0.8		0
						8.0 (Hair)	5.0 (Hair)		2.0		0		0
					20.0	9.0	7.0		5.0+	3.5	5.0+	2.5	0
					23.0	4.0			3.5		2.5		0
					34.0	6.0	6.0	3.0	0		0		0
					20.0	6.0	5.0 (Arm)	6.0	3.0		4.2		0
		100.0	30.0	10.0		8.0 (Right Side)	5.0		1.0		1.3		-
					10.0	7.0	7.0		3.0		1.0		0 (Hair - 1.1)
					20.0	12.0 (Trousers)	4.0		0	(10.0 Shoes)	0		0
					16.0	15.0	6.0	4.5	2.5		1.5		0
						15.0 (Hair)	10.0 (Hair)		5.0+	2.7	2.0		0
					25.0	6.0 (Back)	4.0 (Hair)		5.0+	2.9	2.0		-
						5.0	5.0 (Back)		1.5		0		0
					22.0	10.0 (Hair)	8.0 (Hair)	5.0	3.0		1.5		0
		200.0	30.0	25.0	15.0				0		0		0
						6.0 (Bare on Leg)	6.0 (Hair)	2.0	2.0		0		0
						20.0 (Hair)	8.0 (Hair & Chest)		3.5		2.7		0 (Hair - 0.8)
					10.0	6.0	4.0 (Hair)		5.0+	3.1	1.0		0
					12.0	4.0	4.0 (Hair)		5.0+	2.9	3.0		0
						3.0			2.5		2.0		0
		80.0	70.0	70.0	40.0				4.5		2.5		0
									4.0		3.4		0.1 (Hair - 0.6)
									1.0		0		-
					10.0	10.0 (Hair)	9.0 (Hair)		1.3		0		0
		80.0	50.0	20.0	15.0				4.5		1.0		-
		200.0	100.0	50.0	30.0	4.0			3.0		2.0		-
									5.0+	3.4	5.0+	2.8	0
					25.0	9.0	7.0 (Hair)		5.0+	3.9	5.0+	3.5	0.2 (Hair - 0.9)
		200.0	100.0	30.0	30.0				5.0+	3.0	2.7		0

*In first group evacuated.

PRIVACY ACT MATERIAL REMOVED

TABLE 6.1 CONTINUED

NAME	CLINICAL NUMBER ASSIGNED BY PROJECT 4.1	3 MARCH				4 MARCH		8 MARCH	11 MARCH		15 MARCH		3 APRIL
		BEFORE FIRST SHOWER	SECOND READING	THIRD READING	FOURTH READING	BEFORE SHOWER	AFTER SHOWER			CANADA		CANADA	
					10.0	5.0	5.0 (Hair)	5.0	4.0		1.7		0.1 (Hair - 0.7)
					5.0	15.0 (Hair)	9.0		5.0*	2.9	2.5		0
					20.0	8.0 (Hair)	8.0 (Legs)		5.0*	2.9	3.0		0
					10.0	6.0 (Back)	7.0 (Legs)		5.0*	2.7	4.3		0
						6.0	3.0		1.0		0		0
					30.0	4.0			5.0*	2.9	2.0		0.1 (Hair - 0.7)
					10.0	8.0 (Hair)	6.0 (Arms)		5.0*	2.9	5.0*	2.0	0.2 (Hair - 1.1)
					26.0	6.0	4.0		4.0		2.5		0
						7.0	5.0		3.0		1.0		0
					30.0	7.0 (Hands)	5.0 (Hair)		3.9		2.0		0 (Hair - 0.6)
					15.0	10.0	6.0		5.0	1.5	3.0		0.2 (Hair - 1.0)
						5.0 (Hair)	4.0		2.5		1.0		0
					25.0	7.0	3.0	5.0	2.0		1.0		0
		200.0	100.0	60.0	35.0	4.0			3.5		1.0		0
					5.0	7.0 (Hair)	8.0 (Hair)		5.0*	2.5	3.7	1.0	0.2 (Hair - 0.9)
									1.0		0		0
		400.0	20.0	15.0	7.0				1.0				
					5.0	8.0 (Back)	5.0 (Back)		5.0*	4.4	5.0*	4.0	0.4 (Hair - 2.8)
					20.0	13.0 (Hair)	4.0				2.5		0
						8.0	2.0		5.0*	1.8	3.5	1.9	0
					27.0	5.0 (Hair)	4.0		3.0		1.0		0
					15.0	9.0 (Hair, Chest)	9.0 (Chest)		3.0		3.5	0.9	0

*In first group evacuated.

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* A general review of the literature was not necessary. The Pacific Science Board has recently published a comprehensive bibliography of botanical and ecologic studies of the Pacific Islands (Reference 8 above). This publication includes references concerning the following subjects: geography, geology, climate, water supplies, soils, flora, fauna, ecology, etc. The other Pacific Science Board publications listed contain information pertinent to specific aspects of the present report. The National Geographic Magazine articles are cited primarily for the historical and pictorial coverage they contain.

† Information concerning the availability of this document may be obtained by addressing inquiries to: Pacific Science Board; National Research Council; 2101 Constitution Avenue, N. W.; Washington 25, D. C.

PART 2 AMERICAN MILITARY PERSONNEL

Chapter I

OBJECTIVE

The objective of this study was to supplement clinical data with as much information as possible concerning events during the fallout at Rongerik, including (1) activities of men during fallout, (2) description of fallout, (3) types of clothing worn, (4) food and drink, (5) location of film badges, (6) evacuation and decontamination procedures, and (7) readings of external radioactive contamination of Rongerik personnel.

Chapter 2

PERSONNEL and EQUIPMENT on ENIWETAK ISLAND, 1-2 MARCH 1954

2.1 LOCATION AND DESCRIPTION OF ENIWETAK ISLAND

Rongerik Atoll is situated 135 nautical miles east of Bikini Atoll. Eniwetak Island is located along the southeastern perimeter of Rongerik Atoll.

Eniwetak Island is crescent-shaped. It is 1¼ miles long and approximately ¼ mile wide at the center (Figure 2.1).

As indicated in Figure 2.1, the general housing area was located in the central part of the island with the weather station located near the southwestern end of the island and the communications section located near the northeastern end of the island.

