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RADSAFE

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ENCLOSURE N

TO THE
REPORT BY

COMMANDER
JOINT TASK FORCE EIGHT

ON THE

1962 PACIFIC NUCLEAR TESTS
(OPERATION DOMINIC)

★

RADSAFE

★

HEADQUARTERS
JOINT TASK FORCE EIGHT
WASHINGTON 25, D. C.

JJC-R

4 June 1964

TO: Distribution

SUBJECT: CJTF 8 Report of Radiological Safety Operations, 1962 Pacific Nuclear Tests

1. The subject report is forwarded herewith.

2. This report comprises Enclosure N of the overall report by CJTF 8 to the Chairman, AEC and to the JCS on the 1962 Pacific Nuclear Tests by Joint Task Force EIGHT (Operation DOMINIC). That report, and its other separately-bound enclosures which give details of further aspects of the operation, will be distributed as they are completed and approved.

Charles F. Mudgett, Jr.

CHARLES F. MUDGETT, JR
Brigadier General, USA
Commander

1 Encl
a/s

Distribution:
Appendix C

[redacted]

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REPORT BY COMMANDER JOINT TASK FORCE EIGHT

to the

CHAIRMAN, UNITED STATES ATOMIC ENERGY COMMISSION

and the

JOINT CHIEFS OF STAFF

on the

1962 PACIFIC NUCLEAR TESTS

(OPERATION DOMINIC)

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ENCLOSURE N

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REPORT OF RADIOLOGICAL SAFETY OPERATIONS

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ENCLOSURE N

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REPORT OF RADSAFE OPERATIONS

GENERAL

1. Radiological Safety (Radsafe) Support was part of the 1962 program of JTF 8. This enclosure contains a description of the mission, organization, and activities of the Radsafe Branch and temporary support elements, JTF 8 during the nuclear test series.

2. Radsafe Branch, a part of the J-3 Division, was charged with the responsibility of providing radsafe support for the Task Force.

3. On-site radsafe operations were performed at Christmas Island and Johnston Island. A personnel dosimetry program was conducted at these two sites and at Honolulu, Hawaii. Further details are in Appendix A of this enclosure.

4. Off-site radsafe operations were performed by U.S. Public Health Service at seventeen stations of a surveillance network. A radiochemistry laboratory, located at Honolulu, Hawaii, was established to process the environmental samples obtained from this network and the two on-site locations. Further details are in Appendix B of this enclosure.

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APPENDIX A TO ENCLOSURE N

ON-SITE RADSAFE

INDEX

A. INTRODUCTION AND SUMMARY

1. Radsafe support was devoted to the establishment of procedures to evaluate radiological hazards in order to provide protection to personnel and their environment from unwarranted exposure.

2. Primary objective was to insure that proper radsafe measures were developed and implemented by arranging radsafe services for operations associated with contaminated areas and facilities.

B. OBJECTIVES

1. The mission of the Radsafe Branch was to:

a. Maintain a current plot of all contaminated areas.

b. Provide necessary equipment, such as disposable clothing and radsafe survey instruments, for support of operations associated with contaminated areas or facilities.

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c. Provide dosimetry services for all Joint Task Force EIGHT, (hereinafter also referred to as Task Force or JTF 8), personnel and authorized visitors, to include the issuance and processing of film badges and the maintenance of required records.

d. Advise and assist Task Force personnel as required in the decontamination (decon) of equipment.

e. Operate a radiochemistry laboratory capable of supporting off-site radsafe monitoring stations and any other radsafe operations.

f. Provide trained personnel, as available, to assist CJTG 8.3 and CJTG 8.4 in the accomplishment of their assigned radsafe responsibilities.

C. UNITS PARTICIPATING

Radsafe Branch

Chief	LT COL Gordon L. Jacks, USA
Radiological Safety Officer	MAJOR Arthur L. Knipp, Jr., USA
Clerk	YN2 Marshall B. King, USN

TDY Augmentation

U.S. Army Chemical Corps Radiological Unit	2 OFF	20 EM
U.S. Army Chemical Corps Training Command		8 EM
Los Alamos Scientific Laboratory	1 CIV	
DASA Field Command		1 EM

Off-site Surveillance Network

U.S. Public Health Service	6 OFF

Radio-chemistry Laboratory-Hawaii

U.S. Public Health Service	4 OFF	
U.S. Army Chemical Corps Nuclear Defense Laboratory		3 EM

Photo-dosimetry Laboratory

Los Alamos Scientific Laboratory	1 CIV Health Physicist
	1 CIV Lab. Technican

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JTG 8.3 Augmentation		
U.S. Naval School Command	3 OFF	1 EM
U.S. Naval Damage Control Training Center	1 OFF	
U.S. Naval Radiological Defense Laboratory	1 CIV	
JTG 8.4 Augmentation	2 OFF	15 EM
JTG 8.5 Augmentation		
TU 8.5.1	4 CIV	

D. PLANNING AND PREPARATIONS

1. Two initial steps were taken to develop a radsafe support organization: (1) arranging for skilled personnel to be assigned to the Task Force in a temporary duty status; (2) locating specialized equipment to be obtained by the AEC contractor (TU 8.5.1) through purchase or on a loan basis.

a. Procurement of Personnel: Personnel possessing critical specialties were obtained from all services, Army, Navy and Air Force. The primary source of enlisted skills was the U.S. Army Chemical Corps Radiological Unit organized under Charter to support DOD conducted nuclear weapons tests. This unit furnished qualified monitors, decontamination specialists, and instrument repairmen. In order to establish a photodosimetry program, it was necessary to supplement these personnel with civilian specialists made available by Los Alamos Scientific Laboratory. Arrangements to obtain these personnel were made by special liaison visits to the respective organization by Chief, Radsafe Branch. Additionally, radsafe specialists required by JTG 8.3 operations were arranged for by coordination with JTG 8.3 Radsafe Officer, and U.S. Navy Agencies listed in paragraph C above.

b. Procurement of Equipment: RADIAC (Radiation detection, identification, and computation) instruments and radsafe equipment were obtained primarily from the Nevada Test Site (NTS) or procured by TU 8.5.1. These items were obtained on a loan basis as well as purchases based on stated requirements of Chief, Radsafe Branch. Table 1 contains the main items acquired for use in the forward area.

2. Off-Site: A concept for operations of an off-site monitoring surveillance network was developed by Chief, Radsafe Branch in coordination with and for execution by the U.S. Public Health Service. This network was established under terms of a Memorandum of Understanding between CJTF 8 and the Surgeon General, U.S. Public Health Service. Fifteen USPHS officers were made available to operate the network.

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TABLE 1

RADSAFE EQUIPMENT AND SUPPLIES

QUANTITY	ITEM	SOURCE
4	Sellers Injector Corp. Liquid Jet Cleaners w/ Lance & Discharge Hose	Procured by JTF 8, J-4
2	Gelman Air Sampler w/Dry Test Meter	USPHS
2	T-289 Tritium Monitor	FCDASA
2	T-329A Radiological Urinalysis Kit	"
2	T-336 Radiation Alarm	"
20	E500B Eberline Beta-Gamma Geiger Counter	TU 8.5.1
4	GADORA-2 Eberline Gamma Dose Rate Meter	"
15	E112B Eberline Beta-Gamma Geiger Counter	"
2	FM-3G Eberline Alpha Floor Monitor	"
4500	4.025 Density Goggles	"
2000	4.5 Density Goggles	"
400	Pocket Dosimeter, Bendix Model No. 611 (0-5r)	"
3	FD-2 Eberline Film Densitometer	"
2	FS-11 Eberline Film Badge Evaluation & Recording System	"
2	Cobalt-60 Calibration Source	"
1000	Charg-a-Plate	"
1200	Coveralls	"
1000 pr	Canvas Booties	"
1000	Poly Bags	"
500 rls	Masking Tape	"
50	Respirators	"
50	Full-face Masks	"
10	M-9 CmlC Protective Mask	"
1000 pr	Gloves, Tariff Issue	"
50	Surgeons Cap	"
50	Hoods	"
1	Wound Monitor	"
25	RM-5 Eberline Radiation Monitors w/R-1 Chart Recorder	"
2	PC-6 Eberline Scaler w/SAC-2 & PC4-4 Detector Heads	"
2	E-113 Electronic Tool Sets	"
1	IBM 526 Summary Punch	"
40	Staplex Hi-Vol Air Samplers	"
1	Band Saw (for opening plastic film badge packet)	"
17	PAC-3G (AN/PDR-54) Eberline Alpha Contamination Meter	" 7 (NTS 10)
15	MX5 Beta-Gamma Geiger Counter	NTS
100	AN/PDR-39 (T1B) Gamma Survey Meter	NTS
4	AN/PDR-39 (T1B) Gamma Survey Meter (Modified for high range-500r)	NTS
12	IM-108 Gamma Survey Meter	25th Inf. Div., Ft Shafter
100	AN/PDR-27J Beta-Gamma Survey Meter	Sacramento Sig. Depot, Calif.

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3. Radsafe Support Functions: Since a significant portion of the on-site radsafe operation involved decontamination of aircraft and crews, JTG 8.4 received a major number of the personnel. Included in this apportionment were instrument repair personnel for maintenance of RADIAC and other radsafe instruments. Radsafe Branch was assisted in ground and aerial monitoring surveys by TU 8.5.1, JTG 8.5 and USPHS personnel, and in film badge dosimetry by civilian specialists obtained from TU 8.1.1 (LASL).

a. Chart 1 depicts the functional organization for execution of the radsafe mission on-site and support of radsafe off-site activities. It illustrates the working structure for certain functions of support required at various geographical locations. Personnel were assigned to JTG 8.4 operational control as needed for decon and sample return assistance, and to JTG 8.3 operational control as required for pod recovery and handling operations. The off-site surveillance functions were performed by USPHS officers and are described separately in Appendix B of this enclosure.

b. Chart 2 list the specific tasks performed at various locations by the radsafe elements shown in Chart 1 and indicates the period of time during which the assistance was provided. The numbers of personnel assigned to these tasks varied throughout the operation as the degree of required assistance changed for specific events.

4. Training of Personnel: No training was necessary for the personnel procured by Chief, Radsafe Branch due to the experience gained by these personnel during previous testing operations. JTG 8.3 and JTG 8.4 each conducted its own separate one week training program for task group radsafe personnel. Project personnel in scientific task units and contractor personnel in JTG 8.5 provided their own monitors for recovery and construction missions respectively.

E. OPERATIONS

1. Christmas Island

a. Facilities and Services: The Radiological Safety Program provided support for two major areas of service, on-site and off-site. The radsafe program was planned and administered by the Radsafe Branch, Headquarters, Joint Task Force EIGHT. Generally, the program assigned the responsibility for basic radiological safety to the individual task groups, and the Commanders, Joint Task Group 8.3 and Joint Task Group 8.4 were directed to establish their own radsafe working organization. These task group radsafe units were designed to cope with routine radsafe matters and the problems unique to functions of the task group itself, such as decontamination of sampler aircraft by JTG 8.4 and ship decontamination by JTG 8.3 Special functions dele-

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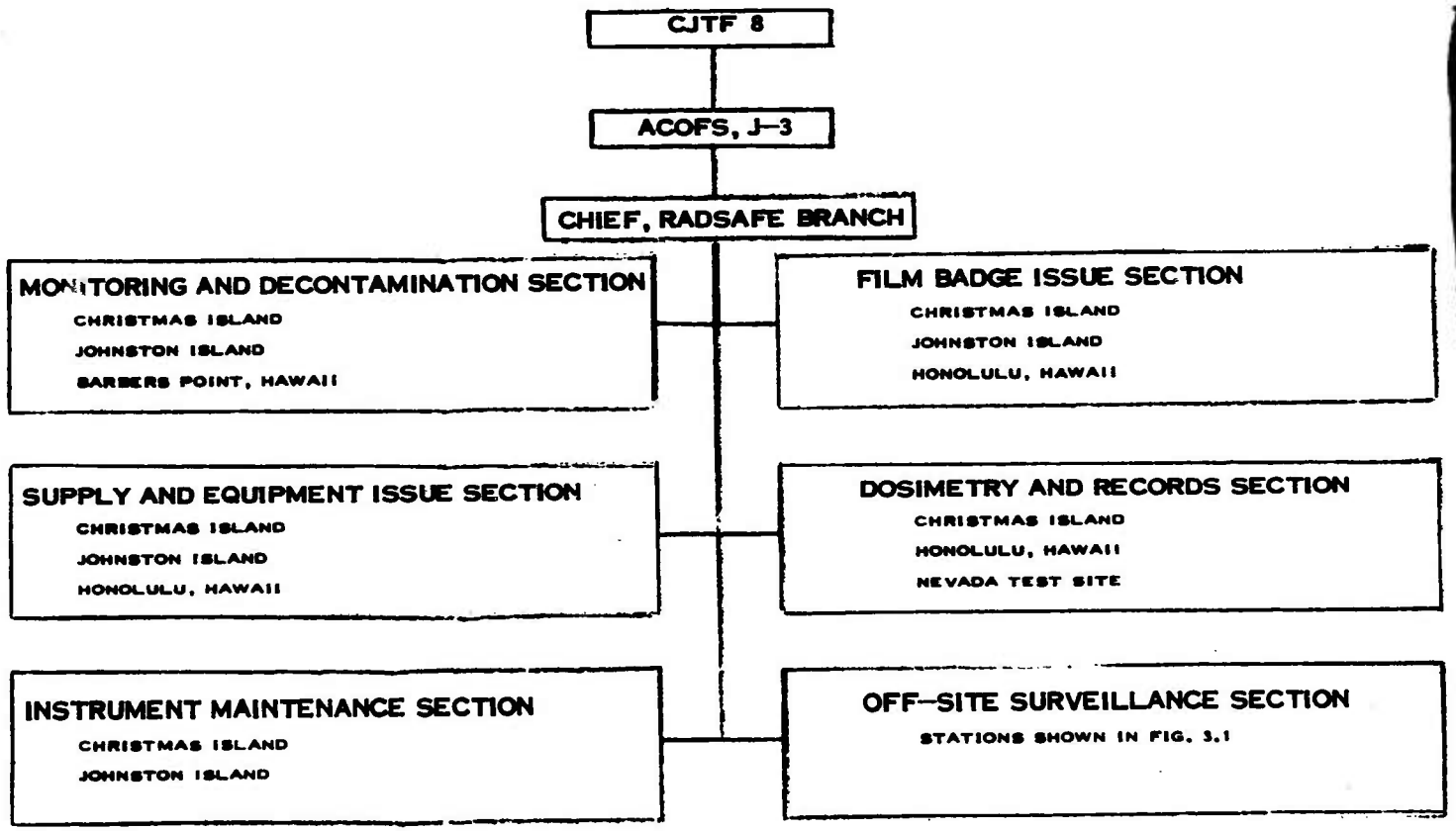

CHART 1 - FUNCTIONAL RADSAFE ELEMENTS ASSIGNED FOR SUPPORT AT CERTAIN LOCATIONS

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CHART 2 - SUPPORT PERFORMED BY RADSAFE ELEMENTS AT CERTAIN LOCATIONS

CHRISTMAS ISLAND (25 APR 62-11 JUL 62)

- AREA MONITORING
- AIRCRAFT DECONTAMINATION
- PERSONNEL AND EQUIPMENT DECONTAMINATION
- FILM BADGE ISSUE AND COLLECTION
- PHOTODOSIMETRY
- PROTECTIVE CLOTHING AND EQUIPMENT ISSUE
- INSTRUMENT MAINTENANCE
- SAMPLE RETURN

JOHNSTON ISLAND (3 JUN 62-3 NOV 62)

- AREA MONITORING AND DECONTAMINATION
- AIRCRAFT DECONTAMINATION
- PERSONNEL AND EQUIPMENT DECONTAMINATION
- FILM BADGE ISSUE AND COLLECTION
- PROTECTIVE CLOTHING AND EQUIPMENT ISSUE
- INSTRUMENT MAINTENANCE
- SAMPLE RETURN
- SCIENTIFIC-POD RECOVERY

OFF-SITE (15 MAR 62-15 DEC 62)

- ENVIRONMENTAL MONITORING
- SAMPLE COLLECTION

HONOLULU, HAWAII (15 MAR 62-15 DEC 62)

- PHOTODOSIMETRY
- PROTECTIVE CLOTHING AND EQUIPMENT ISSUE
- RADIO-CHEMICAL ANALYSIS

NEVADA TEST SITE (15 DEC 62-30 JAN 63)

- PHOTODOSIMETRY

BARBERS POINT, HAWAII (2 OCT 62-3 NOV 62)

- AIRCRAFT DECONTAMINATION
- PERSONNEL AND EQUIPMENT DECONTAMINATION

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gated to task groups are contained in Annex J to CJTF 8 Operation Order 2-62. The nucleus of radsafe personnel came from the Headquarters, Joint Task Force EIGHT, with augmentation provided by U.S. Public Health Service (USPHS), TU 8.1.1, TU 8.1.3 and TU 8.5.1.

b. On-site Radsafe Activities: Specifically, this program was designed to control from a radsafe standpoint all individuals who entered or departed designated "exclusion" areas. The major function was the control of personnel engaged in area monitoring at Christmas Island. Other special functions included the photodosimetry program for the entire Task Force and assistance to Task Groups during the on-site phase of the operation. The Christmas Island On-site Radiological Monitoring Program was designed to provide continuous coverage by means of the actions described below:

(1) Pre-operational Survey to Obtain Baseline Data: This included collection of land and sea biota for laboratory analysis; environmental samplings of food, vegetation, water and soil, air, and marine specimen; radiation background readings along major road networks; and film badge stake lines to record the total integrated dosage throughout the period of the test series.

(2) Establishment of Static Sites for Routine Documentation: This included stations located at London Port, "A" Site, and JTF 8 Joint Operations Center (JOC) to cover the populated area (see Fig. 1). Each station was provided with an Eberline RM-5 Continuous Background Gamma Recorder, a Gamma Survey Instrument (AN/PDR-27J), a rain collector, and a Staplex Hi-Vol Air Sampler (running continuously).

