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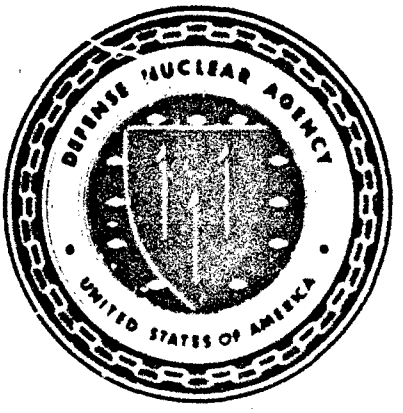
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United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

Prepared by the Defense Nuclear Agency as Executive Agency
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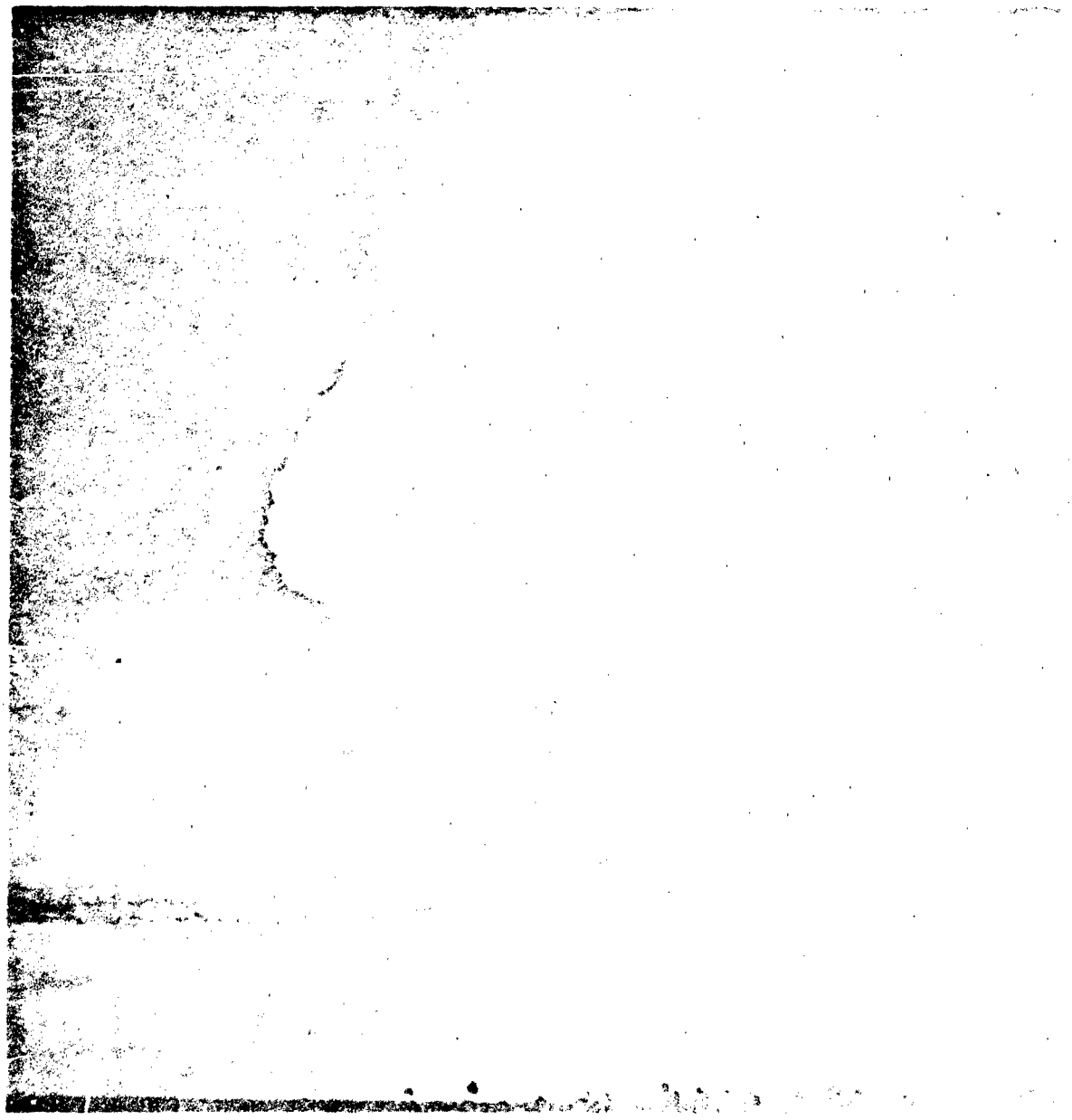
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Nuclear Test Personnel Review (NTPR)	FISHBOWL	TIGHTROPE
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Johnston Island	STARFISH	SWORDFISH
ASROC	BLUEGILL	(Continued)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
DOMINIC I was an atmospheric nuclear weapons test series conducted in the Pacific Ocean area in 1962. It included 5 high-altitude shots at Johnston Island, 29 airdrop airburst events near Johnston and Christmas Islands, one Polaris-launched airburst in the Christmas Island area, and one underwater test in the Pacific Ocean off the United States West Coast. This is a report on DOD personnel with an emphasis on operations and radiological safety.