2.2 LIST OF MILITARY PERSONNEL STATIONED ON ENIWETAK ISLAND, RONGERIK ATOLL, 1 AND 2 MARCH 1954.

Clinical Number Assigned	Air Force	Army

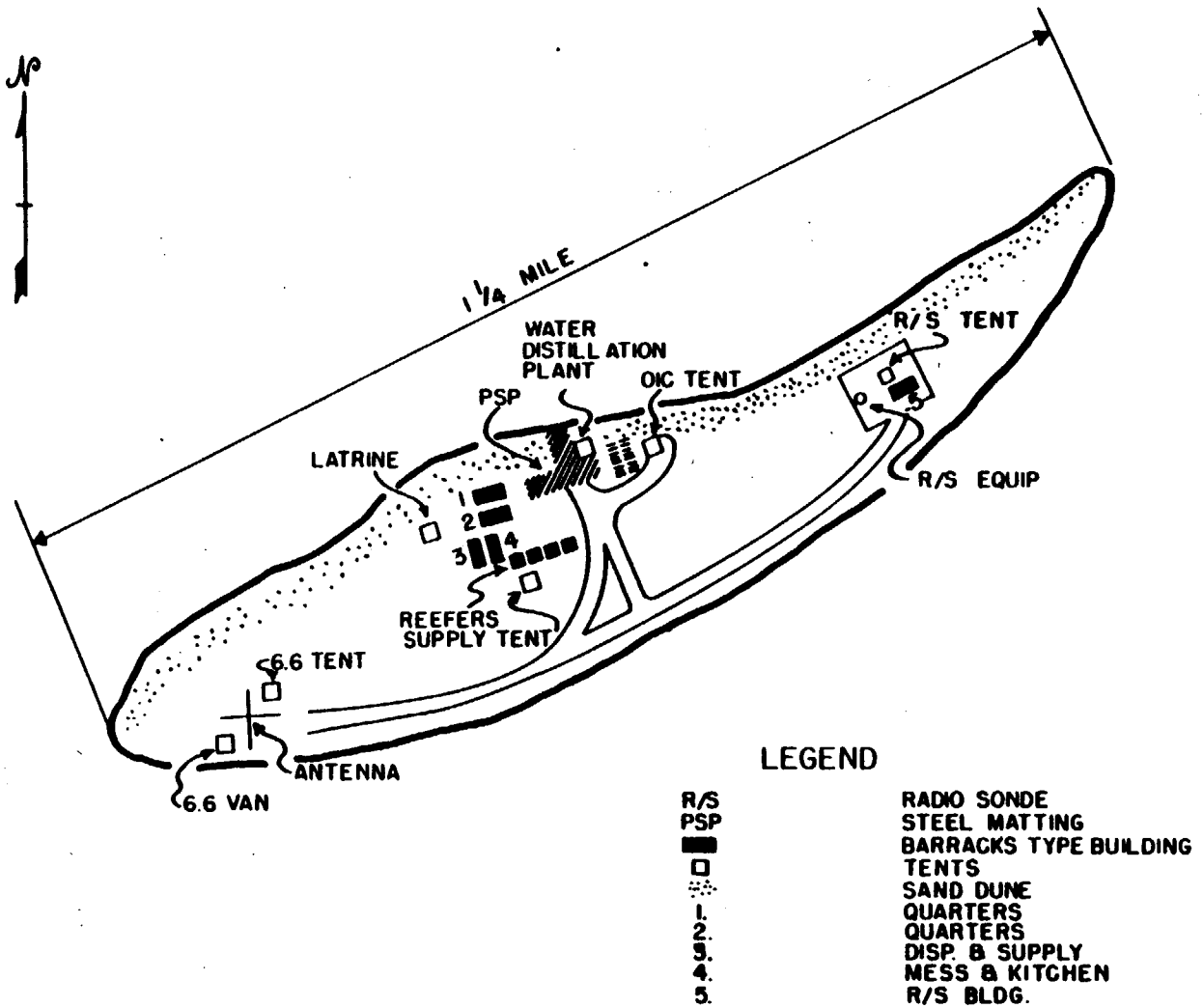

Figure 2.1 Eniwetak Island, Rongerik Atoll, Marshall Islands.

2.3 DUTY ASSIGNMENTS OF PERSONNEL

PRIVACY ACT MATERIAL REMOVED

Detachment Commander	Medical Technician	Supply

2.4 HOUSING

Air Force personnel were housed in Butler Buildings (24-foot-by-8-foot steel quonset huts with screened windows along sides).

Army personnel were housed in a 24-man tent. (No screening. Tent flaps kept elevated at all times.)

2.5 WATER SUPPLY

Distillation unit.

Drinking water was available at housing areas in covered 5-gallon cans.

PRIVACY ACT MATERIAL REMOVED

Chapter 3
EVENTS DURING FALLOUT

3.1 SUMMARY OF INTERVIEWS AND EVENTS DURING FALLOUT

3.1.1 Activities of Personnel.

1 March	1400–1430	Observed onset of fallout.
	1500	Dispatch sent to Eniwetok.
	1530	Men instructed to wear long-sleeve shirts, long trousers, hats, and G. I. shoes. At same time CWO Kapral instructed men to continue regular routine (to avoid hysteria).
	1800	Sent regularly schedule[d] message on weather.
	2100	Sent emergency message.
	2330	Ordered to move all men to permanent buildings.

2 March — Majority of men had canned fruit juice and/or coffee for breakfast. Personnel remained indoors as much as possible.

Eight men evacuated via plane to Kwajalein at 1245 (

Remaining 20 men evacuated to Kwajalein via plane at 1800.

3.1.2 Description of Fallout. Began 1400–1430, 1 March. Early fallout described as "like ashes, white or gray in color. Floated down, like snow." Later in afternoon described as "gritty, like sand."

Men at the radio station collected fallout material. This material, when placed on the surface of a cathode–ray tube (part of ionosphere equipment), caused that portion of the tube surface to glow.

A few of the men described a minimal fallout on 2 March. These statements are questionable and not consistent with the majority of observations.

3.2 INDIVIDUAL INTERVIEWS WITH PERSONNEL STATIONED ON ENIWETAK ISLAND (RONGERIK ATOLL)

The men were requested to supply information regarding their activities during the fallout, a description of the fallout, clothing worn, food and drink, location of film badges, time of evacuation, present enlistment status, etc. This information is presented in the following paragraphs.

S/Sgt,

Duty. Weather Equipment Technician and Assistant Non-Commissioned Officer in Charge of the Rawin Sounde Section.