(3) Mobile Monitoring on Shot Days: All nuclear events at Christmas Island were detonations of devices released from drop-aircraft. These detonations occurred as air bursts over designated target-rafts positioned in open water. Each detonation was planned for execution under favorable atmospheric conditions to minimize the likelihood of contamination (fallout) of land surfaces. Moreover, each event was followed by a post-shot radiological survey of the island to determine that no fallout had been received, or to insure timely warning of the arrival of fallout in case of unforeseen wind shifts or rain squalls. This was accomplished with three two-man teams covering pre-planned routes. Each team was equipped with two AN/PDR-27J low-range beta-gamma survey meters and two AN/PDR-39 (T1B) high-range gamma survey meters. Two teams conducted ground surveys of all major roads between London Port, "Y" Site and "D" Site. The third team conducted a helicopter sweep of the south and southwest coastal area between "D" Site, "MM" Site and Paris (see Fig. 1). Team control was by radio net from the radsafe office at the JOC. Radiation

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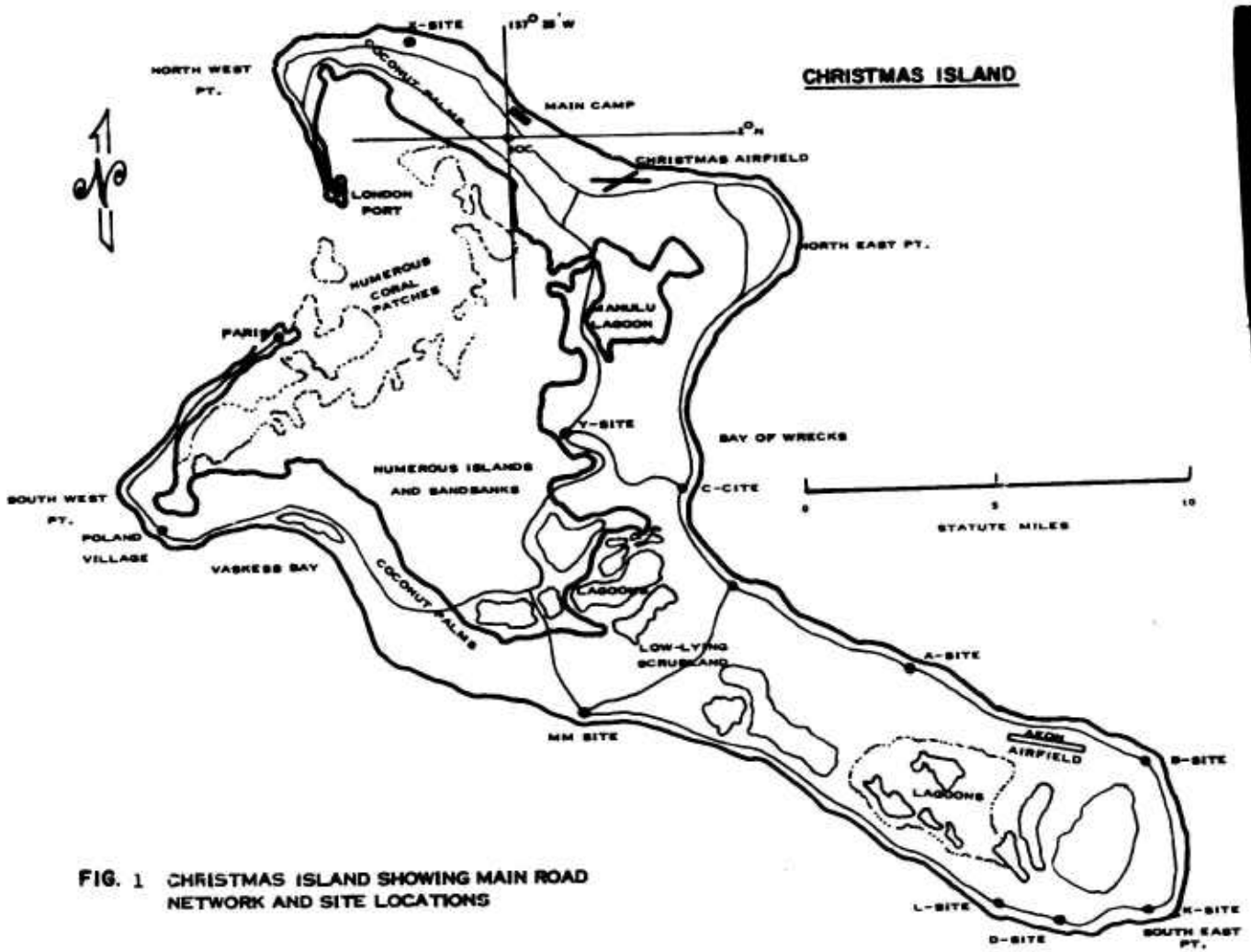

FIG. 1 CHRISTMAS ISLAND SHOWING MAIN ROAD NETWORK AND SITE LOCATIONS

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background readings were tabulated until H plus 5 hours on a log sheet for permanent record.

(4) Cloud Tracking Information: B-57 sampler aircraft, under JTG 8.4, made early penetrations of the radioactive cloud after each event. A member of the Radsafe Branch obtained timely information on cloud movement, and stabilized cloud top and base altitudes from the Air Operations Center (AOC) Controller. This information was necessary for preparation of advisories which specified re-opening of air lanes for passage of commercial aircraft through the announced danger area.

(5) Decontamination: A decontamination facility was established in the vicinity of the main airstrip. Sampler aircraft returning from a cloud penetration mission were taxied onto a specially built hardstand for washdown. This hardstand was of sufficient size to accomodate two aircraft; however, in practice only one aircraft at a time was washed by the jet-sprays from a decon-truck, since only four to seven aircraft participated in a mission. The runoff water was channeled through a trough into a large plastic swimming pool which served as a holding tank for liquid waste effluent. This water was then pumped into a tanker truck for transport to the outfall point for release into the ocean. Aircraft crews and decon personnel were showered and dressed in a nearby decon building of conventional design. The decon facility was supported by an adjacent laundry building outfitted with 4 washing machines, 4 hydro extractors, and 1 large dryer. The aircraft decon pad and personnel decon and laundry facilities were operated by JTG 8.4 under supervision of JTF 8 radsafe personnel. Film badging of mission aircraft crews was performed by radsafe personnel assigned to JTG 8.4 (film badge processing is described in Annex A, para 2).

(6) Post-Operational Survey: All film badges on the stake line were collected, processed, and a record of the total dosage at each point. Additional monitoring information was obtained by survey meter readings along the stake line.

(7) Instrument Maintenance: The mission of the Instrument Maintenance Section was that of maintaining and calibrating all portable RADIAC instruments for JTF 8 Radsafe. The section consisted of one officer and four enlisted men, assigned for duty to JTG 8.4 and located on Christmas Island. By mid-April all instruments had been calibrated and issued to the various groups on Christmas Island and off-site stations. The instruments on neighboring islands were kept operable by constantly exchanging them for newly repaired instruments. During the remainder of April, approximately 200 instruments were calibrated and 80 were repaired. During the month of May, approximately 250 instruments were calibrated and 100 repaired.

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This was due to the almost continuous use of many of the instruments. During the month of June, approximately 50 instruments were calibrated and repaired. During Operation DOMINIC approximately 98 percent of all instruments were in working order at all times. Of these, about 5 percent were held in the instrument repair shop as a contingency replacement of any instrument in need of repair at a crucial time. Any delays in the repair of the instruments were due to shortage of spare parts. Resupply of parts required 60 days procurement lead time. Eberline Instrument Corporation provided electronic engineers at all times to perform maintainance on the Eberline instruments, including the film densitometer. The remainder of equipment of other manufacture were maintained by the U.S. Army personnel assigned to the instrument maintenance shop.

2. Johnston Island

a. Facilities and Services: In contrast to the Christmas Island series, these events produced radiological situations varying from recovery of lightly contaminated scientific pods to rehabilitation of a launch pad. Since certain aspects of these events occasioned an extension of the Johnston Island schedule, it is convenient to divide this portion into two phases for discussion. General aspects will be discussed in this section followed by separate discussion of Phase I and Phase II in paragraph 2b and 2c respectively. Phase I (25 Apr - 25 Jul 1962) refers to that portion of the 1962 nuclear test program which extends from commencement of the series up to and including the BLUE GILL PRIME event. The Christmas Island events were completed during Phase I. Phase II (2 Oct - 3 Nov 1962) refers to the follow-on portion of the test program which resumed after the rehabilitation of THOR Launch Pad No. 1 which was damaged by fire during the BLUE GILL PRIME event. The Phase II portion included air drop events conducted at Johnston Island.

(1) Routine Radiological Safety: The main effort was to provide personnel and equipment essential to the recovery of the scientific instrument pods which became contaminated as a result of the device detonation. Since three such pods required recovery, three fleet tugs (ATF), outfitted with crane and hoist, were situated in standby positions. The search and recovery procedure was planned as follows: A destroyer and three tugs would commence the search during darkness and would be joined by six helicopters during daylight. The helicopters, which flew in mutually protecting pairs, were actually the primary search and recovery means. If the helicopters located the pods they would transport them to the land base. The tugs therefore were an alternate means of transport (if the pods were located in minimum time) to a location where transfer to an M-Boat could be accomplished. This specially configured M-Boat was designed with a shielding wall for crew protection.

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A JTF 8 radsafe specialist, equipped with RADIAC meters to assess the hazard prior to handling of the pods, was stationed on each fleet tug. The ultimate destination of the pods was a radsafe handling and holding area where detained monitoring and decontamination could be performed. The handling area was provided with a field-type hot cell with slave manipulators for remote handling of items found to be more seriously contaminated. However, the hot cell facility was not used due to the fact that all pods recovered bore only low intensity contaminant. Pods were stored in "bee-hive" mounds.

(2) Disaster Control: Each time a device (warhead) was moved in or out of Johnston, a radsafe representative was present at the airstrip to assist as required in the event of mishap involving damage or fire to the device. However, the major effort was concentrated in the manning and equipping of the radsafe component of the Disaster Control Teams. During the launch of a missile carrying a nuclear warhead, Chief, Radsafe Branch stationed 2 officers, 1 instrument specialist, and 2 radsafe personnel from Task Unit 8.5.1 in the TU 8.1.3 bunker. Present at all times, both during shots and between shots, was a health physicist expert from Task Unit 8.1.1 (LASL). This basic team was equipped with 8 AN/PDR-39 (T1B) gamma meters, 4 AN/PDR-39 (T1B) gamma meters modified for high range, 4 GADORA gamma meters, 10 AN/PDR-27J low range beta-gamma meters, 1 MX-5 beta-gamma meters, and sufficient protective ensembles for all members of the disaster control teams including fire-fighting personnel. Although this was normally only a passive measure to provide the means of responding to a radiological disaster, the team was fully employed during two particular shots, the STARFISH and BLUE GILL PRIME events which are discussed in paragraph 2b below. During Phase II, the organization for disaster control was expanded. Disaster Control Teams, both ashore and afloat, were organized to provide for back-up or relief contingency. The two teams were comparable in strength, proficiency and equipment, and each capable of independent response. The purpose of the additional off-shore team was to insure adequate reserve in case relief or replacement of the on-shore team was required.

b. Unusual Incidents During Johnston Island Phase I

(1) STARFISH: The warhead used for the STARFISH event was destroyed in the air shortly after lift-off, causing several pieces of missile skin and miscellaneous debris to fall back onto Johnston Island and adjacent waters. A thorough search for debris was immediately initiated and a goodly collection of alpha contaminated scrap was isolated in an unused corner of the missile launch pad enclosure. No contamination to any portion of Johnston

[redacted]

[redacted]

Island was detected as a consequence of debris impaction onto the island.

(2) BLUEGILL PRIME: This event terminated in a destruct of the warhead on THOR Launch Pad No. 1 (see Figures 2 & 3). During this event, the missile burned on the launch mount and the warhead was intentionally destroyed. This resulted is a deposition of alpha contamination on the launch pad complex, which presented a contamination problem of major proportions. Contaminated debris was scattered throughout the wire-enclosed pad area and neighboring areas. No contamination, other than pieces of removable debris, was found outside the concertina. Metal revetment buildings were highly contaminated with alpha activity. Burning fuel flowing through cable trenches caused contamination of the interior of the revetments and all equipment contained therein. Fuel which spilled and flowed over the compacted coral surrounding the launch mount and revetments resulted in highly contaminated areas. Prevailing winds (15 knots from 110°) at time of destruction caused general contamination of areas downwind of the launch mount. Figure 3 presents the results of the initial radiological survey on the morning following the warhead destruct. The selected point readings around the still undisturbed area are a documentation of general levels of activity obtained by using PAC-3G and Eberline PAC-1S alpha survey meters. No attempt has been made to draw-in isocon lines. The irregularity of deposition can be attributed to fire-spread, fuel run-off, thermal up-drafts, and vortex winds of complex behavior. In view of the nature of this event, lack of particle distribution data, and an urgent necessity to rehabilitate the pad for subsequent shots, no effort was made in analyzing the magnitude and extent of the radiological hazard incident to the destruct of a nuclear device on a launch complex. No launch pad rehabilitation could be attempted until the radiological hazard had been brought under control by careful removal and fixing of contamination. A systematic procedure of debris removal and segregation, top soil (coral) removal, compaction, decontamination of hardstand and revetments, followed by painting and fixation, and finally a sea-disposal of radioactive waste was required for control of the radiological hazard.

(3) The following steps were taken to decontaminate and rehabilitate the pad:

(a) All coral areas were sprinkled with oil to minimize the amount of resuspended contaminated dust. Approximately two inches of top soil was graded off the coral surfaces. This contaminated soil was bulldozed over the embankment into the water at the northwest corner of the pad area.

(b) The concrete pads were scrubbed with detergents and solvents to remove all loose contamination. The pad under the

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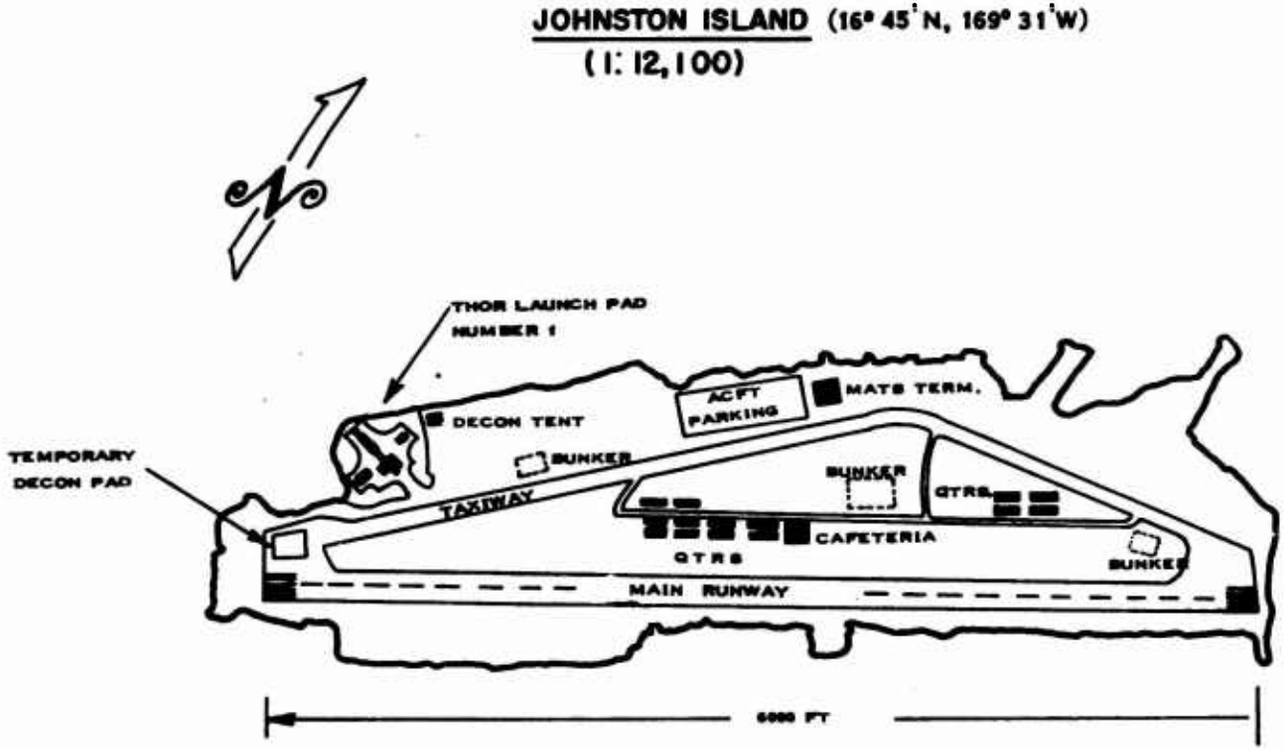

FIG. 2 - JOHNSTON ISLAND SHOWING THOR LAUNCH PAD NR. 1, DECONTAMINATION FACILITIES AND SEVERAL KEY FACILITIES.