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19. KEY WORDS (Continued)

FRIGATE BIRD	CHETCO	OTOWI
ADOBE	TANANA	BIGHORN
AZTEC	NAMBE	BLUESTONE
ARKANSAS	ALMA	SUNSET
QUESTA	TRUCKEE	PAMLICO
YUKON	YESO	ANDROSCOGGIN
MESILLA	HARLEM	BUMPING
MUSKEGON	RINCONADA	CHAMA
ENCINO	DULCE	CALAMITY
SWANEE	PETIT	HOUSATONIC

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FACT SHEET

DOMINIC I was a series of 36 atmospheric nuclear weapon detonations held in the Pacific Ocean area from April to November 1962. These detonations are listed on the table on the following page. They, and the continental DOMINIC II tests, were the last atmospheric nuclear weapon tests conducted by the United States.

Most of the DOMINIC I test shots were detonated in the air after having been dropped from a B-52 bomber. Twenty-four of the airdrops took place from 25 April through 11 July over the ocean just south of Christmas Island. This island is a United Kingdom possession located 1,200 nmi (2,224 km) south of Honolulu. Five more airdrops were detonated in October over the open ocean in the vicinity of Johnston Island, a United States possession 780 nmi (1,445 km) west-southwest of Honolulu. These tests were conducted for the purpose of weapon development. Five high-altitude bursts (up to 400 km) were lofted by rockets from Johnston Island and were designated the FISHBOWL events. These events were for the purpose of studying the effects of nuclear detonations as defensive weapons against ballistic missiles. In addition, the Navy conducted two nuclear tests in the open ocean, the first on 4 May about 435 nmi (806 km) east of Christmas Island and the second on 11 May 370 nmi (686 km) southwest of San Diego, California. The first, called FRIGATE BIRD, was a missile-launched airburst, a proof test of the Polaris weapon system, launched from the submarine, USS Ethan Allen (SSBN-608). The second, called SWORDFISH, was the test of the Navy ASROC system, a rocket-launched antisubmarine nuclear depth charge.

As in previous test series in the Pacific, a joint military and civilian organization conducted these tests, Joint Task Force Eight (JTF 8). JTF 8 was made up of military personnel from all the services and civilians from the Department of Defense (DOD), the Atomic Energy Commission (AEC), the U.S. Public Health Service (USPHS), and contractor organizations. Commander JTF 8 (CJTF 8) was appointed by the Joint Chiefs of Staff (JCS) and reported to the AEC as well as the JCS.