Activities. 1 March: Off duty all afternoon. Ate at 1700 and attended movies in mess hall afterward.

2 March: Worked outside all morning, helping to wash down buildings.

Clothing. Wore shorts, T-shirt, G. I. shoes, and no cap. Changed into long clothing at 1530.

Food and Drink. Ate evening meal 1 March. No breakfast 2 March. Drank coffee. Ate lunch at Kwajalein.

Fallout. Resembled snow or ashes both days (1 and 2 March).

Film Badge. None. Usually with A/1c in the living area.

Evacuated. 1245, 2 March.

Note: High school completed. Has seven months remaining of present enlistment.

Duty. Cook.

Activities. 1 March: On duty. Time equally divided indoors cooking and outdoors washing pans and working around supply tent and reefers. Spent evening playing cards.

2 March: Began work at 0700.

Clothing. Wore shorts, T-shirt, and shoes prior to 1630, 1 March. Changed into long clothing.

Food and Drink. Ate evening meal 1 March and breakfast 2 March.

Fallout.

Film Badge. None. (In same general area as

Evacuated. In first group (1245, 2 March).

Note: Completed junior college. One year remaining in present enlistment.

Duty. Observer with weather group.

Activities. 1 March: Worked outside at weather station. On duty until midnight.

2 March: Stayed in or around quarters.

Clothing. Prior to 1530, 1 March, wore shorts and shoes. Changed into long clothing.

Food and Drink. Ate evening meal 1 March. Had coffee for breakfast 2 March. Began lunch, but did not finish.

Fallout. Noticed fallout at about 1500. "Looked like fine particles of ashes, but felt gritty." At 1400 noticed an X-shaped cirrus cloud that became funnel-shaped just before fallout began.

Film Badge. None. Worked with

Evacuated. In first group (1245, 2 March).

Note: High school completed. Present enlistment to be completed in December 1954.

Duty. Radio operator.

Activities. 1 March: Worked outside around bathhouse and latrine with Ate 1600-1630. Went on duty at radio shack at 1800. (Rain commenced about 2100 and continued for 30 minutes.) At 2100 took truck to pick up Army men and return them to building adjacent to radio shack (where they spent the night).

2 March: Remained on duty until 0800. Stayed in barracks from 0800 to 1245.

Clothing. Wore shorts and short-sleeve shirt 1 March until 1700. Changed to long-sleeve shirt and long trousers. Wore no hat.

Food and Drink. Ate evening meal 1 March and had sandwiches later in radio shack. Ate nothing on 2 March until after arrival on Kwajalein. Drank water from icebox on 1 and 2 March.

Fallout. Observed fallout at 1500 1 March, which he describes as "like snow; particles the size of grains of sand, but floated down, rather than falling straight down; white or silver in color."

Film Badge. None. 1200–2400 (1 March) with . who wore film badge. 2400–0800 (2 March) no film badge at radio shack.

Evacuated. In first group at about 1245. Arrived at Kwajalein at 1445 (2 March).

Note: High school completed. Fifteen months in service.

Duty. Assigned to weather station.

Activities. 1 March: On duty until 0600, 1 March. Was not in tent area 1 or 2 March. Slept until noon 1 March. Back to bed (after lunch) at 1400. Was awakened at 1500. Stayed up most of night (1 March).

2 March: Remained indoors most of time.

Clothing. Dressed in fatigues when awakened at 1500, 1 March.

Food and Drink. Ate evening meal, 1 March. Ate a little lunch 2 March before being told not to. Drank several cups of coffee night of 1 March. Drank coffee and water morning of 2 March.

Fallout. Observed fallout at 1500. "Like ashes, floated down. Looked hazy outdoors."

Film Badge. None. Was with most of time.

Evacuated. In first group (1245, 2 March).

Note: Two and a half years college. One year of present enlistment to complete.

Duty. Rawin Sonde Operator.

Activities. 1 March: On duty day of 1 March until 1630. Took shower before chow. Attended movie in mess hall.

2 March: Worked outside, helping to wash outside of mess hall.

Clothing. Wore shorts until 1530.. Changed to long clothing.

Food and Drink. Ate evening meal 1 March. Had coffee for breakfast, 2 March. No lunch.

Fallout. Observed fallout at about 1500. "White ashes; light, floated down."

Film Badge. None wore badge for group.

Evacuated. In first group (1245, 2 March).

Note: High school education. Thirteen months remaining of present enlistment.

Duty. Rawin Sonde Operator.

Activities. 1 March: Worked at weather station from 0800 until 1700–1730, 1 March. After chow, took shower, and attended movie in mess hall.

2 March: Remained inside most of morning.

Clothing. Wore khaki shorts and shoes. Changed to long clothing at 1530, 1 March.

Food and Drink. Ate evening meal, 1 March. On 2 March ate box lunch brought by first evacuation plane.

Fallout. Monitoring instrument began recording at 1430; was off scale at 1450. Visible fallout noted at 1500. Described fallout as "like sand with white particles the size of cigarette ashes." Closed windows and doors of weather station. Fallout material visible on tables in mess hall and barracks at night.

Film Badge. Worn by e for group. Was hung outside building when men were outside for observation of weather balloon ascension.

Evacuated. In first group (1245, 2 March.

Note: Part of one year college. One and a half years to complete present enlistment.

Duty. Rawin Sonde Section.

Activities. 1 March: On duty at radio, Sonde Section, from 1330 to 1730.

2 March: Remained inside as much as possible, until ordered outside to help wash buildings.

Clothing. Wore shorts and shoes prior to 1530, 1 March. Closed doors and windows of R-S Building at 1515 and put on raincoat. Changed to long clothing at 1530.

Food and Drink. Did not eat evening meal 1 March. " Like dust, except it floated down." Observed X-shaped cirrus cloud at 25,000 feet. just before fallout began.

Film Badge. Wore film badge for weather group. wore film badge for relief or alternate weather group.) Film badge read 38 roentgens.

Evacuated. In first group (1245, 2 March).

Note: One year college. Three years to complete present enlistment.

Duty. Supply.

Activities. 1 March: Worked on records in supply room until 1700, 1 March. Showered before chow. Took truck out for garbage run after chow. Attended movie in mess hall.

2 March: Worked outside getting Army "Duck" ready for evacuating first group of men.

Clothing. Changed into long clothing morning of 2 March. Wore shorts, T-shirt and sandals 1 March.

Food and Drink. Ate evening meal 1 March.