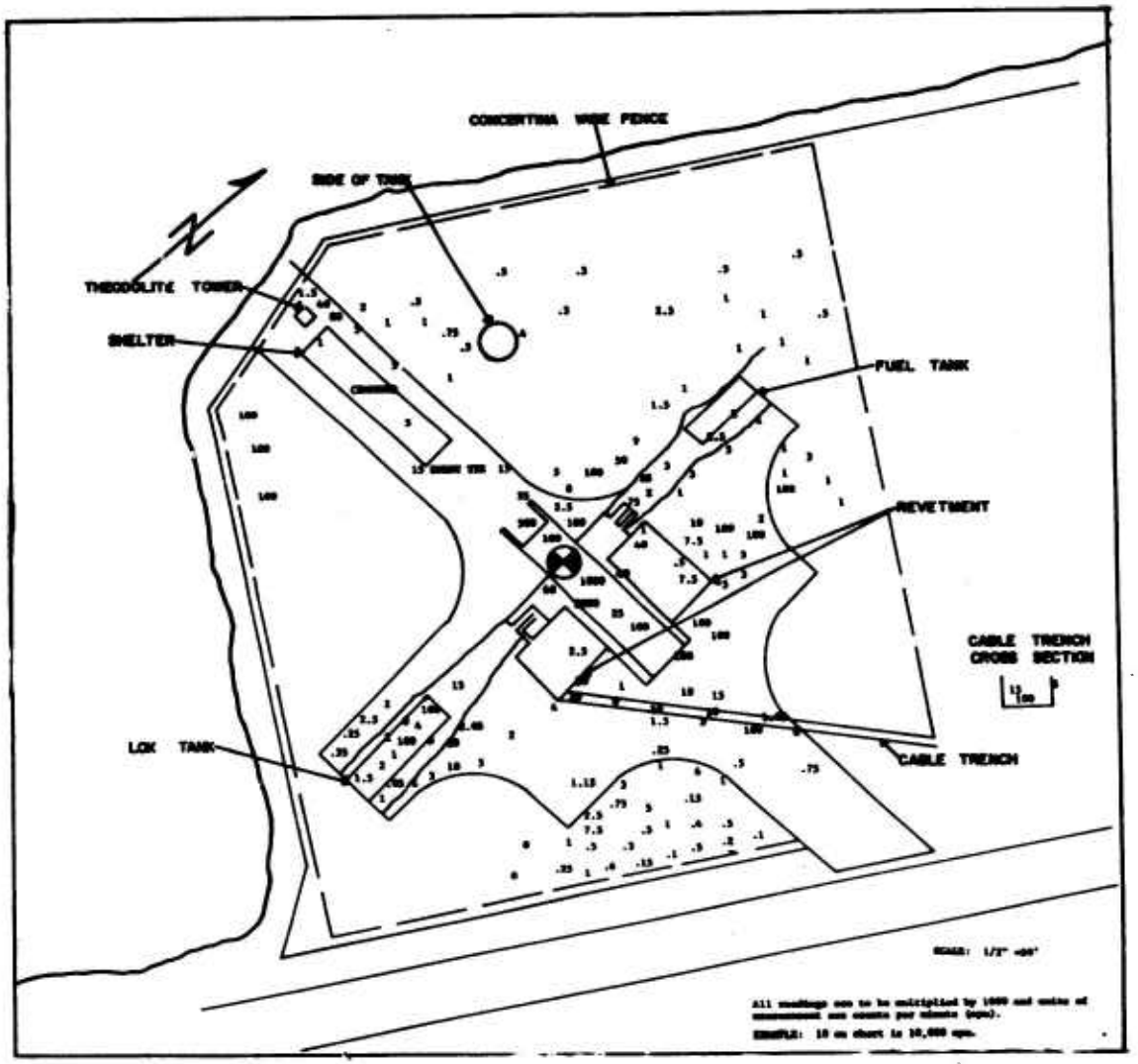

FIG 3 - INITIAL RADIOLOGICAL SURVEY OF THOR LAUNCH PAD NO. 1 ON MORNING FOLLOWING BLUEGILL PRIME ABORT

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launch mount was then coated with epoxy paint. The remainder of the concreted areas, including the fuel tank and lox tank pads were covered with either epoxy or latex paint to fix the remaining contamination.

(c) The revetments were washed, scrubbed and painted.

(d) The bottoms of all cable trenches were coated with one inch of concrete and the sides of the trenches were painted after scrubdown and washing. Contaminated cable trench covers were disposed of and replaced with new covers. Cable conduit pipes leading from the cable trench sumps inside the revetments were sealed at each end with either concrete or steel plate.

(e) The missile shelter was scrubbed or scraped to bare metal and repainted. The wooden ties supporting the shelter rails were covered with concrete.

(f) All electrical ground connection wells were filled with concrete.

(g) All expansion joint grouting on the concrete pad was removed and replaced.

(h) All equipment, tools, etc., that could not be decontaminated was disposed of in accordance with AEC standards by burial at sea.

(i) The long range theodolite tower and the camera tower were scrubbed and repainted.

(j) A radiological exclusion perimeter and a personnel decontamination station were the means of enforcing safety measures and avoiding spread of contamination. The decon facility consisted of a "hot" tent with laundry, two showering compartments, with two shower heads each, a "clean" tent for clothing issue, and monitoring personnel included an enlisted medical corpsman. Air sampling at locations in main camp, adjacent to the decon tent, and within the launch pad enclosure was performed to assess the progressive decline of air-borne hazard arising from artifical resuspension. Task Unit 8.5.1 supplied the labor force and radsafe supervisory personnel during the reconstruction phase. These personnel were required to wear full protective clothing while working in the "hot" area. Six enlisted radsafe personnel and a USPHS officer assisted the JTF 8 Radsafe Officer in supervision of this force. A period of approximately three weeks was required to reduce the alpha contamination to the point where it did not constitute a health hazard.

[redacted]

[redacted]

(4) The following represented the condition of the launch pad area as of the time of termination of the test series:

(a) All contaminated areas and surfaces were covered with protective coatings of either paint, concrete or clean coral sand.

(b) All contamination was fixed. There was no evidence that the alpha contaminant was being moved by either vehicle or personnel.

(c) Daily air samples showed that no contaminant was being resuspended.

(5) The following were the procedures used in maintaining continuous surveillance:

(a) Daily inspections were made of the entire launch pad area by radsafe personnel.

(b) All painted surfaces which showed any deterioration for any reason, such as missile firings or construction work, were checked for loose contaminant and then repainted. Paint chips were placed in barrels for disposal at sea.

(c) Any removal of the clean coral sand and exposure of the contaminated coral, either as a result of missile firings, heavy rains, or construction, was immediately remedied by replacing with clean coral sand. Any loose coral sand that was contaminated was immediately disposed of by dumping into the lagoon.

(d) All chipped or broken concrete was either replaced with fresh concrete or exposed surfaces were painted if contaminated. The concrete fragments were placed in barrels for later disposal at sea.

(e) All personnel working in areas where contaminated coral was exposed were required to wear canvas or rubber booties until such time as the contaminated areas were resurfaced with clean coral sand. Painters chipping paint or repainting contaminated surfaces were required to wear full radsafe gear, including respirators or face masks.

(f) No other radsafe restrictions were required. Shoes of individuals leaving the launch pad were periodically spot-checked.

(g) After each missile firing, radsafe personnel, accompanied by the launch pad post-firing safety crew, inspected the

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area to determine the extent of the contamination problem and initiate any radsafe rehabilitation.

(h) All tools and equipment utilized for any decontamination or rehabilitation were monitored and decontaminated if necessary.

(i) Periodic surveillance was made of the kitchen and dining room for any contamination.

(6) In lieu of any major decontamination effort, the procedures outlined above, implemented by experienced radsafe personnel, provided necessary radsafe protection for personnel on Johnston Island.

c. Johnston Island Phase II: In October 1962, a second series of air drops and a continuation of high altitude events was resumed.

(1) Atmospheric Events: The air drops of devices detonated in the atmosphere again required B-57 sampler aircraft. A decon facility for aircraft and personnel was constructed at Barbers Point, Oahu, Hawaii. After completion of the radioactive cloud sampling mission the B-57s landed at Johnston Island where trained crews from JTG 8.4 removed the samples for sealed container transport to laboratories in CONUS. Since cockpit dose rates in all four events were under 1 r/hr at H plus 4 hours, (radioactive decay varying inversely as the 1.4 power of time during the first several hours), an overnight "cooling" brought the dose rate down to a level permitting aircraft to be flown to Barbers Point without necessity for major decontamination at Johnston Island. A capability for primitive decon was provided at Johnston Island as a contingency for hasty removal of aircraft. A portion of the taxiway was isolated by a concertina wire barrier, and a complete coral berm was built to divert waste water flow into the run-off ditch. Fresh water was pumped through a hose from a reservoir tank for washdown. However, this field expedient was never used since the only radiological decon was that prompted by nuisance puddles of water resulting from short duration rain showers. Radiation levels from these were never more than 20-40 mr/hr close to the surface. The personnel decon facility erected after the BLUEGILL PRIME event was utilized for sampler aircraft crews as well as a routine radsafe support installation.

(2) High Altitude Events: The missile used for the BLUEGILL DOUBLE PRIME event was destroyed in flight and a very small amount of radioactive debris, consisting mostly of light weight fragments of components, fell onto Johnston Island. No injuries

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[redacted]

or contamination resulted. BLUEGILL TRIPLE PRIME event required radsafe support for instrument recovery and handling. Contamination was of low intensity, permitting immediate removal of detector elements from instrumented pods for early analysis.

F. RESULTS

1. Shots and Post-Shot Survey Results: Table 2 contains a list of nuclear events which occurred near Christmas Island and Johnston Island. Technical details pertaining to these may be found in Enclosure L.

a. Readings obtained from stations equipped with continuous background radiation monitoring equipment, high and low range radiation detection and measuring equipment, and air and water sampling equipment, showed a continuously normal background level. At no time were there detectable increases above previously recorded (background) levels on Christmas Island.

b. With the exception of the STARFISH and BLUEGILL PRIME events, no hazardous contamination occurred on Johnston Island. All other events involved only recovery, monitoring, and handling of the scientific pods which were recovered and disassembled without mishap or injury. No personnel radiation exposures of any significance were observed.

G. CONCLUSIONS

1. Separate Radsafe Unit

Experience gained during Operation DOMINIC emphasized strongly that the task unit organization employed during Operation HARDTACK (JTF 7) is a more suitable approach to radsafe operations.

2. Radiological Health Laboratory-Hawaii

This laboratory, which supported the JTF 8 Off-site Surveillance Program of documenting radiation exposure to off-site populations during Operation DOMINIC, was established at Honolulu, Hawaii to provide a facility for the radio-chemistry analysis of air, precipitation, water, milk, food, and soil. The USPHS, working with the Hawaii State Health Department, expanded the existing Hawaiian Surveillance Program so as to provide an extensive fallout monitoring program. As a consequence of these two programs, JTF 8 was provided with a strong capability of assessing radiation for public confidence. The results indicated that fallout encountered was minimal, with no significant exposure occuring to populated groups inside or outside the danger area.

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TABLE 2

NAME OF EVENT	DATE	YIELD RANGE*	TYPE
	CHRISTMAS ISLAND EVENTS		
ADOBE	25 Apr 62	Intermediate	Air Drop
AZTEC	27 Apr 62	Intermediate	Air Drop
ARKANSAS	2 May 62	Low Megaton	Air Drop
QUESTA	4 May 62	Intermediate	Air Drop
YUKON	8 May 62	Intermediate	Air Drop
MESILLA	9 May 62	Intermediate	Air Drop
MUSKEGON	11 May 62	Intermediate	Air Drop
ENCINO	12 May 62	Intermediate	Air Drop
SWANEE	14 May 62	Intermediate	Air Drop
CHETCO	19 May 62	Intermediate	Air Drop
TANANA	25 May 62	Low	Air Drop
NAMBE	27 May 62	Intermediate	Air Drop
ALMA	8 Jun 62	Intermediate	Air Drop
TRUCKEE	9 Jun 62	Intermediate	Air Drop
YESO	10 Jun 62	Low Megaton	Air Drop
HARLEM	12 Jun 62	Intermediate	Air Drop
RINCONADA	15 Jun 62	Intermediate	Air Drop
DULCE	17 Jun 62	Intermediate	Air Drop
PETIT	19 Jun 62	Low	Air Drop
OTOWI	22 Jun 62	Intermediate	Air Drop
BIGHORN	27 Jun 62	Megaton	Air Drop
BLUESTONE	30 Jun 62	Low Megaton	Air Drop
SUNSET	10 Jul 62	Intermediate	Air Drop
PAMLICO	11 Jul 62	Low Megaton	Air Drop
	JOHNSTON ISLAND EVENTS		
BLUEGILL	3 Jun 62	Abort	THOR
STARFISH	19 Jun 62	Abort	THOR
STARFISH PRIME	8 Jul 62	Low Megaton	THOR
BLUEGILL PRIME	25 Jul 62	Abort	THOR
ANDROSCOGGIN	2 Oct 62	Low	Air Drop
BUMPING	6 Oct 62	Low	Air Drop
BLUEGILL DOUBLE PRIME	15 Oct 62	Abort	THOR
CHAMA	18 Oct 62	Low Megaton	Air Drop
CHECKMATE	19 Oct 62	Low	SERGEANT (Strypi)
BLUEGILL TRIPLE PRIME	25 Oct 62	Intermediate	THOR
CALAMITY	27 Oct 62	Intermediate	Air Drop
JOUSATONIC	30 Oct 62	Megaton	Air Drop
KINGFISH	1 Nov 62	Intermediate	THOR
TIGHTROPE	3 Nov 62	Low	NIKE-HERCULES

* Low yield is below 100 KT
Intermediate yield is 100-1000 KT
Low Megaton yield is 1-5 MT
Megaton yield is above 5 MT

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3. Dosimetry Program

The film badge issuing and collection procedure would have been more effective if a charg-a-plate system had been used. This system was not instituted initially, since an extensive film badge issue was not contemplated. However, large issues to meet the requests of the naval task elements, and delays in the test program, with the attendant rotation of personnel, caused the total number of film badges issued to be higher than planned or expected.

4. Background Radiation Levels

As far as can be determined from existing monitoring data and investigations of reported incidents, no hazardous fallout occurred to populated areas or to transient surface craft and aircraft as a result of Operation DOMINIC.

H. RECOMMENDATIONS

1. A separate radsafe task unit should be established and assigned to CJTG 8.1 OpCon. An organized unit of all radsafe personnel offers a better means of conducting radsafe support than achieving it through a large number of isolated small elements. The purpose in forming this organization would be to improve the effectiveness of radiological safety support to the Task Force by consolidating all radsafe capabilities into an integrated effort. The proposed unit would be phased-in during build-up and remain in existence during deployment for operations. Chief, Radsafe Branch, JTF 8, should continue to occupy a staff position and should not command the unit.

The following is a tabulation of the manning requirements for two options of employment under one-site and two-site concepts:

ONE SITE OPERATION

FUNCTION	ARMY		NAVY		AF		TOTALS	
	OFF	EM	OFF	EM	OFF	EM	OFF	EM
Test Site								
Command & Control	1	1					1	1
Film Badge Issue & Collection		3		2				5
Protective Equip. & Supply Issue		1		3				4
RADIAC Instrument Maintenance	1	2					1	2
Dosimetry & IBM Exposure Records		3						3
Monitoring & Decontamination		8						8
Rad-Chem Analysis Laboratory		3						3
Sample Return (JTG 8.4 Augmentation)					1	14	1	14
Seaborne Recovery (JTG 8.3 Augmen.)			1	15			1	15
	2	21	1	20	1	14	4	55

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TWO SITE OPERATION
(Additions for Second Site)

	ARMY OFF	ARMY EM
Monitoring & Decontamination	1	6
Film Badge & Equipment Issue		3
	1	9

2. A post-operational surveillance activity in the Pacific area was continued by JTF 8 under arrangement with USPHS whereby USPHS continued to retain, on a loan basis, JTF 8 owned laboratory equip ment. The Radiological Health Laboratory Hawaii continued to be maintained in a state of minimum operation in order that a long term surveillance could be carried out. This decision was supported by three reasons: (1) USPHS had performed analysis on pre-operational food samples collected from several inhabited islands surrounding the testing area. Consequently, it appeared prudent that subsequent sampling should be performed for a least a year following termination of the test series, i.e., as new food crops come in; (2) Dismantling of the laboratory and storage of the equipment would be costly, and it is probable that any electronic equipment put into storage and not used would deteriorate seriously during the period of storage. Various pieces of equipment were owned by JTF 8, the AEC, and the USPHS. (3) The maintenance of a laboratory capability at the proposed location would contribute to congenial relationships with the State of Hawaii and the Hawaii State Health Department.

3. Film badge issue, collection and processing must be improved by instituting effective control measures and providing sufficient personnel to this important function. The Navy Task Group received over one-half of the total film badge issue. In view of this, it is considered appropriate that this Task Group should assign a minimum of two Navy enlisted personnel to the proposed radsafe task unit to assist in dosimetry service to naval task elements. This would improve the capability of meeting the requirements of the Task Group, while at the same time servicing the remainder of the Task Force in a satisfactory manner. Likewise, the Air Force Task Group should provide one man to assist in dosimetry involving crews flying sampler aircraft. A certain amount of automation of film processing and recording procedures should be established where feasible.

4. The permanent film badge package must be improved so as to prevent deterioration of film subjected to tropical climatic conditions.

5. Voice communications should be expanded to include Johnston Island and Honolulu, Hawaii as a part of the voice net available to Radsafe.

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6. The decon laundry facility should be manned with personnel supplied by the AEC contractor under operational supervision of the Task Force Radsafe Officer

7. All recommendations listed in Section H of Appendix B should be included for completeness.

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ANNEX A

TO APPENDIX A OF ENCLOSURE N

PHOTODOSIMETRY

1. Film Badges: The film badge program was designed to provide a dosage indicating device to all personnel in the Task Force in order that complete dosage information could be maintained on everyone entering the Christmas and Johnston Islands area during the Operation. Film badges were issued to all individuals upon their arrival at these locations, with instructions that the badge would be worn at all times, and would be turned in on recall by Radsafe Branch, upon exit from any contaminated area, return from a cloud sampling mission, or upon departure from the test area. The badge consisted of the DuPont 556 film packet (508 component 0-10r range and 834 component 0-1000r range) dipped in ceresin wax and then packaged in a rigid polyvinly chloride (PVC)case. The purpose of the wax dip and the PVC case was to make the film packet impervious to moisture in order that it might be worn for several months without deterioration. Based upon extensive experience, and a check of overall efficiency of the packaging of similar badges used during Operation HARDTACK (JTF 7), it was not expected that any significant failure in packaging would occur. However, near the end of the operation when certain film lots were being processed, it was observed that higher-than-expected dosage readings were being obtained. An immediate check of the rosters revealed that the individuals who had worn the badges could hardly have received such dosages, since they had not participated in any operation which would have subjected them to such an exposure. A subsequent analysis of the film indicated that the film pack suffered deterioration due to environmental conditions. This deterioration was sufficient to cause an erroneous reading of the film. Careful examination of the film base fog revealed the pattern observed to be that characteristically associated with environmental damage such as heat, light,and humidity, and not that of ionizing radiation. The wax dip was suspected of being inadequate, rendering the film packet vulnerable to seal failure with resultant light damage.