Fallout. Was told about fallout at 1500, 1 March. On 2 March, observed that fallout material was 1/4 to 1/2 inch deep along sides of "Duck."

Film Badge. None.

Evacuated. In second group (1800, 2 March).

Note: Eleventh grade, high school. Two and a half years to complete on present enlistment.

Duty. Weather group; night duty.

Activities. 1 March: Slept in tent by weather station until about 1400. Remained

in tent area and returned to work at 2000. Worked until midnight, when message was received to cease operations. Slept remainder of night in area.

2 March:

Clothing. Dressed in long clothing about 1430 (including cap and heavy shoes).

Food and Drink. Did not eat evening meal, 1 March. Ate cereal for breakfast, 2 March.

Fallout. Observed fallout about 1445. "Like grains of snow." Could still see a little fallout on 2 March.

Film Badge. None (worked with

Evacuated. In second group (1800, 2 March).

Note: One year college. Twenty-eight months to complete present enlistment.

Duty.

Activities. 1 March: Worked outside all afternoon until 1600. Took shower after chow and then played dominoes in mess hall from 1800 until 0600, 2 March.

2 March: Spent most of morning outside washing off chow hall.

Clothing. 1 March: Wore T-shirt, fatigue trousers, and shower shoes until 1700 when he changed to long clothing.

Food and Drink. Ate evening meal 1 March. Did not eat breakfast or lunch 2 March, but did eat caramels and drink grape juice at the dispensary.

Fallout. Noticed fallout at 1430, 1 March. Looked like ashes and felt like ashes when rubbed off. Later (night of 1 March), changed to sandy character and was like sand on 2 March—white and powdery.

Film Badge. Wore film badge which read 44 roentgens. Spent most of time in housing area.

Evacuated. In second group (1800, 2 March).

Note: Completed 3 years of a 4-year enlistment. Has had 2 years of college. Has bad anemia and received two courses of therapy.

Duty. Cook.

Activities. 1 March: Worked outside at supply tent and around reefers afternoon of 1 March. Showered after chow and spent evening writing letters (in bed).

2 March: Prepared breakfast. (Five men ate, i. e., ... ıd three Army men). Prepared lunch, but just as it was ready, was told not to serve men.

Clothing. Wore long white trousers, T-shirt, shoes and cap (with perforations) on 1 March.

Food and Drink. Ate evening meal, 1 March, and breakfast on 2 March.

Fallout. First noticed fallout at 1500 on 1 March. "Like tiny grains of sand." Fallout still in evidence on 2 March.

Film Badge. None.

Evacuated. In second group (1800, 2 March).

Note. Finished high school. Nine months to complete present enlistment.

Duty. Detachment Commander, WREP No. 1, Rongerik Atoll.

PRIVACY ACT MATERIAL REMOVED

Activities. "1 March 1954. Viewed shot at 0645L from bathhouse. Looked directly at light, was prepared to shield eyes with towel if it became necessary. Ate breakfast. Wore class X clothing (short trousers, T-shirt, shirt, cap, socks and shoes). Supervised some maintenance on power units and reefers. Had lunch. After lunch, noticed reduced visibility. About 1430L, sent out message regarding reading of automonitor. By 1600L fallout had increased to the point at which particles could almost be seen falling. Visibility had decreased to 3 to 4 miles and air appeared to be extremely hazy. Took shower about 1630L. Had dinner at 1800L. During the day drank water and juices. Stayed outdoors practically all day. Had fungus infection in left ear, so I did not go swimming. Went to sleep in tent on windward shore of island. Stayed in tent all night.

2 March: Got up and washed about 0630L, wore long-sleeve shirt and trousers, cap and shoes. Had normal breakfast. Visibility had improved noticeably. Gray dust covered all buildings and trees. At 1030L, received message from Headquarters, WREP to cease all operations, except radio communications and to stay inside buildings. Complied with message as much as possible. Had no lunch but drank grape juice from refrigerator. At 1230L eight men, in alphabetical order, were flown out to Kwajalein. During afternoon drank more grape juice. Took shower at 1530L. Wore same clothing. Crew washed mess hall building with salt water hose inside and out. Stayed in mess hall most of afternoon. I was evacuated with the rest of the detachment on the second trip at 1800L. Did not wear a film badge at any time. Spent all my time in the living area after the shot. There was at least one badge on the buildings and at least three airmen wore film badges in the living area at all times."

Duty. Night duty, Army group.

Activities. 1 March: Slept from 1230 to 1400 (night man of Army group). Remained in tent area until chow. Took shower outdoors, after chow. Slept from 1930 to 2230. On duty in Army area from 2230 until approximately 0100, while other two Army personnel were sleeping. Moved to weather building after 0115, 2 March, and spent remainder of night there.

2 March: Spent most of time around housing area.

Clothing. Shorts only until 1500–1530, 1 March. Changed into long clothing, with hat and shoes.

Food and Drink. Ate evening meal 1 March. Ate breakfast and part of lunch, 2 March. Drank water from five gallon tins located in Army area.

Fallout. Noticed fallout when awakened at 1400, 1 March. By evening "looked like a sheet over tent." Material observed on surface of all buildings and equipment, both out- and in-doors, i.e., tables in messhall, etc.

After chow, examined fallout material under microscope. "About same size as sand particles. Under microscope sand particles appeared solid–fallout particles looked like crystals. Material not soluble in water on microscope slide. Crystals had rough edges."

[redacted] was present when fallout material was observed to cause cathode tube to glow. He also observed that the material glowed in the dark.

Film Badge. None. Film badge hanging in tent.

Evacuated. In second group (1800, 2 March).

Note: Graduated June 1951 from Brooklyn College, School of General Studies (small business major). Discharge date: 12 August 1954.

Duty. Weather group, night duty.

Activities. 1 March: Slept until awakened at 1545. Went on duty at weather station 2000 hours. Worked until midnight.

2 March: Went back and forth from barracks to mess hall several times. Went to wash in shower room once. Outdoors approximately 1 hour during evacuation.

Clothing. Dressed in long clothing when awakened at 1545, 1 March.

Food and Drink. Did not eat evening meal on 1 March. Drank approximately 1 quart liquid 1 March. No food eaten 2 March, drank approximately 1 pint liquid.

Fallout. Observed fallout after being awakened at 1545, 1 March. Sky seemed overcast. Fallout looked like fine ash, similar to that resulting from burned paper.

Film Badge. None (worked with Neil).

Evacuated. In second group (1800, 2 March).

Note: One year college. Four months remaining of present enlistment.

Duty. Weather group, night duty.

Activities. 1 March: Slept until 1500–1530. After chow at 1730, went back to work at 2000, at weather station. Worked until midnight. Slept until 0700.

2 March: Spend equal amounts of time indoors and outdoors.

Clothing. Wore fatigue clothing from 1530, 1 March, until evacuated (with exception of sleeping time night of 1 March).

Food and Drink. Ate evening meal 1 March, and had cheese and crackers at weather station at about 2200. Had coffee only on 2 March.

Fallout. "Like snow."

Film Badge. Wore film badge for alternate weather group. Wore badge until noon 1 March. Film badge read 38 roentgens.

Evacuated. In second group (1800, 2 March).

Note: Completed 3 ½ years of college. Eight months remaining of present enlistment.

Duty. Radio operator.

Activities. 1 March: Worked from midnight until 0700. Returned to living area for breakfast and then slept until 1400. Remained inside most of time.

2 March: On duty at 0700. Worked until noon.

Clothing. Dressed in fatigues at 1400, 1 March.

Food and Drink. Ate evening meal 1 March. Ate breakfast and a "little lunch 2 March."

Fallout. Observed when subject man awoke at 1400, 1 March. "At first was heavy like snow. Seems there was a little on 2 March."

Film Badge. None. wore film badge for group.

Evacuated. In second group (1800, 2 March).

Note: Completed junior college. One year and 2 months remaining of present enlistment.

Duty. Radio operator.

Activities. 1 March: On duty at radio shack all afternoon. Went outside to weather station every hour (20 feet away). Had chow at 1800. Showered after chow and returned to movie in mess hall, where he remained until 2300. Slept in barracks next door.

2 March: Spent an hour cleaning up mess hall. Stayed inside remainder of morning. Spent an hour in radio shack at noon. Remained inside until 1630. Worked at radio shack from 1630 until just before being evacuated. (Radio shack about the size of a piano crate. Could not completely close door.)

Clothing. Wore shorts until afternoon of 2 March.

Food and Drink. Ate evening meal 1 March. No appetite 2 March. Became thirsty and drank more than the usual amount of water during the afternoon.

Fallout. First noticed fallout at 1400, 1 March. Described as "silvery, grayish dust, which looked like snow. Particle size—like course salt." Did not observe fallout 2 March. (Later described a talcum—like fallout on morning of 2 March.)

Film Badge. None. wore badge for group.

Evacuated. In second group (1800, 2 March).

Note: Completed high school. Three and a half years remaining of present enlistment.

Duty. Detachment Non-Commissioned Officer in Charge (WEH Equipment Supply)

Activities. " 1 March 1954: Awoke approximately 0630, was outside at time of shot. At 1450 local time the RAD meter (TN3A) began to rise. At 1500 a message was sent giving readings. At this time the visibility was hazy and when looking toward dark areas small particles could be seen falling. At this time I went to the area to get long sleeve and long trousers for the men on duty at the "R" section. Also at this time, all personnel was notified to change into different clothing with long sleeves and trousers with legs. This time I remained indoors as much as possible. Remained up until final message was received to cease operation. At approximately 2400 I notified the Army personnel to move to the "R" section and remain inside the metal building there. Transportation was furnished them.

2 March 1954: Awoke 0700. Remained in mess hall throughout day as much as possible. Had mess hall completely washed down at 1000L. Kept personnel inside throughout the day. Left island approximately 1700L and actual takeoff was 1800L."

Clothing. T-shirt and shorts until 1500L, 1 March. Then till arrival at Kwajalein, long-sleeve shirt and trousers and cap.

Food and Drink. Supper 1 March 1954. Coffee and water remainder of stay, Exception of sandwich from box lunch from aircraft.

Fallout. Noticed 1500 1 March as a hazy appearance, when looking toward dark background, i.e., buildings. Could notice small particles with appearance of an ash. This continued and increased in intensity toward evening. Continued throughout evening. Next morning tents and equipment were covered with this ash.

Film Badge. Yes, wore on left shirt pocket from 1800L, 28 February until arrival at Kwajalein 1900L, 2 March 1954.

Evacuation. Second group (1800L 2 March 1954).

Note: Education, high school, WEA Obs., NCO School, WEA EQ 7EOH. Present enlistment, indefinite (career).

Duty. Water distillation man.

Activities. 1 March: Operated a 300-gallon Badger unit (a vapor compression unit under a tarpaper roof with two sides of shelter enclosed and two sides open). Showered after chow and stayed either in chow hall or barracks until 2200–2230.

2 March: Stayed in mess hall for 2 hours. Spent remainder of morning washing down mess hall, inside and outside.

Clothing. Wore shoes and shorts 1 March until 1630, changed to long clothing.

Food and Drink. Ate evening meal 1 March. Ate cereal for breakfast on 2 March. Ate flight lunch brought on SA16 at 1300 and drank a beer at 1400, 2 March.

Fallout. Subject man did not notice fallout until it was called to his attention at 1630. At that time he said it looked hazy and he could see sandy material on roofs and upper surface of equipment.

Film Badge. None wore badge for group).

Evacuated. In second group (1800, 2 March).

Note: Completed 10th grade in high school. Discharge date: 15 January 1955.

Duty. Rawin Sonde Operator.

Activities. 1 March: Worked near weather station until 1630–1700. Remained indoors most of evening.

2 March:

Clothing. Wore shorts, short-sleeved shirt, and hat prior to 1530, 1 March. Changed into long clothing at that time.

Food and Drink. Ate evening meal 1 March. Did not eat breakfast or lunch 2 March. Drank very little water. Opened can of tomato juice and drank 2 glasses about 1400, 2 March.

Fallout. Observed at about 1400, 1 March. "Like coarse white dust, but floated down like ashes." By night, was covering upper surface of all objects indoors.

Film Badge. None vore badge for group).

Evacuated. In second group (1800, 2 March).

Note: Completed 2 years college. Has 1½ years remaining of present enlistment.

Duty. Medical Technician for WREP No. 1 on Rongerik.

Activities. 1 March: Awakened about 0645 by terrific bright light. Ran outside, looking toward source and saw orange, rust-colored glow spreading over horizon.