2. Film Badge Processing and Record Posting:

a. Two dosimetry sections were required for the Pacific Test Area. One was established at Christmas Island and the other in Honolulu, Hawaii. The Christmas Island section handled all film badge dosimetry for the Christmas Island operations, using the Honolulu installation as a back-up. The Honolulu installation performed all dosimetry for Johnston Island the Barbers Point personnel of the Task Force.

b. During the period 1 April - 1 November 1962, 43,000 film badges

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were issued, processed, and the information recorded. Records were maintained on approximately 30,000 individuals. Film was processed using standard techniques. Density shown on film was then read using the Eberline densitometer and converted into dosage using a standard calibration dosage curve. The calibration curve was established under the normal process of exposing unused film against a known radiation source strnegth for specified periods of time.

c. The dose records cards (5 x 8 cards) were prepared in the Honolulu section, utilizing four to six female clerks hired locally. Approximately 20,000 five-by-eight data cards were typed and initial dosages posted.

d. Film badges worn by sampler aircraft crews were collected immediately after each event and returned to Radsafe Branch Dosimetry Section for expeditious processing (6 hrs) of dosage information to successive sampler crews. A photodosimetry trailer on loan from the USAF, operated by JTF 8 radsafe personnel, was located in the JOC area. This trailer contained the necessary equipment for developing and drying film. Subsequently, film was read in the FS-3 densitometer manufactured by the Eberline Instrument Corporation. Two such instruments with auxilliary punch card readout, together with an addressograph machine, were situated in the building next to the trailer. This completely air conditioned building housed the dosimetry section and the TU 8.5.1 radsafe office on one end, the JTG 8.4 instrument repair section on the other end, and provided utilities service to the photodosimetry trailer.

e. Near the end of the Christmas Island test series, the dosimetry operation at Christmas Island was relocated in Honolulu, Hawaii.

f. On 1 November 1962 the Honolulu dosimetry operations were terminated and preparations were initiated to transfer all processed film, film requiring processing, and records and materials to the Nevada Test Site (NTS), Mercury, Nevada. Reynolds Electrical and Engineering Company (REECo), located at NTS had agreed to do the final portion of the film badge processing and prepare a final IBM listing with the assistance of several selected JTF 8 radsafe personnel. Four of the original JTF 8 radsafe personnel arrived at NTS on 7 November 1962, and the remaining three arrived during the period 17-20 November 1962. The equipment and associated materials began to arrive at NTS between 14-17 November 1962.

g. Approximately 10,000 film badge packets were opened by JTF 8 radsafe personnel and sent to the REECo dosimetry laboratory for processing. Approximately 1,000 additional five by eight data cards, NAVMED forms (Naval Medical Forms indicating U.S. Navy issue), and approximately 30,000 listings were posted, finalized and coded for IBM key punching during the period 17 November 1962 - 11 January 1963.

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h. In order to utilize the IBM system for listing final rosters, organization codes were established by groups in the quantities indicated below:

GROUP	NUMBER OF SEPARATE CODES
HQ JTF 8	10
U.S. Army	92
U.S. Navy	162
U.S. Air Force	400
Civilians	85
Total:	749

i. Interim listings were furnished by the IBM division of REECo, and after the final review, all dose cards were sorted and the final listings were prepared in the quantities as follows:

TYPE	NUMBER OF LISTINGS
Alphabetical	12
Alphabetical-Organization	12
Service-Alphabetical	4
Service-Organization	4
Numerical-Non-Returned Badges	4
Alphabetical-Non-Returned Badges	4
Unassigned Badges	4

j. All copies of the final rosters were delivered to Hq, JTF 8, Washington, D. C. by the NCOIC, JTF 8 Radsafe Branch. The reports were then separated and sent to the proper cognizant agency: Surgeons General, U.S. Army, U.S. Air Force; Chief, Bureau of Medicine and Surgery, Navy Department; Chief Medical Officer, U.S. Coast Guard; and the Division of Operational Safety, USAEC.

k. Four JTF 8 radsafe personnel remained at NTS for the final roll-up which included assembling all final data records and processing film into acceptable order for proper storage at NTS by REECo. Upon completion of all dosimetry work for Operation DOMINIC, with the exception of unreceived film badges, the JTF 8 Radsafe Branch Dosimetry Section was dissolved and all personnel returned to their home station.

3. Pocket Dosimeters: Pocket dosimeters, Bendix Model No. 611, 0-5 r range, were also used as a means of obtaining quick information on aircraft crew dosage.

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APPENDIX B TO ENCLOSURE N

OFF-SITE RADSAFE

INDEX

A. INTRODUCTION AND SUMMARY

1. History of Phase I

a. Acting in accordance with a Memorandum of Understanding, dated 5 Feb 1962, between the Joint Task Force EIGHT and the U. S. Public Health Service (USPHS), the USPHS participated in the off-site radiological safety program for inhabited islands which was established in conjunction with nuclear weapons testing activities in the Pacific, "Operation DOMINIC". The USPHS assisted JTF 8 by providing personnel and necessary equipment for this program.

b. In addition to staffing and operating a radiological safety laboratory in Hawaii to carry out necessary analysis, the USPHS maintained a fallout assessment center within JTF 8 Headquarters. Reports

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of radioactivity levels in air were transmitted to the fallout assessment center for operational use and later incorporation in the Public Health Service reports of the operation to be provided to the Task Force.

c. During Operation DOMINIC, the Radiological Safety Program was effected in three stages, pre-operational, operational, and post-operational, with on-site and off-site activity in each stage. The operational stage was divided into two phases. Phase I involved the activities during the period April 1962 through July 1962 centered at Christmas Island, and Phase II involved the activities during the period August 1962 through November 1962 when Johnston Island was the center of events. On-site programs concerned activities at JTF 8 Headquarters on Christmas and/or Johnston Islands and the off-site programs involved the seventeen (17) station network established on other islands throughout the Central Pacific within a radius of 2,000 miles of Christmas Island. Primarily the program at the on-site stations of Christmas and Johnston Islands was air and precipitation monitoring, environmental sampling, background monitoring, and personnel and equipment monitoring. At the off-site stations the program was chiefly air and precipitation monitoring, environmental sampling, and background monitoring.

d. The degree of monitoring was related to the distance from the test site and population on the islands. Four primary stations (see Section D, para 1a) on larger islands with relatively large native and foreign populations near the test sites were manned by the USPHS support activities group; six secondary stations (see Section D, para 1b) were on islands populated mainly by JTF 8 personnel who operated the equipment; and, nine background stations (see Section D, para 1c) on distant islands were equipped with continuous background recording equipment operated by the weather groups and scientific personnel assigned to the islands, and in the case of two French Polynesian Islands, by French scientific personnel.

e. Monitoring techniques were selected to provide a capability of determining the radiological situation at any time to continuously document all levels that might lead to a radiation exposure. In this regard, equipment to measure external gamma radiation ranging from background levels to emergency levels were provided as well as continuous sampling apparatus. Documentary instrumentation consisted of film badges, continuous recorders, air samplers, and composite precipitation collectors. Food, soil and vegetation sampling provided further information of documentary nature. A description of these techniques is included in Section E, para 2, of this Appendix.

2. History of Phase II

a. Upon completion of Phase I of Operation DOMINIC several

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island stations in direct support of the Christmas Island tests were deactivated, e.g., Tahiti, Nuku Hiva, Malden, Fanning and Washington Islands. The Palmyra and Penrhyn Stations were deactivated but were re-established on the 3rd and 4th of October 1962 for support of the Johnston Island tests.

b. The Christmas, Johnston, French Frigate Shoals, Midway, Wake, Kwajalein and Canton Island stations were placed on standby basis the 1st of August, and re-activated on 22 September 1962, the date of establishment of the danger area around Johnston Island. The Tutuila, Viti Levu, Tongatabu and Rarotonga stations remained operational for the entire period 1 August through 18 November 1962.

c. Existing communication networks of various organizations were used to keep the off-site headquarters in Honolulu informed of all off-site station situations at all times. Servicing and supervision of these wide-spread stations was accomplished from the USPHS Honolulu Office.

d. After sufficient time lapse to permit adequate coverage, following completion of the Johnston Island tests, the stations were de-activated as transportation became available. The off-site stations were completely de-activated and post-operational sampling accomplished by 25 November 1962.

e. Thirteen stations were maintained for the Phase II off-site program. Eight off-site stations (Christmas Island, Penrhyn Island, Canton Island, Johnston Island, Wake Island, Midway Island, French Frigate Shoals, and Kwajalein Atoll) collected air and precipitation samples, and obtained periodic external gamma readings with AN/PDR-27J GM survey instruments. Five stations (Palmyra Island; Viti Levu, Fiji;Tutuila, American Samoa, Tongatabu, Tonga Islands; and Rarotonga, Cook Island) collected precipitation samples and made periodic external gamma readings with an AN/PDR-27J GM survey meter.

f. The effectiveness of these stations for indicating and documenting fallout was adequate. However, biological sampling during and after Phase II of Operation DOMINIC was performed to further insure a complete evaluation of the radiological situation.

g. Monitoring techniques for Phase II were identical to those of Phase I, with the exception that no RM-5 continuous gamma radiation monitors were used and no film badges were utilized at the off-site stations. Results from Phase I film badges had shown that they would not give reliable results under the environmental conditions (i.e. light, temperature, and humidity), thus they were not used during Phase II.

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3. Interpretation of Summary Results by Station

a. Hawaii - No fallout occurred other than traces in air samples and precipitation.

b. Christmas Island - All stations on Christmas Island recorded only minor fallout typical of "world wide fallout". No immediate fallout occurred from any test as shown by shot day readings as well as by the five continuously operated stations maintained by USPHS.

c. Fanning Island - No fallout of any significance occurred. An increase in the air concentration to 20 uuC/M^3 on 24 May 1962 occurred that was reflected in grass, but nothing of any consequence. The highest precipitation deposition occurred in the period 26 June through 8 July 1962, but no effect was noted in the food samples or drinking water collected afterwards.

d. Washington Island - Trace amounts of fallout, which occurred on 21 May 1962, were reflected in precipitation for the week of 14-21 May, and in grass. The only other instance of fallout was on 14 July 1962, just prior to rollup 15 July 1962. The levels were decreasing at this time, and internal and external exposures were insignificant. The highest deposition occurred on 14 July by a 5 inch rain, but cistern water supplies were essentially unaffected.

e. Palmyra Island - The highest air concentrations (58 uuC/M^3, 7 days age) observed during the operation was measured on 25 June 1962. Other significant increases here were 43, uuC/M^3 (6 days age) on 17 May 1962, and 39 uuC/M^3 (3 days age) on 21 June 1962. No external radiation occurred.

f. Malden Island - No exposure to the 30 JTF 8 personnel stationed here during the period April through 13 July 1962.

g. Penrhyn Island - The only significant fallout was by rain on 12 May 1962. This resulted in a maximum credible exposure of less than 50 millirems to the adult thyroid from drinking cistern water.

h. Canton Island - Only "world wide fallout" occurred as shown by air samplers.

i. Viti Levu - Samoa - Tongatabu - Rarotonga - Tahiti - No fallout.

j. Nuku Hiva - No fallout occurred with the exception of an increase in the air concentration to 26 uuC/M^3 (3 days old) on 14 July 1962. The sample for 15 July was missing so it is not known if the concentration continued to increase or not. On 16 July, the activity

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had decreased to 5 uuC/M^3. No samples have been received after that date .

k. Johnston Island - Wake Island - Midway Island - French Frigate Shoals - Kwajalein Atoll - No fallout.

B. OBJECTIVES

1. The USPHS contracted with JTF 8 of the DOD to provide off-site radsafe during Operation DOMINIC in the Pacific. Objectives of this operation were:

a. To provide on-the-spot radiological safety competence to the populated islands and to represent the Commander, JTF 8 on these islands.

b. To provide early warning of fallout on populated areas and to recommend action to be taken in the event of fallout or imminent fallout of significant proportions in populated areas.

c. To assess the radiological situation as it affects populated areas and to provide a current situation display for the information of JTF 8.

d. To document radiation levels in principal populated areas for a distance extending approximately one thousand miles from the test area.

2. The purpose of this Appendix is to discuss in general terms the methods used, the results obtained, and to interpret the data in terms of population exposure. A general operational history is presented, stations are described, methods of laboratory analysis presented, and the results are summarized and interpreted for the period 1 February 1962 through 18 November 1962. Since there was only one event at Johnston Island prior to 31 July 1962, Phase I relates primarily to Christmas Island operations. Several of the off-site stations were still in operation after 31 July 1962 in support of Johnston Island activities.

C. STATIONS PARTICIPATING

Chart 3 is a list of stations participating and shows respective operating dates.

D. PLANNING AND PREPARATIONS

1. Facilities and Services: Under the terms of the Memorandum of Understanding dated 5 Feb 1962, between the Commander, JTF 8 and the Surgeon General, U.S. Public Health Service (USPHS), a network of off-site

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	PHASE I			PHASE II	
STATIONS LOCATION	ESTABLISHED	SHUTDOWN	STANDBY	RE-ACTIVATED	SHUTDOWN
Christmas Island					
Airfield	24 Apr 62	15 Jul 62			
JOC	18 Apr 62		1 Aug 62	22 Sep 62	21 Nov 62
London Port	24 Apr 62	15 Jul 62			
A Site	24 Apr 62	15 Jul 62			
D Site	27 Apr 62	15 Jul 62			
Y Site	27 Apr 62	15 Jul 62			
Honolulu, Oahu, Hawaii	23 Apr 62				20 Nov 62
Fanning Island	18 Apr 62	14 Jul 62			
Washington Island	22 Apr 62	15 Jul 62			
Palmyra Is., Line Islands	24 Apr 62	16 Jul 62		3 Oct 62	21 Nov 62
Malden Is., Line Islands	23 Apr 62	13 Jul 62			
Penrhyn Is., Cook Islands	23 Apr 62	25 Jul 62		4 Oct 62	23 Nov 62
Canton Is., Phoenix Islands	17 Apr 62		1 Aug 62	22 Sep 62	14 Nov 62
Johnston Island	30 May 62		1 Aug 62	22 Sep 62	20 Nov 62
Wake Island	4 Jun 62		1 Aug 62	22 Sep 62	25 Nov 62
Midway Island	28 May 62		1 Aug 62	22 Sep 62	5 Nov 62
French Frigate Shoals	29 May 62		1 Aug 62	22 Sep 62	8 Nov 62
Nuku Hiva, Marquesas Islands	9 Jun 62	31 Jul 62			
Faaa, Papeete, Tahiti	6 Apr 62	31 Jul 62			
Kwajalein Atoll, Marshall Is.	16 Apr 62		1 Aug 62	22 Sep 62	6 Nov 62
Viti Levu, Fiji Islands	20 Apr 62				18 Nov 62
Tutuila, American Samoa	22 Apr 62				14 Nov 62
Tongatabu, Tonga Islands	19 Apr 62				20 Nov 62
Rarotonga, Cook Islands	20 Apr 62				15 Nov 62

CHART 3 - RADSAFE STATIONS PARTICIPATING IN OPERATION DOMINIC

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monitoring stations was operated by the USPHS for JTF 8 to document the radiation exposure to significant populated groups in and outside the danger areas of Christmas and Johnston Islands. This network shown on Figure 4 consisting of Primary Stations, Secondary Stations, and Background Stations, totaled 19 stations. The network was operated out of Christmas Island with the Primary Stations reporting daily and the Secondary and Background Stations reporting weekly to the Radsafe Office at Christmas Island.

a. Primary Stations: Primary stations were established on Fanning Island (Line Islands), Washington Island (Line Islands), and Honolulu, Hawaii (Oahu) in addition to the ones on Christmas Island (Line Islands). These stations were manned by USPHS officers with equipment and sampling techniques to document all forms of radiation exposure. On both Washington and Fanning Islands the assigned USPHS officer acted at Island Commander and Evacuation Officer. Two-way radio contact with the Radsafe Office at Christmas Island was maintained.

b. Secondary Stations: Secondary stations were operated on the islands of Canton (Phoenix Islands), Malden (Line Islands), Penrhyn/Tongareva (Cook Islands), Palmyra (Line Islands), Midway Johnston, and French Frigate Shoals (Tern Islands). These stations (with the exception of Palmyra and Johnston Islands) were located just outside the danger area and were designed to document air concentration and the external radiation background. The USPHS group at Christmas Island made checks of precipitation and important food items where situations warranted such action. These stations were operated by Task Force Project Groups and Weather Groups.

c. Background Stations: Background stations were operated by Task Force Project Groups or Weather Groups for JTF 8 on Tutuila (Samoa Islands), Rarotonga (Cook Islands), Tongatabu (Tonga Islands), Viti Levu (Fiji Islands), Wake Island, and Kwajalein Atoll. The background stations at Taichae, Nuku Hiva (Marquesas Islands) and Papeete, Tahiti (Society Islands) were manned by French personnel. These stations were rather distant from the test area and were designed primarily for documenting the external radiation background as well as any changes therein.

E. OPERATIONS

1. Description of Monitoring Stations: These stations are discussed below listing location, equipment, operator, dates of operation, and other pertinent information such as population, water and food supply, etc., as one of three types.

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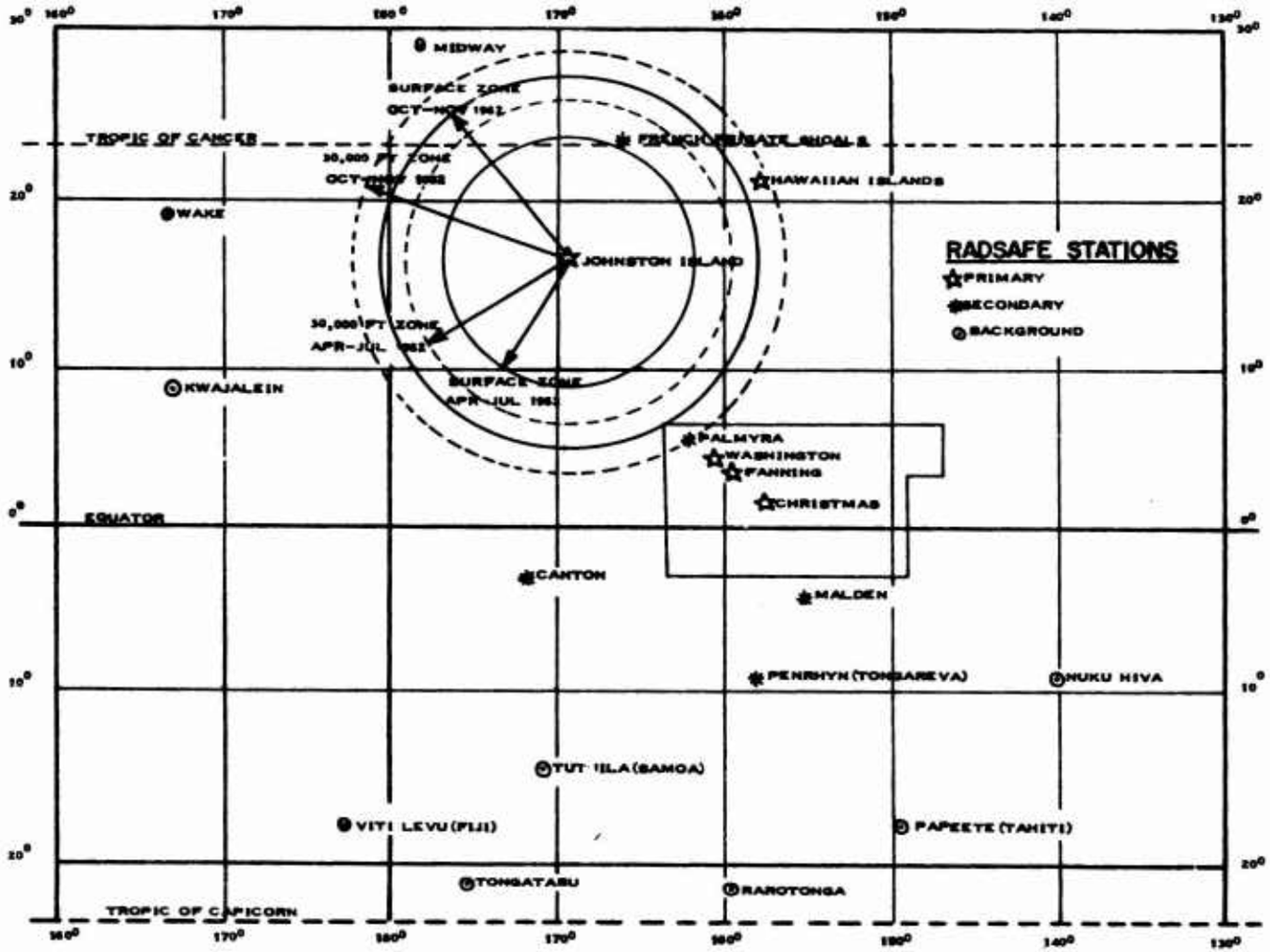

FIG. 4 - PACIFIC OCEAN AREA SHOWING RADSAFE STATIONS AND BOUNDARIES OF DANGER AREAS

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a. Primary Stations: These stations were on major populated islands near the test areas and were manned by USPHS officers trained in radiation measurements and evaluation techniques. This type of station was designed to have a high capability of on the spot interpretation for such matters as emergency evacuation measures, local governmental relations concerning radiation, and maintaining the public confidence. These stations were equipped to measure air concentrations and document external radiation levels, and the USPHS officers implemented food, water and precipitation sampling techniques and field estimates of radiological hazards. Direct contact with the Radsafe Office at Christmas Island was provided by good radio communications. Daily reports of the radiological situation were received at Christmas Island from these stations.

(1) Christmas Island - During Phase I of Operation DOMINIC, Christmas Island was the location of JTF 8 headquarters. For continuous documentation of exposure to the major populated areas of the island as well as for evidence of local contamination on shot-days, USPHS personnel assigned to JTF 8 Radsafe Office controlled the operation of five stations (Main Camp, London Port, A-Site, D-Site and Y-Site) located on Christmas Island. Since large numbers of people were present at Main Camp, London Port and A-Site, these stations were operated as complete units and equipped with Eberline RM-5 continuous gamma radiation monitors, AN/PDR-27J GM survey meters, and precipitation collectors. D-Site and Y-Site were equipped with Eberline RM-5's and AN/PDR-27J's, and an air sampler was operated at Y-Site on shot days. All these stations were established shortly after 18 April 1962 and operated until mid-July when Phase I was completed. Thereafter only Main Camp (JOC) remained in operation until completion of Phase II, and it was shutdown on 21 November 1962. Prior to the first test on 25 April 1962 pre-operational samples of water, soil, coconut milk, green coconuts, fish, hermit crab and langouste were collected. Film badges were issued to key natives and all test personnel. In addition film badges were placed on trees and houses in the village of London Port. Water, food and environmental samples were collected periodically throughout Operation DOMINIC. From JTF 8 headquarters all the other monitoring stations were supplied and they in turn reported back their data. Based on this data, CJTF 8 was kept advised of the radiological situation existing in 9 million square miles of the Pacific Ocean. After the last test of Phase I, post-operational samples were collected and on 20 July 1962 the USPHS personnel relocated to the Radiological Health Laboratory in Honolulu, Hawaii to provide support for the Phase II tests at Johnston Island.

(2) Hawaii - To provide support for both phases of Operation DOMINIC with particular consideration being given to the Johnston Island operation, the Hawaii station was established on

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23 April 1962 at the Radiological Health Laboratory-Pacific in Honolulu. It was equipped with an Eberline RM-5 continuous gamma radiation monitor, AN/PDR-27J GM survey meter, an air sampler, and a precipitation collector. Pre-operational, operational, and post-operational samples of local foods and environment were collected during the tests at Christmas and Johnston Islands. Operation of the station was accomplished by USPHS officers, assigned on Invitational Travel Orders to the JTF 8 staff, at the laboratory. The station was shutdown on 20 November 1962.

(3) Fanning Island - On 18 April 1962, before Phase 1 of Operation DOMINIC commenced, this station was established and equipped with AN/PDR-27J GM survey meters, a "cutie-pie" portable ionization chamber, an Eberline RM-5 continuous background radiation monitor, Hi-Vol air sampler, precipitation collector, film badges, and communication equipment. USPHS officers assigned to the JTF 8 staff operated the station routinely taking daily gamma scans, periodically collecting food, water, precipitation, environmental samples, and air filter samples. In this British possession, film badges were placed in all locations where people were concentrated. There was a brief introductory course in radiation given, and the United Kingdom officials were informed of the measures to be employed in the event of an emergency. Working relationships between Her Majesty's representatives and JTF 8 forces were effected by the USPHS officer. The station was shutdown on 14 July 1962 when the USPHS officer departed.

(4) Washington Island - On 22 April 1962 this station was established and manned by a USPHS officer equipped with GM survey meters, a portable ionization chamber, a continuous gamma radiation monitor, precipitation collector, an air sampler, and film badges. Local food stuff and water samples,collected in the vicinity of the village on the west end of the island, were obtained for analysis. Film badges were placed in local dwellings. Routinely, weekly rain samples and daily air samples were collected; four daily surveys were made with the GM meters, and the RM-5 was operated continuously. Cordial relations were established with the plantation manager and his Gilbertese workers by the USPHS officer, who officially represented CJTF 8, and kept the local population informed of the radiation levels and advised them of the protective measures taken for their safety, and the plans to be effected in case of an emergency. Before the station was shutdown on 15 July, after Phase I was completed, post-operational samples were collected.

b. Secondary Stations: These stations were located on islands near the test areas where a fair probability of some local fallout existed. These stations were not operated by USPHS personnel directly, but were operated by JTF 8 Weather or Scientific Groups who were properly instructed. In general they were equipped with the same equipment as the primary stations but did not represent the same on-site capability. Frequent visits to these stations to obtain water, vegetation, and other

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"indicators" of fallout were made. Communications with the Radsafe Office at Christmas Island provided interpretation or assistance for any unusual occurrence. Weekly reports of radiation levels were received from these stations.

(1) Penrhyn Island - Penrhyn Island (Tongareva) is located in the Northern Cook Islands (New Zealand) and was established on 23 April 1962, and equipped with an RM-5 continuous gamma radiation monitor, two AN/PDR-27J portable GM meters, five film badges, and an air sampler for use by the New Zealand Government. An additional air sampler was installed on 9 June 1962 for JTF 8 use. The equipment was operated by the Geotechnical Corporation Group supporting the activities of the Air Force Technical Application Center (AFTAC). The station was located at the airstrip outside the Geotechnical Corp. trailer. Periodic samples of the water supply were taken. The station was operated through 25 July 1962 and re-activitated as shown in Chart 3.

(2) Malden Island - Malden Island, part of the Southern Line Islands (UK), was established on 23 April 1962 and equipped with an RM-5 continuous gamma radiation monitor, five film badges, two AN/PDR-27J portable GM survey meters, a precipitation collector, and an air sampler. The station was operated by weather station personnel of Joint Task Group 8.4. Although this atoll is normally unpopulated, a group of 30 people were on the island throughout the operation. The station was operated until 12 July 1962, at which time all equipment was removed, and USPHS personnel departed the island. Samples of soil and vegetation were collected periodically during the operation and at the time the station was shutdown.

(3) Palmyra Island - Palmyra Island is a part of the Northern Line Islands (UK). The station was established on 24 April 1962, and equipped with an RM-5 continuous gamma radiation monitor, two AN/PDR-27J portable GM survey meters, five film badges, and an air sampler. The equipment was operated by the Geotechnical Corp. Group supporting AFTAC activities. The station was operated until 16 July 1962, the equipment removed, and samples of water, vegetation and soil were collected. The station was re-activated as shown in Chart 3.

(4) Canton Island - Canton Island, Phoenix Islands (US-UK) is administered by the Federal Aviation Agency (FAA). The station was established on 17 April 1962 and equipped with an RM-5 continuous gamma radiation monitor, five film badges, one AN/PDR-27J portable GM survey meter, and an air sampler. The station was located near the office of the U.S. Weather Bureau and personnel from this office operated the equipment and collected composite precipitation samples every two weeks. This station was placed in standby status and reactivated as shown in Chart 3.

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(5) French Frigate Shoals - The French Frigate Shoals station was established on 29 May 1962 and equipped with an air sampler, two AN/PDR-27J portable GM survey meters, and five film badges. The equipment was operated by the U.S. Army 125th Signal Corps Group. The station was in standby status from 1 August 1962 until it was re-established on 22 September 1962 as shown in Chart 3.

(6) Johnston Island - Johnston, which was the headquarters for conducting the high altitude test program of Operation DOMINIC, required a population of hundreds of JTF 8 personnel. An RM-5 and an air sampler were placed in operation on 30 May 1962 in support of the high altitude tests. On occasion, special samples were received from JTF 8 for processing at the USPHS laboratory, but routine sampling was minimal. The station was in standby status from 1 Aug 1962 until 22 Sep 1962 at which time it was re-activated as shown by Chart 3.

c. Background Stations: These stations were located on islands rather distant from the test areas and were equipped primarily to document a change in the external radiation level. The stations were operated for USPHS by JTF 8 Weather or Scientific Groups who were properly instructed. Continuous gamma radiation monitoring equipment was the primary instrumentation used. Frequent visits were made to each station to inspect the equipment and take local samples for documentation. These stations represented locations where no significant fallout would be expected, but were maintained to provide some capability of assessing radiation for public confidence. Weekly reports were received of the radiation levels from these stations. Communications were available to the Radsafe Office on Christmas Island for interpretation for public information.

(1) Tutuila - The Tutuila (American Samoa) station was established on 22 April 1962 and was equipped with an RM-5 continuous gamma radiation monitor, an AN/PDR-27J portable GM survey meter, five film badges, and a precititation collector. The station was located about 8 miles from Pago Pago in the JTF 8 Weather tent, and was operated by the JTF 8 Weather Group. The station was operated until 20 Nov 1962.

(2) Viti Levu - The Viti Levu (Fiji Island (UK)) station was established on 20 April 1962 and was equipped with an RM-5 continuous gamma radiation monitor, an AN/PDR-27J portable GM survey meter and film badges. The station was located 17 miles from Nandi Airport at the Stanford Research Institute (SRI) site near Saweni Beach. Data from this station, furnished by SRI personnel, was intended to be representative of the Fijian Island Group. Samples of vegetation, milk, soil, and water were collected periodically. The station was in operation until 18 November 1962.

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(3) Tongatabu - The Tongatabu (Kingdom of Tonga) station was established on 19 April 1962 and was equipped with a RM-5 continuous gamma radiation monitor, five film badges and an AN/PDR-27J portable GM survey meter. The station was located at the U.S. Army 125th Signal Corps installation at the airport, and was maintained by this group. The station was in operation until 20 Nov 1962.

(4) Rarotonga - Rarotonga, (Cook Islands,(UK)), was established 20 April 1962 to represent the Southern Cooke Island Group, and was equipped with a RM-5 continuous gamma radiation monitor, five film badges and an AN/PDR-27J portable GM survey meter. The station was located about one mile from the airport at the Stanford Research Institute (SRI) facility, and was operated by SRI personnel. The station was in operation until 15 Nov 1962.

(5) Nuku Hiva - The Nuku Hiva (Marquesas Islands (French)) station was established on 9 June 1962, and equipped with a RM-5 continuous gamma radiation monitor, an AN/PDR-27J portable GM survey meter, air samplers and a precipitation collector. The station was located at the hospital, at Taiohae Bay, Nuku Hiva, and was operated by personnel of the French Government which took duplicate samples for the French Atomic Energy Commission. The station was closed down on 31 July 1962.

(6) Tahiti - The Tahiti (Society Islands (French)) station was established on 6 June 1962, and equipped with a RM-5 continuous gamma radiation monitor, an AN/PDR-27J portable GM survey meter, air samplers, and a precipitation collector. The equipment was located near the Weather Bureau at Papeete Airport, and was operated by the French Government which took duplicate samples for the French AEC. The station was closed on 31 July 1962.

(7) Kwajalein Atoll - The Kwajalein (Marshall Islands(US)) station was established on 16 April 1962, and was located about one-half mile from the MATS terminal at the U.S. Weather Bureau installation. The station, equipped with a RM-5 continuous gamma radiation monitor, five film badges and an AN/PDR-27J portable GM survey meter, was operated by U.S. Weather Bureau personnel. On 17 June 1962 the RM-5 was replaced with an air sampler. The station was in standby status from 1 Aug through 22 Sep 1962, at which time it was re-established as shown by Chart 3.

(8) Wake Island - The Wake Island (US) station was established on 28 May 1962 and equipped with an air sampler, two AN/PDR-27J portable GM survey meters and five film badges. It was located at the U.S. Navy Weather Station and was operated by Navy Weather personnel. The station was in a standby status from 1 Aug through 22 Sep 1962, at which time it was re-established as shown in Chart 3.

(9) Midway Island - The Midway Island (US) station was eatablished on 28 May 1962 and equipped with an air sampler, two AN/PDR-27J portable GM survey meters and five film badges. It was

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located at the U.S. Navy Weather Station and operated by Navy Weather personnel. The station was placed in a standby status from 1 August 1962 until 22 Sep 1962 at which time it was re-established as shown by Chart 3.

2. Monitoring Techniques: Monitoring techniques were selected to provide a capability of determining the radiological situation at any time to continuously document all levels that might lead to a radiation exposure. In this regard, equipment to measure external gamma radiation levels from background to emergency levels was provided as well as continuous sampling apparatus. Documentary instrumentation consisted of film badges, continuous recorder, air samplers, and composite precipitation collectors. Food, soil, and vegetation sampling provided further information of a documentary nature. The following is a general discussion of the techniques employed.

a. External Gamma Radiation Measurement - The primary instruments used to measure external gamma radiation were film badges, the AN/PDR-27J portable GM survey meter, and the Eberline Instrument Company Model RM-5 continuous gamma radiation monitor. Film badges were placed at each station in populated areas. Attempt were made to avoid situations that would tend to bias the reading, e.g. dense vegetation, unreasonable heights, closeness to large bodies of water, etc.. The badges were Dupont Film Type 508-834, hermetically sealed in hard plastic with a lead filter for hard gamma radiation dosage determination. The badges were put out with the intention of leaving them about three months. Experience during Operation HARDTACK showed that this could be done with this type of badge without damage or loss of significant exposure. The badges were processed at the end of the operation (about 3 months later) and any exposure greater than 50 millirems reported (50 mr was chosen to be the lower limit of detection). The AN/PDR-27J is a portable Geiger Mueller (GM) Survey Meter (commonly referred to as the 27J) utilizing a high range probe and a low range end window type probe to provide a range of 0-500 mr/hr with four scales (0-.5, 0-5, 0-50 and 0-500 mr/hr). The instrument is quite rugged and yet very sensitive (changes of .01 mr/hr on the lower scale are readily detectable). It is transistorized with printed circuitry, utilizing a six flashlight D-cell (BA-30) battery complement as a power pack, and is very reliable maintaining calibration very well. Readings were taken in a representative area three feet above ground and the calibration checked with a radium check source four times daily (only twice daily at some background stations). The RM-5 is a continuous gamma radiation recorder utilizing a GM probe connected to a count rate meter and recorder circuit contained in a cabinet. Both the strip chart recorder (30 days chart) and the loop type recorder (8 days chart) were used. The recorder is logarithmic with a range of 0.01 to 100 mr/hr. This equipment was placed at the stations to continuously document the gamma radiation level. Performance was acceptable with close observation, but since the equipment was new, many minor repairs had to be made. This was not good for field use during this type of operation where hundreds

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of miles and transportation represented serious problems in maintenance. Towards the end of the operation, however, reliability was increased with the correction of several malfunctions. The manufacturer later recalled the instruments for re-working to increase reliability and reduce down time. In many ways this was a field test of the instruments, with a constant comparison with the 27J. The instrument calibration was checked twice daily with the 27J check source and the date and time initialed on the chart. Charts were collected, analyzed and filed by the USPHS group at Christmas Island.

b. Air Sampling - The standard high volume air sampler (Hi-Vol) with four inch diameter sampling head was used to collect daily 24-hour air samples using MSA 2133 dust filters. The sampler was placed in a screened shelter out of doors, as high above ground as convenient, such as on a roof. Measurements of the air volumes were made utilizing visi-floats calibrated on the sampler in cubic feet per minute (cfm) by a laboratory rotometer. The filters and corresponding data sheets were sent to the USPHS laboratory in Hawaii for analysis. Field estimates of the air concentrations were made at primary stations. These were entered on the filter data sheet, logged and reported to JTF 8 Radsafe Office at Christmas Island daily. This method consisted of reading the filter with the end window probe of the 27J and comparing this reading with that from a four inch diameter standard of $Sr\text{-}Y^{90}$ (40,000 uuc). Concentrations measured by this means were usually within a factor of two of the concentrations measured in the laboratory.

c. Precipitation Collection - The objective of this method was to estimate the amount of fission products (deposited on the island) which might become an internal hazard via the food chain or the drinking water supply. It appeared immaterial whether the fallout was dry or with rain, thus no attempt was made to separate the two. Weekly samples were collected and a one gallon aliquot of this was sent to the laboratory for analysis. The collector was a standard 20 gallon plastic garbage can which had a fairly large top area ($0.13M^2$). Any substance falling through this area, either dry or in the form of rain, represented deposition per unit area and this was the unit (uuc/M^2) in which the results were reported. In a few locations there was very little rain and evaporation was a problem. In these cases a large funnel $0.4M^2$ was constructed and a five gallon carboy used for collection of the composite sample.

d. Drinking Water Collection - One gallon samples of the primary drinking water supply were collected periodically. In cases where cistern water was used, it was samples since a more immediate situation due to rainout of activity could be seen. This made cistern water a better fallout indicator than surface or well water. In several cases data concerning area of the cistern collector, tank capacity, daily rainfall, and population were used to advantage in estimating the significance of fallout activity in the cistern sample. The primary analysis of this water was for gross beta and specific radionuclide concentrations where they were applicable.