Held sick call after breakfast and after lunch. Repaired outdoor movie screen. When fallout began, told two other men working in area (S/ and A/2c t) to cover exposed upper half of bodies, and to stay inside mess hall. Stayed inside dispensary. Changed to coveralls. Ate dinner. Returned to dispensary. Took shower and went to bed at approximately 2200.

2 March: Ate breakfast. Held sick call. Washed down outside of mess hall and floors. Stayed with other men in mess hall until evacuated.

Clothing. Wore T-shirt and shorts until about 1700. Afterward wore coveralls and pith helmet.

Food and Drink. 1 March: Ate breakfast, lunch and dinner. Drank from opened can of grape juice from dispensary refrigerator.

2 March: Ate nothing from mess hall. Drank juices from dispensary refrigerator. Ate flight lunch from first evacuation plane.

Fallout. First noticed at 1500, 1 March. Continued falling after dark. Appeared as heavy dust on all surfaces.

Film Badge. None (wore badge in approximately same working area).

Evacuated. In second group , 800, 2 March).

Note: Completed high school. Indefinite enlistment.

Duty.

Activities. 1 March: Worked in equipment van, developing film, until 1630–1700. (Equipment van located near Army personnel's tent.) Bathed outside with buckets at washstand. Walked path through trees to chow at 1700. Returned to equipment van after chow and remained in van until 2000. Was in tent from 2000 until midnight. Moved to weather equipment building next to radio shack at midnight.

2 March: Remained indoors as much as possible.

Clothing. Wore shorts until 1530, 1 March. Changed to long clothing.

Food and Drink. Ate evening meal 1 March. Ate breakfast and had glass of orange juice at lunch on 2 March. Drank water from 5-gallon covered cans located outside Army tent.

Fallout. Compared particle size to grains of sand. Fallout material white in color, "like light ashes." Tent became covered with material. Enough fallout material to cover thumb-nail, when planed on cathode-ray tube (part of ionosphere equipment), caused that portion of tube to glow. Tube continued to glow in dark, a whitish-pink color. Rain made material "run like whitewash," but did not remove it from tent surface.

Film Badge. Positioned inside tent on tent-pole 7 feet above tent flooring. (Sides of 24-man tent kept elevated.)

Linograph-ortho Kodak (Shellburst film) in equipment van, when checked during evening 1 March, was " all blackened at 4 minutes in D19 Developer at 68°."

Evacuated. In second group (1800, 2 March).

Note: Completed high school. Present enlistment complete 11 March 1955.

Duty. Radio mechanic, day duty.

Activities. 1 March: Worked until about 1700 (in and outdoors). Took shower after chow.

2 March: Worked until noon.

Clothing. Wore shorts only until after evening meal, 1 March.

Food and Drink. Ate evening meal, 1 March. Did not eat anything on 2 March before being evacuated. Did drink water.

Fallout. First observed fallout on tent surface. Does not remember what time it began. Fallout material on desk surface inside radio shack.

Film Badge. Non wore badge for group).

Evacuated. In second group (1800, 2 March).

Note: Completed high school. Present enlistment complete 24 January 1955.

Duty.

Activities. 1 March: In Army area "in the woods" reading all afternoon (until 1600–1630). Went for swin (10 minutes) and took shower just before chow. Walked through woods to chow and walked back to Army area afterward, returning to tent at 1830. Stayed outside until 1900, walking along beach. Worked in equipment van from 1900 until 2230. Awakened at 2230. Continued working until about midnight when notified to cease operations and to go to permanent building. Automatic equipment left "on."

2 March: Walked back and forth between Air Force area and Army area to check equipment, otherwise remained inside.

Clothing. Wore short-sleeve shirt, shorts and shoes afternoon of 1 March. Changed to long clothing at 1630.

Food and Drink. Ate evening meal 1 March. Ate small breakfast, and part of lunch 2 March.

Fallout. Since was reading under trees he did not notice fallout until called it to his attention at 1530. noticed material on arms which he described as "like pollen." When notified to change clothing, fallout was heavy enough to get in 's eyes "a time or two" as he walked to tent.

Observed fallout material under microscope at dispensary. Fallout particles described as smaller than sand particles and more uniform in size.

Corpsman put out moistened slide to collect particles, but slide was dry when examined. Particles collected on piece of paper glowed in the dark. Tried to repeat observation next morning, but could not find a place dark enough to tell whether or not material still glowed.

Film Badge. None

Evacuated. In second group (1800, 2 March).

Note: College graduate. Discharge date: 10 August 1954.

Duty. Cook.

Activities. 1 March: Spend afternoon (until 1530–1600) cleaning pots and pans outside mess hall. After chow, played cards in mess hall until 2200.

2 March: Remained inside all morning.

Clothing. Wore only long trousers and shoes until advised by Pletsch to change to long clothing with cap at 1530.

Food and Drink. Ate evening meal 1 March. Drank can of beer in lieu of breakfast. Ate box lunch from first evacuation plane at noon, 2 March.

Fallout. First noticed fallout at 1430, 1 March. "Looked like light sleet; floated down like ashes. Next day felt like sand."

Film Badge. None wore badge for men working in same area).

Evacuated. In second group (1800, 2 March).

Note: Education: 10th grade, high school. Indefinite enlistment.

Duty. K. P. duty, days.

Activities. 1 March: Worked outside more than inside until 1530. At that time,

went down and told Army men to stay indoors. Returned to mess hall and remained indoors.

2 March: Remained indoors.

Clothing. Wore shorts only until 1530, 1 March. Changed into long clothing (fatigues) at that time.

Food and Drink. Ate very little at evening meal, 1 March. Did not eat breakfast or lunch, 2 March.

Fallout. Did not notice fallout until told by others.

Film Badge. None.

Evacuated. In second group (1800, 2 March).

Duty. Powerman, electrician.

Activities. 1 March: Went out to R-section to bring men in for lunch. Hauled gasoline to Army section and R-section. Ate lunch. Worked on magnetos and engines near Air Force area in afternoon. At 1530 went down to Army section and told Army personnel to change into long clothing. Returned to work. After evening chow, checked engines (reefers, etc.) and afterward played cards in chow hall.

2 March: Worked outside on engines until noon. Left reefer doors open when evacuated.

Clothing. Wore shorts, T-shirt, cap, and heavy shoes before 1500, 1 March.

Food and Drink. Ate evening meal 1 March, and drank coffee 1 and 2 March.

Fallout. First noticed fallout while on way down to Army section to advise men to change clothing. Appeared "like tiny snowflakes." A small amount still falling next day (2 March).

Film Badge. None.

Evacuated. In second group (1800, 2 March).

Note: Education: High school, 10th grade. Has 5 years of present enlistment to do.

Chapter 4
DOSIMETRY

4.1 INSTRUMENTATION

At 1430 on 1 March first indication of radioactive fallout was detected on a TN3A meter (24-hour, continuous recording meter). Meter located at Radio-Sound Section. Read 0.9 ma at 1450.

4.2 FILM BADGES

Fourteen film badges were received at Eniwetak on 19 February. Eight were placed in a reefer in the mess hall. The remaining six were distributed as follows:

One to Army group. Assigned to [redacted]. Was positioned 7 feet above floor of tent on tent pole. Reading: 46 roentgens.

Two assigned to Radio–Weather Station. One worn by [redacted], the other by [redacted] Reading: 38 roentgens.

One assigned to [redacted] (in housing area). Reading: 44 roentgens.

One assigned to [redacted]. Worn on left shoulder pocket. Reading: 40 roentgens.

One placed on side of building in housing area. Located shoulder-high and moved east-west to avoid direct sunlight. Reading: 44 roentgens.

The above film badge readings were given the men while they were at Eniwetak (source unknown).

Dispatch No. 240 431 A from CTG 7.1, Eniwetok and COMNAVSTA, Kwajalein, received 25 April, reads:

"Film badge readings are as follows:

[redacted]	40 r	[redacted]	40 r
[redacted]	40 r	[redacted]	40 r
[redacted]	40 r	[redacted]	52 r
[redacted]	40 r	[redacted]	40 r
[redacted]	44 r	[redacted]	98 r
[redacted]	40 r	[redacted]	98 r
[redacted]	40 r	[redacted]	98 r

[redacted] in custody of TU 7, TG 7.1 until completion of operation, at which time they will be forwarded to AFSWP."

The dispatch contains the distribution list for the film badges as originally proposed. However, as previously stated, only six of these badges were actually distributed (see preceding paragraphs for distribution). It is further noted that the film badge readings of the dispatch differ somewhat from the readings reported by the men who wore or were responsible for them.

The final estimated values of the exposure for the Rongerik Group are corrected for shielding from buildings and differ from the film badge readings and the doses calculated from the dose rate and decay curves, as discussed in Chapter 1 of the final report of Project 4.1.

4.3 LOCATION OF FILM BADGES AND LISTS OF PERSONNEL WORKING IN SAME GENERAL AREAS

1 assigned to Sieber (Army group)
Positioned on tent pole 7 feet above
floor of tent.

2 assigned to Radio-Weather Section.
1 badge worn by [redacted].
1 badge worn by [redacted]

3 located in living area.
1 worn by [redacted]
1 worn by [redacted]
1 located on side of building.

Chapter 5
EVACUATION and DECONTAMINATION

5.1 EVACUATION OF PERSONNEL TO KWAJALEIN

Eight men (first eight in alphabetical order) were evacuated from Rongerik via plane at 1245, 2 March. The remaining twenty men were evacuated via plane at 1800.

5.2 DECONTAMINATION PROCEDURES

Upon arrival at Kwajalein, the personnel from Rongerik, the evacuation planes and their crews, were subjected to a thorough decontamination regime.

An emergency decontamination area had been established. This area consisted of a large shower room and two buildings for storing contaminated clothing. The buildings and the surrounding area were enclosed with a temporary wall of burlap.

Each man took from 5 to 11 showers on 2 March.

5.3 RESIDUAL EXTERNAL CONTAMINATION OF RONGERIK PERSONNEL

The preliminary readings of the external radioactive contamination of the Rongerik personnel (on 2 March) ranged from 5 to 250 mr/hr. Following repeated showers, the counts were reduced to from 4 to 25 mr/hr. The decontamination program was continued through 6 March, with readings being made on each successive day. These readings are shows in Table 5.1.

TABLE 5.1 MEASUREMENT OF RADIOACTIVE CONTAMINATION OF MILITARY PERSONNEL FROM RONGERIK ATOLL AS DETERMINED BY MONITORING WITH A RADIAC SET NO. AN/PDR-27c SURVEY INSTRUMENT (ALL READINGS IN MR)

Name	Rate or Rank	Service Number	Clinical No. Assgd. by Project 4.1	2 March					3 March	4 March	5 March	6 March	3 April
				Reading Prior to First Shower	Reading After First Shower	Third Reading	Fourth Reading	Total No. Showers or Washings	Reading After Last Shower				
First group evacuated.	B/Sgt			80.0	5.0	5.0	5.0	11	5.0	1.0			0
	A/1c			6.0	6.0	5.0		10	5.0	1.0			0
	A/1c			5.0	5.0	5.0		8	5.0	2.0			0
	A/1c			250.0	10.0	10.0	10.0	10	10.0	2.5			0
	A/1c			5.0	5.0	5.0	5.0	7	4.0	1.0			0
	A/2c			5.0	5.0			7	5.0	1.0			0
	A/1c			5.0	5.0	5.0		7	3.5	1.0			0
	A/1c			5.0	5.0	5.0	5.0	7	4.0	2.0			0
Second group evacuated.	B/Sgt			150.0	10.0	10.0	10.0	5	10.0	5.0	3.0	2.5	0
	A/3c			20.0	10.0	10.0	10.0	5	10.0	3.5	1.0		0
	A/1c			25.0	10.0	10.0	10.0	5	10.0	1.5			0
	A/1c			25.0	15.0	15.0	15.0	5	15.0	2.0	2.0		0
	W. O.			45.0	15.0	15.0	15.0	5	15.0	5.0	4.5	3.5	0
	Pfc			100.0	15.0	15.0	15.0	5	15.0	4.5	3.5	2.5	0
	A/1c			15.0	10.0	10.0	10.0	5	10.0	2.0	2.0	1.0	0
	A/1c			5.0	5.0	5.0	5.0	5	5.0	2.5			0
	A/3c			25.0	15.0	15.0	15.0	5	15.0	4.5	3.0	3.0	0
	S/Sgt			100.0	10.0	10.0	10.0	5	8.0	2.5			0
	M/Sgt			20.0	15.0	15.0	10.0	5	10.0	4.0			0
	A/1c			15.0	10.0	8.0	8.0	5	8.0	2.0 (blister on hand)			0
	A/3c			10.0	5.0	5.0	5.0	5	5.0	4.0 (hands)			0
	T/Sgt			15.0	5.0	4.5	4.0	5	4.0	3.5 (hair)			0
	Cpl			40.0	15.0	10.0	10.0	5	10.0	7.0 (hair)		2.0	0.5
	A/1c			15.0	5.0	5.0	5.0	5	5.0	3.0 (chest)			0
	Pfc			150.0	15.0	15.0	15.0	5	15.0	10.0 (hair)			0
	S/Sgt			20.0	5.0	4.5	4.5	5	4.5	2.0 (hair)			0
	A/3c			200.0	25.0	25.0	25.0	5	25.0	10.0 (hair)			0
	S/Sgt			100.0	10.0	10.0	10.0	5	10.0	2.5 (hair) 10.0 (callous on hands)			0

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1 Commanding General, Hdqs. Military District of Washington, U.S. Army, Room 1543, Building T-7, Gravelly Point, Va.