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e. Food Sampling - This was done for pre- and post-operational evaluation. Samples of the major food items, such as fruits, coconuts, and fish were collected for documentation of any increases in radiation levels due to the nuclear tests. If fallout had occurred during the operation, these would have been collected for documentation and evaluation; however, there was no routine food sampling program. On those islands where milk was produced, a few spot samples were collected primarily as an indicator of fresh fallout.

f. Environmental Samples - These are classified in this manner since they represent primarily an indication of a change in the radiation environment. These samples were primarily vegetation and soil; but silt deposits, plankton, seaweed, sea water, etc., were possible samples in this category. Collection was based on suspected fallout, but no routine sampling was done. For example, if a slight fluctuation in the backgroundlevel was indicated after a large rain, a sample of grass orscaevola leaves would be collected for analysis primarily as an indication of whether or nor fallout had actually occurred. These samples appeared to be the quickest indicators of fallout deposition. Grass and soil were collected as pre- and post-operational samples at most stations. Grass collections involved clipping the grass at ground level from an area of one square yard that was reasonable flat and undisturbed. All this grass was composited as one sample for analysis. Collection of soil was usually done after collecting the grass sample and in the same area. One square foot of top soil, one inch deep, was collected from the clipped area. These samples were processed and thr results were used and interpreted as fallout "indicators".

F. RESULTS

1. General

a. The data and sample analysis results are presented in a separate three-part report* published by the U.S. Public Health Service. The results are discussed below in terms of the three major areas; pre-operational, operational, and post-operational. The significance of these results in terms of assessing the radiation exposure contributed by the testing during Operation DOMINIC is discussed. Also included are remarks about the adequacy of methods employed and analyses performed in terms of what would be desired for better interpretation of radiation exposures in the Pacific.

b. Basic criteria for evaluation of fallout were based on the recommendations of the International Commission on Radiological Protection

* Reference:

USPHS Report, 1962 Pacific Nuclear Tests (Operation DOMINIC), "Off-Site Surveillance Program", March to November 1962, Parts 1-3.

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(ICRP) and the Federal Radiation Council (FRC), and on the regulations contained in Annex J of the Operation Plan for the 1962 Pacific Nuclear Test Series (Operation DOMINIC).(Annex C). These criteria were interpreted for exposure to those employed directly with the tests and also for population groups ar large, where reduced exposure levels were recommended. Fortunately, there were no situations where these criteria could not readily be met; thus fallout interpretation was relatively easy.

c. The general nature of fallout that occurred was what is typically know as"world wide fallout" that tended to be in a band close to the Equator. There was no immediate fallout that occurred on populated areas. There were two instances of fallout and these are discussed in paragraphs 3b and 3c below. These occurred on Penrhyn Island (12 May) and on Washington Island (14 July) with fission product ages of from four to eight days. This was not specifically "world wide fallout" but was not immediate fallout either.

d. The absence of immediate fallout on populated areas depended to a large degree on the caution exercised in predicting fallout trajectories and the use of this information in deciding whether to test on a certain day or not. Perhaps the largest single factor that influenced this typical fallout pattern was the nature of the test events themselves. All the tests were conducted as air bursts; thus the accumulation of debris in the cloud was minimal as compared to surface detonations. This meant that there was little likelihood of immediate settling of fallout, but that it was carried by the upper winds and dispersed only to appear several days later in low concentrations in air and rain.

e. Another general feature of the fallout observed was that the primary vehicle was the rain. The instances of both Penrhyn and Washington Islands were a result of deposition by rain. In this regard, it appeared that an important part of the surveillance was precipitation collection and this combined with vegetation sampling (Scaevola and grass) proved to be the best indicators of fallout deposition. This required routine sampling in those areas where cistern type water supplies were used so as to gain some idea of internal exposure that might result as a direct consequence of fallout in the rain. Fortunately, the mechanism of deposition by rain and accumulation on grass and then in the milk, was not present in this area since local milk production was very rare in most of the islands excluding. Milk was sampled as food in Hawaii, and a few samples taken in the Tonga and Fiji Islands primarily as fallout "indicators". In no cases were significant levels noted in milk which appears to be the best indicator of radioactivity in the food chain.

f. It can be stated that the background levels that existed at the time the tests were begun were for all practical consideration undisturbed. This is true also for the occurrences at Penrhyn , and at Washington Island where there was an increase to four times background followed by a quick return to normal. This is the general conclusion that must be drawn. The following discussions are related primarily

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to the reasons why this conclusion was drawn as well as to demonstrate what the surveillance program showed in specific areas.

2. Interpretation of Pre-Operational Results

a. These results show in general the typical fission product distribution (Ce-144, Zr-Nb-95, Ru-106, Cs-137) that was common at this time as a result of the fallout from the soviet test series in the fall of 1961. This is confirmed by preliminary results obtained by personnel from the Radiation Biology Laboratory of the University of Washington, who did extensive pre-operational sampling in this area*.

b. Samples were taken on the primary stations, Christmas Island, Hawaii, Fanning and Washington Islands, as well as on Samoa. Not all the results were reported for Hawaii, where the five major islands were sampled, since those samples from Oahu were representative of the total. Tuna fish was sampled at Samoa, since the area off Christmas Island was a fishing area for boats that deposited their catch in Samoa. No specific radionuclides were detectable, and the gross beta activities were relatively low. Extremely low concentrations existed in the well water from Christmas, Fanning, and Washington Islands. The water from Hawaii contained low levels of Zr-95 but nothing of any significance. Hawaii milk is also quite low in Strontium and Cesium. Cesium-137 seems to be the predominant isotope in fruits from Christmas, Fanning, and Washington Islands, while the vegetables and fruits from Hawaii show the typical Soviet fallout spectrum previously mentioned.

3. Interpretation of Operational Results

a. This area includes the largest number of samples and those of all types. Whereas pre-operational and post-operational sampling involved mostly food items, the operational phase placed a great deal of emphasis on air and precipitation sampling and external radiation measurements as well as environmental sampling.

b. Only two instances of early (first few days) fallout occurred during the operation phase. This commenced on Penrhyn Island on 12 May 1962 and on Washington Island on 14 July 1962. A sample of rain water collected from a roof at Penrhyn on 13 May indicated fresh fission products of four days age at the time of collection. This sample, on the date of collection, contained approximately 3600 uuc/l of Iodine -131**. Since the fresh drinking water supply for Penrhyn was known to be cistern supply, this occurrence was investigated

Reference: *Report for TU 8.5.3 participation in Operation DOMINIC entitled "Radionuclide Content of Foodstuffs Collected at Christmas Is. and at other Islands of the Central Pacific During Operation DOMINIC, 1962." (Univ. of Washington Laboratory of Radiation Biology USAEC Contract No. AT(45-1) 1385, Report No. UNFL-87).
** This concentration could provide a daily intake of I-131 that would exceed by a factor of 4 the values in Range III (100-1000 uuc/l daily intake) specified by the FRC.

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to estimate the possibility of an exposure resulting in a dose to the thyroid. At no time was this considered to be hazardous, but the effort was made to document, as well as possible, any exposure that might have resulted. Investigation and calculation estimated an exposure to the adult thyroid of less than 50 millirems (500 millirem for children) as a result of this occurrence. All the activity was brought down in rain and resulted in only a barely detectable increase in the external gamma radiation level (0.01 to 0.015 mr/hr). This of course went unnoticed. The fallout is believed to have occurred as a result of the event announced on 9 May and was the result of cloud rainout from a portion of the upper cloud that drifted along the predominant upper-wind trajectory toward the southeast settling into the easterly trade winds below 20,000 feet, which carried it over Penrhyn where rainout occurred. No significant internal or external exposure resulted, and exposures were well below the recommendation of the ICRP and the FRC for populations at large.

c. Just before roll-up of Washington Island, a detectable increase in the gamma radiation background was noted. This occurred on the morning of 14 July 1962, three days after the last announced event at Christmas Island, and after the accumulation of about five inches of rain. The external background increased from 0.01 mr/hr to 0.04 mr/hr on 14 July. A sample of precipitation was taken on 14 July, and on 15 July another precipitation sample and scaevola leaves were taken. The laboratory results of these samples indicated a rather large deposition of 6 day old fission products due to the the rain. By the afternoon of 15 July, the radiation level had decreased to 0.03 mr/hr. This level is insignificant for external exposure, but it is significant in that it pointed out that the accumulation of fallout had stopped with the rain. The situation is of no apparent importance since there is no direct manner in which the deposition could enter the food chain other than through a cistern water supply. A sample of cistern water was taken after fallout had stopped and the levels were well below tolerance.

d. The two situations discussed above indicate the importance of the effectiveness and sensitivity of the surveillance program for detecting any changes in the radiological situation.

e. The following is a more specific discussion of results:

(1) Air Samples - The stations near the Equator received fallout that fluctuated constantly with an age on the order of 10 days or greater. The levels at the stations relatively far from the Equator

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such as Tahiti and Nuku Hiva to the South (1400 & 600 miles below the Equator) and Johnston, Kwajalein, Midway, Wake, Hawaii, and French Frigate Shoals to the North (near distance about 900 miles North of the Equator) were fairly constant and quite low. In no case did air concentrations approach the Maximum Permissible Concentrations (MPC) recommended by the ICRP. The highest concentration observed was 58 uuc/m^3 on Palmyra on 25 June 1962 with a fission product age of 7 days. Annex J, CJTF 8 Operation Plan 2-62, dtd Feb 1962,(Annex C)specified an MPC limit of 100,000 uuc/m^3 for continuous occupational exposures to mixed fission products of 3-10 days age. This level can be reduced by a factor of 10 and utilized for a population group (10,000 uuc/m^3 for 3-10 days old fission products). When the levels are compared to these criteria, it is noted that they were quite low.

(2) Precipitation Results - Concentrations of Iodine-131 were quite low with the exception of the one sample from Penrhyn. In no other cases did the Iodine levels in rain approach a hazardous level. It is felt that the program of precipitation sampling was the most important one in assessing the occurrence of fallout. This program could have been improved by having more stations and a more controlled collection system. Even though the results are primarily indicators, they are about the most sensitive for detecting fallout and estimating deposition.

(3) Water Samples - Very few of these were taken since fallout was so minimal.. The criteria by which the water supplies were sampled was on the basis of reported fallout from other sources such as external radiation readings and air sample and precipitation results. Several samples were taken on Christmas Island for routine evaluation and these contained essentially no radioactivity. This was also true for Johnston, Tongatabu, and Rarotonga. The samples from Penrhyn were documentation of the residual activity from the 13 May fallout. There was very little Iodine present and the gross concentrations were low. The water at this time (13 May) was safe for unlimited consumption (ICRP & FRC). Precipitation results after this date indicated no need to further sample the cistern supply other than the post-operational water supply sample which also contained very little radioactivity.

(4) Environmental Samples - Since fallout was almost non-existent, these samples were very minimal. The attitude of collecting samples only after fallout was reported was adopted for these samples as it was for water samples. Only vegetation (grass,scaevola, messerschmida) on Washington and Fanning Islands contained fresh fission products. Since these were not consumed and there were no grazing animals present on either island, the results are only indicative of some fallout. Washington had some fallout prior to 23 May and Rarotonga prior to 11 July, but the levels are of little significance other than as "indicators". The sampling of grass was used to advantage during the operation since it was, perhaps, the most sensitive indication of the occurrence and nature of fallout.

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(5) External Gamma Radiation Levels - As noted previously, these measurements were made with the AN/PDR-27J, the RM-5, and the film badge. It was estimated from 27J and RM-5 data that the film badge should show essentially zero activity, but this was not the case. Erratic readings, due to weathering of the badges, were obtained showing variations from zero up to several hundred millirem for several places on the same island. This is contrary to the good results obtained during Operation HARDTACK using this type of badge with Dupont 502 film. This turned out to be a field evaluation also of the badge using the 508-834 packet. The only conclusion that can be drawn is that this type film does not withstand the heat, light, and humidity conditions (present in this area) and give reliable results. This was unfortunate in that it eliminated one phase of the program for documentation; however, the excellent results obtained by the 27J and those obtained by the RM-5 were sufficient to provide the necessary measurements. The 27J results were the most reliable obtained during the operation. The primary stations took four readings daily and the secondary and background stations took at least two daily. Calibration was checked at each reading by a uniformly prescribed method and the stability of the instruments was remarkable. Only two cases of significant increase were noted. These were the two, described previously in paragraphs 3b and 3c above, on Washington and Penrhyn Islands. Other readings appeared to be of no significance and probably were misinterpretations of needle fluctuation of these low levels. The RM-5 results were for the most part good continuous documentation of gamma radiation levels. One of the most notable comments about the performance of the RM-5 is that there were hardly any opportunities for it to read above the normal background of 0.01 mr/hr. The instrument usually responded to daily calibration checks quite well though some drift, usually downward, was noted. When malfunctions occurred, they were usually readily discernible and the 27J readings were relied upon for interpretation. A slight increase in the background was measured on Penrhyn on 13, 14, 15, and 16 May 1962 with a gradual rise to 0.015 mr/hr that returned to the normal background of 0.01 mr/hr thereafter. The RM-5 had been removed on 12 July from Washington Island, prior to the increase in background on 14 July, so no opportunity was available to determine if it would have shown this increase. Undoubtedly it would have since the instrument was functioning satisfactorily when shutdown. All other locations showed no significant increase. The total exposure to external gamma radiation during Operation DOMINIC was essentially zero. The maximum infinity dose on both Penrhyn and Washington Islands was less than 10 millirem. The ICRP and FRC specify as guidelines a yearly exposure of less than 500 millirem to individuals in a population, and 170 millirem for population groups. With the exception of film badge results, the external gamma radiation documentation was very good.

4. Interpretation of Post-Operational Results

The water results show essentially no increase above the pre-operational levels on Christmas Island and Hawaii. The Washington Island cistern supply results confirm the presence of fallout earlier, but the levels themselves show minimum residual. Results

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from the water supplies of the other islands also show insignificant levels of residual radioactivity. The post-operational environmental samples showed the typical pattern of accumulation on vegetation. Soil samples also show "indications" of fresh fission products, but both types of samples showed minimum residual due to the tests. The soil sample data was of significance. The gross beta levels were lower in several instances than the sum of the component radionuclides. The gross beta analysis was performed on a small aliquot that was dried. Extrapolation of this to the total mass of the sample results in a large error. The specific radionuclide determinations were performed on the entire sample mass by the gamma spectrometer and are more meaningful. In either case, the results are accepted as "indicators" only of fresh fallout. In this regard, the results of the gamma spectrometer are more significant since relative abundances of radionuclides are determined. In summary, the results show no accumulation of radioactivity on the islands in the area influenced by Operation DOMINIC.

G. CONCLUSIONS

1. As a result of the off-site program, certain conclusions can be drawn. These are summarized as follows:

a. The mission of the USPHS to keep the CJTF 8 informed of the radiological situation throughout the Pacific was successfully realized.

b. The operation was completed without a significant public reaction against radiation levels due in large part to the ability of the USPHS to quickly and accurately report to interested groups the levels that existed in their locale.

c. A total of 19 island stations utilizing 34 sampling points was used to document the radiation levels in an area approximately 9 million square miles around Christmas and Johnston Islands during Operation DOMINIC. This network provided information such that the radiation exposure to any population group within this area could be evaluated with reasonable certainty and accuracy.

d. Fallout throughout the monitoring area was extremely minimal. There was no significant exposure to population groups inside or outside the danger areas and for all practical pusposes, the background radiation levels were not exceeded. This was probably due to test detonations at relatively high altitudes.

e. Good results were obtained utilizing proven sampling techniques for air, water, food, precipitation, soil, and vegetation.

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f. Reliable sample analysis was obtained by use of a well equipped radiological laboratory employing very sensitive gamma spectroscopic and radiochemistry techniques.

g. Experience was obtained to enable refinement of off-site radiological monitoring procedures. This is discussed below in Section H entitled "Recommendations".