ATOMIC ENERGY COMMISSION ACTIVITIES

3 U.S. Atomic Energy Commission, Classified Technical Library, 1901 Constitution Ave., Washington 25, D.C. ATTN: Mrs. J. M. O'Leary (For DMA)
2 Los Alamos Scientific Laboratory, Report Library, PO Box 1663, Los Alamos, N. Mex. ATTN: Helen Redman
5 Sandia Corporation, Classified Document Division, Sandia Base, Albuquerque, N. Mex. ATTN: H. J. Smyth, Jr.
3 University of California Radiation Laboratory, PO Box 808, Livermore, Calif. ATTN: Clovis G. Craig
1 Weapon Data Section, Technical Information Service Extension, Oak Ridge, Tenn.
65 Technical Information Service Extension, Oak Ridge, Tenn. (Surplus)

AEC Technical Information Service Extension
Oak Ridge, Tennessee

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sensitivity of these animals to protracted and acute exposure to penetrating gamma rays at various exposure rate has provided a basis for the estimation of survival of domestic animals; and, furthermore, these data are valuable in predicting the unknown consequences of radiation exposure on man.

The LD$_{50/30}$ for swine, sheep, goats, burros, and dogs have all proved to be on the range of 280-350 rads, measured in air, with bilateral, fallout-field type exposure. The tissue doses are much lower and these values will be discussed. Temporal variation of radiation sensitivity after a singly sublethal exposure varies greatly from species to species. The pig appears to recover from an initial dose extremely rapidly and enters a period of marked radioresistance. The sheep is slower to recover while the burro appears to be the slowest. Extremely variable patterns of response to lower dose rates have been seen and these will be discussed in detail.

Ca—5. *Acute and Delayed Effects of Fallout Radiation on Man.* Robert A. Conard, Brookhaven National Laboratory, Upton, N. Y., 11973.

This presentation describes the acute and delayed radiation effects on a human population accidentally exposed to fallout in the Marshall Islands in 1954. The 82 people on Rongelap and 23 Japanese fishermen received the largest exposure which, however, proved to be sublethal. Hematological depression from whole body irradiation, burns of the skin and epilation from skin irradiation and internal absorption of radionuclides resulted. Nearly complete recovery from acute exposure was evident by one year. In the Marshallese, later findings believed to be related to exposure were an 11-year lag in complete recovery of peripheral blood elements, the occurrence of about double the usual number of miscarriages and stillbirths among the exposed women during the first 4 years, some residual scarring and pigment aberrations at the sites of previous "beta burns" and a slight retardation of growth and development mainly in exposed boys. The most significant late finding has been the development of thyroid abnormalities between 9 and 13 years post exposure in 16 Marshallese children and 3 adults, presumably as a result of initial exposure to internally absorbed radioiodines. All 16 children were exposed at less than 10 years of age (84% of this age group). Based on radiochemical urine analyses, it was estimated that the thyroid dose in the younger children was 7–1400 rads or about 10 times the estimated adult dose due largely to the smaller size of their thyroids. Thyroid surgery in 11 cases revealed 10 cases of benign adenomatous goiter and 1 case of cancer in a 40-year-old woman. Two boys with greatest growth retardation have developed hypothyroidism and some of the other children show evidence of thyroid hypofunction, indicating that injury to this organ is the causative factor in growth retardation. Early indications are that use of thyroid hormone treatment in the exposed group is having a beneficial effect in reducing nodules and enhancing growth in the children. Effects of residual fallout contamination on body burdens of radionuclides of the Rongelap people will also be briefly discussed.

Da—1. *The Effects of Gamma Radiation Combined with Weightlessness on Biologic Systems in Biosatellite II.* Joseph F. Saunders*, Bioscience Programs, Office of Space Science and Applications, National Aeronautics and Space Administration, Washington, D. C.

The effects of combined weightlessness and radiation have been determined on a variety of living organisms using measured quantities of gamma radiation from a known source, ^{85}strontium, contained in Biosatellite II. The objectives of the mission were to study the possibility that the effectiveness of radiation is modified by some other factor in space flight, particularly greatly reduced gravity. As will be demonstrated, such modifications did occur as revealed by the results obtained in seven reliable experiments previously studied in Earth laboratories.

The seven experimental systems included *Tradescantia*, commonly known as the blue flower—spiderwort, *Neurospora crassa*, larvae and adults of *Drosophila melanogaster*, *Tribolium con-*

fusum, lysogenic bacteria ... *...ngland...*. Particular emp... mutations. Identical expe... lessness from the combin...
The biologic design of ... performance, environme... the operations concerned ...

Da—2. *Eff... of Spa...* R. H. T. M... NTS
The genetic system ... radiosensitive. The syste... factors such as temperat... drugs. Lysogenic bacter... genetic regulatory mech...
Two different strains ... growth and virus induc... experiment plan includ... cell divisions occurred ... tionary phase prior to ... nonradiation and three ... tions. The plan includ... terial potential to in... differentiating a 10...
Results of work to d... cantly higher densiti... ... 3. Frequency of virus ... eters will be presented.
These results will be ... them in part.

Da—3. *Genetic Effect... Mission.* F. J. de S... tory, Oak Ridge, T...
The genetic effects ... II mission was studied of Neurospora and the collected on the surfa... and on the ground. Po... curves for survival of ... sive lethal mutations ... recessive lethal mutatio...
The recessive lethal ... and multilocus deletion ... type, "reparability" and ...
Present data from the mission indicate that th... radiation on cellular ina...