H. RECOMMENDATIONS

1. Attempts were made to develop background for most of the following recommendations in the previous section. In some cases, however, this was not practicable so these recommendations will be made with a little background material. These are as follows:

a. The same area of fallout measurement should be maintained. During any future tests in the Christmas Island area, USPHS should strive to establish early the stations in the Marquesas and Society Island groups. This should be easily done in view of the good working arrangement that existed with the French Territorial Government in Tahiti.

b. A USPHS officer should be assigned to Penrhyn Island for any future tests at Christmas Island. The primary reason for this is coordination of fallout surveillance with the program carried out by New Zealand in the Cooke Island and other New Zealand Territories. Extremely good relations were maintained by USPHS with the representatives of the New Zealand Health Department (Dominion X-Ray & Radium Laboratory, Christchurch) stationed on Penrhyn Island. Informal conversations indicated an interest by New Zealand Authorities in exchanging results; and thus, minimize duplication of effort. They would be of considerable help in collecting samples in remote areas for use in added documentation of islands impossible to reach by transportation used by JTF 8.

c. One of the major problems encountered in the off-site program was transportation to Washington and Fanning Islands. The use of LTS's was very inadequate for shipment of samples as well as for rotation of personnel. It was estimated during this operation that 4000 foot air strips could be constructed on these islands at a cost of just a few hundred dollars utilizing local native labor. The efficiency of the JTF 8 Radsafe mission could be improved if these air strips, with necessary service, were provided.

d. A most valuable item utilized during the operation was good voice communication via the ECHO network with the stations on Fanning, Washington, Penrhyn, and Palmyra. This should be maintained with possible expansion to include Johnston Island and Honolulu, Hawaii.

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e. It is recommended that the same close cooperation be maintained with the Hawaii State Health Department. This was invaluable during the operation for keeping the people of Hawaii informed of the radiological situation within the State. The maintenance of the laboratory in Hawaii is definitely recommended for ease of operation and reliability of results. In this regard, the expansion of the facility to include a radio-chemical laboratory would be very valuable for future operations. This would replace the radio-chemical trailer which is, at best, costly to establish, ship, and maintain for short periods of time.

f. It is recommended that the operation of the off-site stations be modified to include the following:

(1) All stations within 500 miles of the test site should be equipped with High Volume air samplers, AN/PDR-27Js, and precipitation collectors. All stations outside the 500 mile radius should be equipped with low volume air samplers, ion exchange resin type precipitation collectors, and AN/PDR-27Js. The RM-5 should be used only if an experienced operator is available such as on USPHS manned islands.

(2) This modification would give the best documentation at a minimum of effort by groups who are understandably inexperienced in sample collection. The air sampler would be a type that would require no maintenance or calculations. These air samples would be collected every 3 or 4 days, and counted in the low background counters at the laboratory. In this way, good documentation is obtained with a reasonable sample load. The ion exchange resin type precipitation collector would require only the removal of the resin columns once each week and mailed to the laboratory. This eliminates handling water containers and estimating rainfall collection, but still give good documentation of deposition of radioactive material by wet and dry fallout. The 27J is the best instrument for external gamma radiation measurements. Four readings daily would give all the information necessary in evaluating exposures.

2. It is felt that this particular type program is the best and most efficient one that could be used, based on experience gained during Operation DOMINIC. The policy of releasing radiation information to local officials should be maintained during future operations.

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ANNEX A

TO APPENDIX A OF ENCLOSURE N

RADIOLOGICAL HEALTH LABORATORY - HAWAII

1. Laboratory Facilities in Honolulu

a. Additional support for radiological analysis of food, water, and air samples was provided by a complete laboratory facility in Honolulu, Hawaii. The laboratory was located in Hawaii to support both the Christmas Island and Johnston Island operations, and to insure a low radiation background installation, making possible complete and accurate radio-chemistry analysis of environmental samples. (An account of this laboratory's efforts is documented in the reference: Part 2, page N-B-16). Support facilities for film badge dosimetry were also installed in the laboratory which was located in the Hawaii State Health Department Building. The Hawaii State Health Department made this space available under an agreement whereby JTF 8 would install all equipment and provide all utilities. The laboratory was under the direction of a USPHS officer. The laboratory was augmented by a rad-chem trailer which was on loan from the U.S. Army Chemical Corps Nuclear Defense Laboratory. In preparation for its use in off-site support, a suitable modification and rehabilitation was necessary prior to shipment from the parent laboratory. Costs incident to rehabilitation and shipment were met by JTF 8 radsafe funds.

b. This laboratory, which supported the JTF 8 Off-site Surveillance Program of documenting radiation exposure to off-site populations during Operation DOMINIC, was established at Honolulu, Hawaii to provide a facility for the radio-chemical analysis of air, precipitation, water, milk, food, and soil. The USPHS, working with the Hawaii State Health Department, expanded the existing Hawaiian Surveillance Network Program so as to provide an extensive fallout monitoring program. As a consequence of these two programs, CJTF 8 was provided with a strong capability of assessing radiation for public confidence. The results indicated that fallout encountered was minimal, with no significant exposure occurring to populated groups inside or outside the danger area.

c. A post-operational surveillance activity in the Pacific area was continued by JTF 8 under arrangement with USPHS, whereby USPHS continued to retain on a loan basis JTF 8 owned laboratory equipment. The Radiological Health Laboratory-Hawaii was relocated to Damon Tract, and continued to be maintained in a state of minimum operation in order to carry out this long term (1 Yr) surveillance.

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(1) The conviction to retain this laboratory was supported by:

(a) The USPHS had performed analysis on pre-operational food samples collected from several inhabited islands surrounding the testing area. Consequently it appeared prudent that subsequent sampling should be performed for a least a year following termination of the test series, i.e., as new food crops came in.

(b) Dismantling of the laboratory and storage of the equipment would be costly and it was probable that any electronics equipment put into storage and not used would deteriorate seriously. Various pieces of equipment utilized by the laboratory are owned by JTF 8, the AEC, and the USPHS.

(c) The maintenance of a laboratory capability at the proposed location would continue the congenial relationship with the Hawaii State Health Department. The building facility for the laboratory was provided by the USAEC.

d. Results - As far as can be determined from existing monitoring data and investigations of reported incidents, no hazardous fallout occurred to populated areas or to transient surface craft and aircraft as a result of Operation DOMINIC. A complete documentation of all radiation levels is contained in Reference: Part 1, on page N-B-16.

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ANNEX B TO APPENDIX B

MEMORANDUM OF UNDERSTANDING

Between

JOINT TASK FORCE EIGHT OF THE DEPARTMENT OF DEFENSE
AND
PUBLIC HEALTH SERVICE OF THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

1. Program

Joint Task Force Eight of the Department of Defense (JTF-8) and the Public Health Service of the Department of Health, Education, and Welfare (PHS) hereby agree that the PHS will provide assistance to JTF-8 in staffing and planning a radiological safety program for inhabited areas; and assist in operating said program during tests of nuclear devices when such tests are authorized by the President. The nature and extent of the services to be provided under this agreement are described below in "2. Scope of Work" which may be modified by mutual agreement from time to time as circumstances warrant.

2. Scope of Work

The Public Health Service will provide the necessary equipment and qualified radiological safety personnel to be on duty at such sites as required by JTF-8 during the operational phase:

a. When deemed necessary, a PHS officer will act as a JTF-8 Task Force Detachment Commander and provide radiological safety surveillance for any designated inhabited areas.

b. The PHS will operate a fallout information center (FOIC) within Hq, JTF-8, with functions to include, but not be limited to:

(1) Providing displays of current air and surface radexes, radiological situation maps, and such allied data as may be appropriate.

(2) Assisting in providing technical advisory assistance to CJTF-8, Task Group Radiological Safety Officers, and to certain other agencies as may be required.

(3) Furnishing estimates of expected fallout in inhabited areas based on reports from aerial monitoring, cloud tracking aircraft, and any other appropriate sources.

(4) Arranging for instrumentation on and receiving radiological data from installations such as Weather Stations in inhabited areas.

(5) Documenting and reporting on fallout reaching inhabited areas.

(6) Provide, staff and operate a radiological safety laboratory to carry out necessary analyses for support of any radiological safety operations.

3. Funding

It is the intention of the parties hereto that JTF-8 will pay for all actual costs incurred by the PHS in the performance of the work covered by this agreement; provided, that the total amount to be paid by JTF-8 shall not exceed an estimated cost of $100,000 for Operation DOMINIC: provided further, that following any revision of "2. Scope of Work" this estimated cost may be revised by mutual consent. The PHS will bill for such actual costs on SF-1080 and will be reimbursed by JTF-8.

4. Security

In the performance of work under this agreement, the PHS shall, in accordance with Atomic Energy Commission and Department of Defense security regulations and requirements, safeguard Restricted Data and other classified matter and protect against sabotage, espionage, loss and theft of classified documents, materials, equipment, processes, etc., which may be in the possession of the PHS or its personnel in performance of work under this agreement.

5. General

a. Insofar as practical, JTF-8 will provide facilities, equipment and services necessary to carry out activities included under "Scope of Work."

b. The services to be performed under this agreement will be under the overall general supervision of the Assistant Chief of Staff, J-3 (Operations & Plans), JTF-8.

c. Any utilization, dissemination, or public release of information derived from activities under this agreement will be in accordance with policies prescribed by JTF-8.

6. Period of Agreement

This memorandum of understanding will become effective on the date when approval has been subscribed hereon by representatives of both the PHS and JTF-8. It shall remain in effect until terminated by either party hereto upon sixty (60) days written notice to the other party.

For Joint Task Force Eight of the Department of Defense:

Date: 31 JAN 1962 APPROVED: Alfred D. Starbird

ALFRED D. STARBIRD
Major General, USA
Commander

For the Public Health Service of the Department of Health, Education and Welfare:

Date: 2/5/62 APPROVED: R J Anderson

ROBERT J. ANDERSON
Assistant Surgeon General
Deputy Chief, Bureau of State Services

MEMORANDUM OF UNDERSTANDING

Between

JOINT TASK FORCE EIGHT OF THE DEPARTMENT OF DEFENSE
AND
PUBLIC HEALTH SERVICE OF THE DEPARTMENT OF HEALTH,
EDUCATION, AND WELFARE

In accordance with Paragraph 1, PROGRAM, of the Memorandum of Understanding between Joint Task Force Eight of the Department of Defense and the Public Health Service of the Department of Health, Education, and Welfare, it is requested that Paragraph 3, FUNDING, be modified in the following particulars: 1) the amount of $100,000 was an estimated amount, and a more realistic projection based on experience gained and also a need for additional personnel with their attendant expenses necessitates requesting an additional $30,000 for Fiscal Year 1962, making a total for Fiscal Year 1962 of $130,000, and 2) that $100,000 be made available to carry out Paragraph 2, SCOPE OF WORK, in Fiscal Year 1963. The services covered in SCOPE OF WORK will remain unchanged in Fiscal Year 1963.

The Public Health Service will continue to bill for actual costs on Standard Form 1080.

Please indicate your approval by executing three copies of this letter of agreement and returning them to us. There are two copies enclosed for your retention.

For Joint Task Force Eight of the Department of Defense:

Date: 15 June 1962 APPROVED: [signature]

For the Public Health Service of the Department of Health, Education, and Welfare:

Date: _____ APPROVED: [signature]
for ROBERT J. ANDERSON
Assistant Surgeon General
Deputy Chief, Bureau of State Services

MODIFICATION NO. 2
MEMORANDUM OF UNDERSTANDING
between
JOINT TASK FORCE EIGHT OF THE DEPARTMENT OF DEFENSE
AND
PUBLIC HEALTH SERVICE OF THE DEPARTMENT OF HEALTH,
EDUCATION, AND WELFARE

In accordance with Paragraph 1, PROGRAM, of the Memorandum of Understanding between Joint Task Force Eight of the Department of Defense and the Public Health Service of the Department of Health, Education, and Welfare, dated February 5, 1962, it is requested that the following be incorporated as Modification No. 2 of the Memorandum of Understanding. Paragraph 2, SCOPE OF WORK, be modified by the addition of the following:

> Section (7). Maintain the capability of long-term postoperational surveillance to include operation of the laboratory in Honolulu, Hawaii, until December 31, 1963. Equipment procured with JTF-8 funds will be placed on a loan basis with PHS for use in this laboratory.

Paragraph 3, FUNDING, be modified in the following particular:

> The funding of FY 1963, originally at $100,000 by Modification No. 1, be increased by $30,000 to a new total of $130,000. This increase will cover operational support expenses until December 31, 1962, and postoperational support of the surveillance laboratory in Honolulu until December 31, 1963.

The remaining sections of the Memorandum of Understanding will remain in effect unchanged. The Public Health Service will continue to bill for actual costs on SF 1060.

Please indicate your approval by executing three copies of this modification and returning them to us. There are two copies enclosed for your retention.

For Joint Task Force Eight of the Department of Defense:

Date: Oct 16, 1962 APPROVED: /s/ Thomas L. Mann
Col, GS
Chief of Staff

For the Public Health Service of the Department of Health, Education, and Welfare:

Date: Oct 12 1962 APPROVED: /s/ R. J. ANDERSON
ROBERT J. ANDERSON
Assistant Surgeon General
Chief, Bureau of State Services

ANNEX C

TO APPENDIX B OF ENCLOSURE N

ANNEX J TO CJTF 8 OPLAN 2-62
RADIOLOGICAL SAFETY OPERATIONS

1. General.

a. Radiological Safety of all task force military and civilian personnel is a command responsibility, and radiological safety activities will be performed through normal commmand channels.

b. Each task group and task unit concerned will be responsible for furnishing qualified monitors for all working parties entering areas where exposure to radiation is probable. Regardless of their organization, monitors will be responsible directly to their party leaders as advisors on matters pertaining to radiological safety.

2. The Commander, Joint Task Force Eight, will:

a. Assume overall responsibility for the radiological safety of task force personnel.

b. Inform CINCPAC of hazards which may develop in areas outside the task force responsibility.

c. Establish and maintain radiological monitoring stations on certain populated islands, utilizing existing weather and U.S. Public Health Service installations where possible.

d. Subsequent to each detonation occurring in the atmosphere, announce R-Hour (R Hour is the earliest time after a detonation that general re-entry can commence to all areas except the Radiological Exclusion Area (RADEX)).

3. The Radsafe Branch, J-3, JTF 8, will:

a. Provide the following radiological safety services for operations associated with contaminated areas or facilities:

(1) Maintain a current plot of areas of radioactivity.

(2) Provide necessary equipment, such as disposable clothing and radsafe survey instruments, for support of operations in contaminated areas.

(3) Provide dosimetry services for all task force personnel and authorized visitors to include the issuance and processing of film badges and the maintenance of required exposure records.

b. Advise and assist task force personnel as required in the decontamination of equipment.

c. Operate a radiochemistry laboratory capable of supporting off-site radsafe monitoring stations and any other radsafe operations.

d. Provide trained personnel, as available, to assist CJTG 8.3 and CJTG 8.4 in the accomplishment of their assigned radsafe responsibilities.

4. The Commander, Joint Task Group 8.3, will:

a. Be responsible for the radiological safety of all personnel assigned or attached to this Task Group, including MSTS ships.

b. Provide monitors and decontamination crews aboard each ship in accordance with normal ship organization, including MSTS ships.

c. Establish and maintain Radsafe Centers as required for afloat operations in contaminated areas.

d. Provide aircraft support, to include helicopters, as required for radiological surveys, cloud tracking, and any other post-shot radsafe operations.

e. Require Radsafe Reconnaissance and Barrier Patrol Aircraft to make pertinent reports through the appropriate CIC/AOC in accordance with the Communications and Reporting Annexes of CJTG 8.3 Operation Order.

f. Establish and maintain radsafe monitor and decontamination services for any aircraft and crew assigned to any element of JTF 8 as it becomes necessary.

5. The Commander, Joint Task Group 8.4, will:

a. Be responsible for the radiological safety of all personnel assigned or attached to this Task Group.

b. Provide aircraft support as required for cloud tracking and any other post-shot radsafe operations.

c. Establish and maintain radsafe monitor and decontamination services for all aircraft and crews assigned to any element of JTF 8 as required.

d. Provide crews and monitoring services for the removal of radioactive samples collected by aircraft.

e. Operate the Sample Return Compound, to include the monitoring necessary for the removal and packaging of all radioactive sources and samples.

f. Require Radsafe Reconnaissance and Barrier Patrol Aircraft to make pertinent reports through the appropriate CIC/AOC in accordance with the Communications and Reporting Annexes of CJTG 8.4 Operation Order.

g. Provide for the reporting of approximate air radiation intensities encountered on regularly established weather reconnaissance or cloud tracking flights operating out of Christmas Island.

h. Provide for the reporting of radiation intensities encountered at certain designated outlying weather stations. Necessary radsafe equipment will be furnished by CJTF 8.

i. Establish and maintain Radsafe Centers as required. On Christmas Island, the Radsafe Center will provide the following services to all JTF 8 personnel:

(1) Radiological surveys if necessary.

(2) Operate radsafe instrument maintenance and repair as required.

(3) Maintain personnel decontamination facilities as required.

(4) Maintain a Plutonium Decontamination Team as required.

6. The Commander, Joint Task Group 8.5, will:

a. Be responsible for the radiological safety of all personnel assigned or attached to this Task Group.

b. Assist the Radsafe Branch, J-3 Division, JTF 8, in providing the necessary radiological services for operations in contaminated areas as required, to include personnel and radsafe instruments and equipment.

c. Upon approval of CJTF 8, make available on requisition to all Task Groups and Task Units high density goggles and disposable clothing as required.

7. The Commander, each Task Unit, will:

a. Be responsible for the radiological safety of all personnel assigned or attached to his unit.

ALFRED D. STARBIRD
Major General, USA
Commander

OFFICIAL

/s/ H. E. PARSONS

H. E. PARSONS
Colonel, USAF
ACofS for Operations & Plans

N-B-3-3

APPENDIX 1 TO

ANNEX J TO OPLAN 2-62

RADIOLOGICAL SAFETY REGULATIONS

1. Hazards Control and Radiological Safety Center

a. A JTF 8 Hazards Control and a JTG 8.4 Radiological Safety Center (Radsafe Center) will be established and maintained. When required, a Radsafe Center will be established by JTG 8.3. The Hazards Control Center, composed of the Task Force Hazards Evaluation Branch, the Task Force Radsafe Branch, and the Fallout Plotting Center will operate collectively to discharge the Task Force responsibilities for effective operation of the off-site radsafe program, dissemination of shot briefing material and the maintenance of displays of radiological information. In addition, the Hazards Control Center will operate the Photodosimetry Facility. The Radsafe Center will be established by CJTG 8.4 and will serve as operations headquarters for the radiological safety activities of JTG 8.4

b. Detailed Duties

(1) Hazards Control Center will:

(a) Be responsible for the preparation of radsafe forecast information (fallout plot, surface and air RADEX) for each event.

(b) Disseminate the air and surface RADEX prior to shot time (forecast), and will originate messages from time to time after shot time announcing R (Reentry) hour, radiological clearances of previously closed areas, radiological directives to task groups, advisories to commands external to the Task Force and revisions of the air and surface RADEX, as required.

(c) Maintan displays of radiological information pertinent to the test area, and having an impact outside this area to include RADEX information, cloud trajectories and their relation to occupied islands, air and surface routes contiguous to the danger area, ship movements in the danger area, and such other items of special radiological consideration as may be required by the operation of scientific projects.

(d) Be responsible for advice on and prediction of thermal radiation and blast overpressure effects, and such other effects as may be important, on various elements within range of

each test device. This will include such vulnerable elements as plants and tree stands, man-made structures, equipment and material, and personnel under varying degrees of protection.

(e) Be physically located in the Operations Division (J-3), Headquarters, JTF 8.

(2) Radsafe Center, JTG 8.4

(a) The Radsafe Center will maintain control of contaminated areas and keep current information with regard to any contaminated area. The Radsafe Center will have cognizance over decontamination of aircraft and equipment, operation of the contaminated laundry, personnel decontamination facilities, provide the necessary disposable clothing for personnel working in contaminated areas, and establish and maintain a radsafe instrument repair facility.

(b) In the event that reentry into contaminated land areas is required, the Radsafe Center will provide information for the planning of radsafe operations and the disposition of all working parties within the contaminated area. The Radsafe Center will establish and maintain check points for the control of entry into contaminated areas as required.

(3) Radsafe Center, JTG 8.4:

(a) The Radsafe Center will maintain control of contaminated areas afloat and keep current information with regard to any contaminated ship or area. The Radsafe Center will have cognizance over the planning of radsafe operations and the disposition of all working parties within the contaminated area. The Radsafe Center will establish and maintain check points for the control of entry into contaminated areas, will provide the necessary disposable clothing and radsafe instruments for personnel working in contaminated areas, and provide personnel decontamination facilities as required.

2. General

a. Radiological Defense (RadDefense) Operations or Radiological Safety (Radsafe) Operations, short term RadOps, are general terms. They are used to denote the means by which a unit can control and confine damage and radiological effects of an atomic explsosion or of avoiding health hazards to personnel. They are interpreted to include measures such as training, organization, distribution of radiological personnel, development of techniques and procedures, use of detecting equipment, protection or removal of exposed personnel and decontamination of personnel, structures and equipment.

b. Following each detonation there will be areas of radiological contamination. These areas are designated as Radiological Exclusion Areas (RADEX). Prior to shot time, forecast RADEX will be disseminated by CJTF 8. These RADEXES will represent a forecast from H-Hour until dissemination of a later RADEX at about H plus 6 hours, or earlier. The later RADEXES will be based upon the master radiological situation map maintained in the JTF 8 Hazards Control Center. Since the air RADEX after shot times will be based on monitored tracking by aircraft over significant large ocean areas, information promulgated from the forecast air RADEX may have to be extended beyond the originally anticipated six hour period.

c. If it becomes necessary, a surface RADEX will be determined by actual survey with Radiation Detection Indication and computation (RADIAC) equipment. Aircraft and vehicles as required will be used to accomplish these surveys. Water samples will be utilized if deemed necessary.

3. The Maximum Permissible Exposure (MPE's) and Maximum Permissible Limits (MPL's) as stated herein are applicable to a field experimental test of nuclear devices in peace time wherein numbers of personnel engaged in these tests have been previously exposed or will be continuously exposed to potential radiation hazards. It may become necessary from a study of personnel records to reduce the MPE for certain individuals who have recently been over-exposed to radiation.

4. Due to the special nature of field tests, it is considered that a policy of strict adherence to the radiological standards prescribed for routine work is not realistic. The regulations set forth herein have been designated as reasonable and safe compromise considering conservation of personnel exposure, the international importance of the test and the cost aspects of operational delays chargeable to excessive radiological precautions. In all cases other than emergencies or tactical situations the ultimate criteria will be limited by the MPE's for personnel. Special instances may arise such as in the case of an air-sea rescue within the RADEX in which operations will be carried out without regard to the MPE's and MPL's prescribed herein.

5. All task force personnel will be required to wear film badges. Certain cases may arise, such as outlying stations, where such a requirement may not be practical. Task Force radiation dosage control will start with the first shot and terminate upon departure of individuals from the forward area, or on the last shot plus seven days, whichever occurs first. Subsequent to this period, any radiation dosage control that may be found necessary will be prescribed by CJTG 8.5.

6. MPE

a. MPE for personnel participating in this operation is 3.0 roentgens (gamma only) per consecutive 13 week period, with a maximum of 5.0 r for the calendar year. Individuals 18 years old may receive no more than 1.25 r per 13 week period during their 19th year. No individual who has not reached his 18th birthday by 1 May 1962, shall be occupationally exposed to any ionizing radiation.

b. A special MPE of 20 roentgens (gamma only) is authorized for the operational period for air crews, maintenance crews and recovery crews associated with air-sampling aircraft. Any dose in excess will be properly accounted for in writing by the Commander of the unit.

7. Authorization for individual exposures in excess of the established MPE will be granted only by the Commander, JTF 8 and only in specific cases for which operational requirements provide justification. Any dose in excess of the specified roentgen total will be considered as an over-exposure and will be properly accounted for in writing by the Commander of the unit.

8. Personnel whose previous radiation dose history indicates that the total accumulated dose 1 January 1962 is equal to or in excess of the age-prorated dose (defined as 5 (N-18) rem where "N" is the age in years) will under no conditions be allowed to receive a total dose in excess of 5 rem under the conditions of para 6.a. and b., and provided his total accumulated dosage does not or will not exceed 60 rem on his 30th birthday.

9. Those individuals exposed to ionizing radiation in excess of the value computed by para 6.a. above will be informed that appropriate remarks will be included in their medical records. Military personnel in this category will be advised that they should not be exposed to further radiation until sufficient time has elapsed in order to bring their average radiation dose down to 0.1 roentgens per week. Civilian personnel in this category will be as determined by the laboratory or agency having administrative jurisdiction over such personnel.

10. All land or sea areas in or near which a detonation takes place will be considered contaminated until cleared for operations by the Task Force Commander. Contaminated land and water areas will be delineated as such. Personnel entering these areas will be subject to clearance by the appropriate Radsafe Center and will normally be accompanied by a radsafe monitor. Clothing and equipment as required will be issued to personnel. Contaminated areas of intensities less than 10 mr/hr (gamma only) will be considered unrestricted from a radsafe standpoint. Areas coming within this limit will be designated specifically by CJTF 8 prior to unrestricted entry.

11. Radsafe monitors assigned to individuals or groups working in contaminated areas or with contaminated equipment will act in an advisory capacity to keep the party leader informed of radiation intensities at all times. The party leader is expected to accept this advice and act accordingly. It is the responsibility of both the leader and the members of the recovery party to adhere to the limits established in these regulations.

12. Dosimeter devices and protective clothing (coveralls, booties, caps, gloves, respirator, etc.) as deemed necessary will be issued to personnel entering contaminated areas by appropriate Task Group Radsafe Centers.

13. All personnel within viewing distance of an atomic detonation who are not supplied with protective goggles (4.025 neutral density goggles) will turn away from the detonation point and close their eyes during the time of detonation.

14. The arrival and proposed use of radioactive sources at Christmas Island will be reported to the Radsafe Officer, JTG 8.4.

15. Transportation of radioactive material to and from the forward area shall be in accordance with AEC regulations for escorted shipment of such material. The assignment of couriers and Radsafe monitors will be the subject of separate instructions. No radioactive material shall be removed from the test sites except as authorized in experimental projects.

16. All samples of radioactive material which are couriered in aircraft will be packaged and loaded so as to reduce radiation to a minimum. Prior to departure of such aircraft, Sample Return Director, JTF 8, will have a survey made of the aircraft cargo to determine if adequate precautions have been taken. The following criteria will determine space and packaging requirements:

a. Prior exposure of aircraft crew, courier and passengers.

b. Anticipated future exposure on trip, considering length of trip, compartmental loading requirements and capability to isolate personnel from radioactive material.

17. All air and surface vehicles or craft, used in contaminated areas will be checked through the appropriate task group decontamination section upon return from such areas.

18. The MPL's listed herein are to be regarded as advisory limits for control under average conditions. All readings of surface contamination are to be made with Geiger Counters, with tube walls not substantially in excess of 30 mg/cm^2 with shield open unless otherwise specified. The surface of the probe should be held one inch to two inches from the

surface that is under observation unless otherwise specified. For operational purposes the contamination MPL's presented below will not be considered applicable to spotty contamination provided such areas can be effectively isolated from personnel.

a. Personnel and Clothing MPL's

(1) Skin readings should not be more then 1.0 mr/hr. Complete decontamination by bathing will be utilized for readings in excess of this level. If the body is generally contaminated and especially if contamination is on the eyes or gonads, special efforts should be made to reduce the contamination level. In general, however, it is not considered profitable to abrade the skin or epilate the scalp in an attempt to reduce stubborn contamination below 1 mr/hr (about 1000 cpm).

(2) Underclothing and body equipment such as the internal surfaces of respirators should be reduced to 2 mr/hr.

(3) Outer clothing should be reduced to 7 mr/hr.

b. Vehicle MPL's

(1) The interior surfaces of occupied section of vehicles should be reduced to 7 mr/hr (5 mr/hr if using AN/PDR-27J for monitoring instrument). The outside surfaces of vehicles should be reduced to less than 7 mr/hr (gamma only - shield closed) at five to six inches from the surfaces.

c. Ship and Boat MPL's

(1) Ship and boat MPL's cannot be quantitatively established. They are dependent upon location of contamination, use of space, personnel hazards, etc. Specified instruction will be issued by CJTG 8.3 upon reporting of contamination.

(2) For ships and boats operating in contaminated waters, reasonable allowance will be made to differentiate between the relative contribution to the total flux from fixed contamination and that due to "shine" from contaminated waters.

(3) In general, ships and boats operating in waters near shot sites after shot times may become contaminated. Monitors shall be aboard all such craft operating after shot time, either as passengers or members of the crew, until such time as radiological restrictions are lifted.

(4) At the conclusion of the operation, final clearances will be granted by task group commanders or by commanding officers, if so ordered, to those ships and boats showing no point of contamination greater than 15 mr/day (beta and gamma) and no detectable alpha. Other ships and boats will be granted operational clearances by task group

commanders or by commanding officers if so ordered. An operational clearance implies that contamination exists and that special procedures as necessary are instituted aboard ship.

(5) Individuals on board ships of the Task Force shall be protected collectively from hazards of blast, heat and radioactivity by movement and positioning of ships.

(6) Ships with personnel aboard will not be placed inside the 1.0 psi line unless specifically directed otherwise. Bearings of danger from immediate radioactive fallout for ships operations will be established by CJTF 8 on the basis of forecast wind directions at the intended time of detonation.

d. Aircraft MPL's

(1) The interior surfaces of occupied sections of aircraft should be reduced to 7 mr/hr.

(2) No aircraft in the air at H-Hour will be at slant ranges from ground zero less than as determined by the following effects unless specifically directed otherwise. (Based on maximum predicted yield and 20 mile visibility)

(a) Blast (at predicted shock arrival): 0.5 psi.

(b) Thermal (H-Hour): Fabric control surfaces: 1.0 cal/cm^2

Metal control surfaces: 6.0 cal/cm^2

(3) After detonation no aircraft shall operate inside the air RADEX, or closer than 10 nautical miles from the rising or visible cloud, unless specifically directed otherwise. Non-expected aircraft involved in routine operations encountering unexpected regions of aerial contamination will execute a turnout immediately upon detecting such contamination. Cloud tracking aircraft will execute turnout from contaminated areas at a level of not more than 3.0 r/hr. If a tactical or emergency situation arises where aircraft must enter the air RADEX or visible cloud, tactical exposure allowances shall apply.

(4) All multi-engine task force aircraft in the air at H-Hour within 100 miles of the detonation point shall carry a person designated as radiological safety monitor, equipped with suitable radiac

equipment and a RADEX plot. This monitor shall be capable of calculating allowable exposures under both tactical and operational conditions.

(5) All persons in aircraft at shot time, or at subsequent times, shall wear film badges when engaged in operations in or near the cloud or RADEX track.

(6) Crew members of aircraft in the air at zero hour will take special precautions to avoid (for at least 10 seconds) the direct and reflected light resulting from the burst, at the discretion of the airplane commander. This may be accomplished by protective high density goggles, by turning away from the burst with eyes closed, by covering the eyes with forearms, by turning cockpit lights up to highest intensity, or by any combination of the above.

19. In air and water the following continuous levels of radioactivity are considered safe from the standpoint of personnel drinking and breathing (uc-microcurie):

Water: Beta-Gamma Emitter
10^{-3} uc/cc (calculated to H plus 3 days)

Air: Fission Products
10^{-7} uc/cc

20. The Radsafe Officer, Hq, JTF 8 will maintain standard-type film badge records of radiation exposures for all task force personnel. Records will indicate full name, rank or rate, serial or service number, social security number, organization, home station or laboratory, date of exposure and remarks such as limitations on assignment because of over-exposure. Upon completion of the operation, disposition of these records will be as follows:

a. A consolidated list of exposure listing all personnel in the Task Force by full name, rank or rate, serial or service number, social security number, organization, home station or laboratory, and exposure in milli-roentgens will be forwarded to Chief, DASA.

b. A consolidated list of personnel and exposure, as indicated in para 20.a. above will be forwarded to the Director, Office of Operational Safety, AEC.

c. A consolidated list of personnel and exposure of each task group will be forwarded to each Task Group Commander. Further distribution will be specified at a later date.

d. All exposed film badges, calibration films and curves, and cumulative dosage record cards for all personnel in JTF 8 will be forwarded by Radsafe Officer to the Superintendent, Radsafe Division, Reynolds Electric and Engineering Company, Mercury, Nevada for permanent retention and storage.

21. Training

a. The inclusion of radiological safety organizations throughout the Task Force will require two general levels of training: Basic Indoctrination and Technical Training. The scope of instruction within each of these levels will vary in accordance with the requirements of different operational and staff levels. Basic indoctrination will include primary non-technical instruction in radiological safety measures and techniques. This must be imparted to all personnel of the Task Force to enable them to perform their assigned duties efficiently within the allowable low exposures regardless of the presence of radioactive contaminants. Technical training will include the training of the majority of the personnel who will be required to staff the Task Force Radiological Safety Organizations and perform the technical operations involved. This will be accomplished through the utilization of existing service courses and establishment of suitable courses at task group levels. This instruction will be designed to train radiological defense monitors, decontamination personnel and radiological instrument repairmen.

22. These regulations have the concurrence of the Surgeon General, USA; Chief Bureau of Medicine and Surgery, USN; the Surgeon General, USAF; and the Director, Division of Operational Safety, AEC.

ALFRED D. STARBIRD
Major General, USA
Commander

OFFICIAL: /s/ R. J. BIGART

for H. E. PARSONS
Colonel, USAF
ACofS for Ops & Plans

[redacted]

APPENDIX C TO ENCLOSURE N

to

CJTF 8 REPORT OF 1962 PACIFIC NUCLEAR TESTS

DISTRIBUTION

DOD ACTIVITIES:

Secretary of Defense	1
Deputy Secretary of Defense	1
Dir of Defense Research & Engineering	1
Assistant to Secretary of Defense (Atomic Energy)	3
Chairman, Joint Chiefs of Staff	4
Commander-in-Chief, Atlantic	1
Commander-in-Chief, Pacific	1
Director, Defense Atomic Support Agency	9
Commander, Field Command, Defense Atomic Support Agency	1
Director, Defense Communications Agency	1

AEC ACTIVITIES:

Chairman, U.S. Atomic Energy Commission	4
Director, DMA, USAEC	2
Nevada Operations Office, USAEC	2
Albuquerque Operations Office, USAEC	1
San Francisco Operations Office, USAEC	1
Honolulu Branch Office, USAEC	1
Director, Los Alamos Scientific Laboratory	4
Director, Lawrence Radiation Laboratory	4
President, Sandia Corporation	4

US ARMY ACTIVITIES

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Ass't Secretary of the Army (R&D)	1
Chief of Staff, U. S. Army	1
Deputy Chief of Staff, U.S. Army	1
Asst Chief of Staff, Intelligence, U. S. Army	1
Chief, Research and Development Command, U.S. Army	1
Commander-in-Chief, USA Pacific	3
Commanding General, Continental Army Command	1
Commanding General, USA Material Command	1
Commanding General, USA Missile Command	1

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US AIR FORCE ACTIVITIES:

Secretary of the Air Force	1
Ass't Secretary of the Air Force (R&D)	1
Chief of Staff, U.S. Air Force	35
Commander-in-Chief, SAC	1
Commander-in-Chief, PACAF	1

US NAVY ACTIVITIES:

Secretary of the Navy	1
Under Secretary of the Navy	1
Ass't Secretary of the Navy (R&D)	1
Chief of Naval Operations	1
Commandant, U.S. Marine Corps	1
CNO - OP-09	1
CNO - OP-90	1
CNO - OP-93	1
CNO - OP-95	1
CNO - OP-03	1
CNO - OP-04	1
CNO - OP-05	1
CNO - OP-06	1
CNO - OP-07	1
CNO - OP-75	1
CNO - OP-09E (Naval Warfare Analyses)	1
CNO - OP-03EG(Dir Operations Evaluation Gp)	1
Commander-in-Chief, Atlantic Fleet	1
Commander-in-Chief, Pacific Fleet	1
Commander, MSTS	1
Commanding General, Fleet Marine Force, Pacific	1
Chief of Naval Personnel	1
Chief of Naval Material	1
Chief of Naval Research	1

TASK FORCE ACTIVITIES:

Commander, Joint Task Group 8.3	1
Commander, Joint Task Group 8.4	1
Commander, Joint Task Group 8.6	1

[redacted]