CJTF 8 was assigned overall responsibility for radiation safety. The Radsafe Branch, located organizationally in the Operations and Plans Office of Headquarters JTF 8, was responsible for overall control of monitoring and decontamination, issuing radiological safety (radsafe) supplies and equipment, maintaining radiac instruments, procuring all film badges, developing and interpreting exposed badges, and maintaining cumulative radiation exposure records for everyone who was badged. These records were compiled and are extant in a document referred to as the Consolidated List of Exposures. This branch also managed an extensive offsite radiation surveillance network on 17 remote islands throughout the Pacific Ocean. Task groups, which were subordinate to JTF 8, had command responsibility for radiological safety within their organizations.

DOMINIC I detonations, 1962

Date	Test Name	Yield[a] and Remarks
Spring-Summer 1962 -- Weapon Development Airdrops South of Christmas Island (except as noted)		
25 Apr	ADOBE	Intermediate
27 Apr	AZTEC	Intermediate
2 May	ARKANSAS	Low megaton range
4 May	QUESTA	Intermediate
6 May	FRIGATE BIRD	Polaris proof-test, airburst in Christmas Island Danger Area
8 May	YUKON	Intermediate
9 May	MESILLA	Intermediate
11 May	MUSKEGON	Intermediate
11 May	SWORDFISH	ASROC proof-test, low-yield underwater burst 370 nmi (686 km) southwest of San Diego
12 May	ENCINO	Intermediate
14 May	SWANEE	Intermediate
19 May	CHETCO	Intermediate
25 May	TANANA	Low
27 May	NAMBE	Intermediate
8 Jun	ALMA	Intermediate
9 Jun	TRUCKEE	Intermediate
10 Jun	YESO	Low megaton range
12 Jun	HARLEM	Intermediate
15 Jun	RINCONADA	Intermediate
17 Jun	DULCE	Intermediate
19 Jun	PETIT	Low
22 Jun	OTOWI	Intermediate
27 Jun	BIGHORN	Megaton range
30 Jun	BLUESTONE	Low megaton range
8 Jul	STARFISH	FISHBOWL shot, 1.4 MT at 400 km over Johnston Island
10 Jul	SUNSET	Intermediate
11 Jul	PAMLICO	Low megaton range
Autumn 1962 -- Conducted in the Johnston Island Danger Area		
2 Oct	ANDROSCOGGIN	Intermediate-yield airdrop
6 Oct	BUMPING	Low-yield airdrop
18 Oct	CHAMA	Low megaton range airdrop
19 Oct	CHECKMATE	FISHBOWL shot, low-yield, tens of kilometers over Johnston Island
25 Oct	BLUEGILL	FISHBOWL shot, submegaton, tens of kilometers over Johnston Island
27 Oct	CALAMITY	Intermediate-yield airdrop
30 Oct	HOUSATONIC	Megaton range airdrop
1 Nov	KINGFISH	FISHBOWL shot, submegaton, tens of kilometers over Johnston Island
3 Nov	TIGHTROPE	FISHBOWL shot, low-yield, tens of kilometers over Johnston Island

Note:

[a]Low yield -- less than 20 KT; intermediate yield -- 20 to 1,000 KT.

Source: Announced United States Nuclear Tests, NVO-29 (Rev. 1), Office of Public Affairs, U.S. Department of Energy, Nevada Operations Office, January 1980.

Film badges were issued to everyone who was stationed on Christmas and Johnston islands and all Navy ships directly involved with the tests. Persons on remote islands monitoring for radiation or conducting experiments were not badged. Of the over 28,000 participants in DOMINIC, over 25,000 were badged. Badges were issued for extended periods to ensure that all possible exposure was recorded.

Because all but one of the shots were airbursts, there was little or no fallout problem and no residual radiation area around the surface zero. Although SWORDFISH, the underwater shot, produced no fallout it did create a short-lived radioactive base surge and a pool of radioactive water around the detonation. The base surge dissipated in less than an hour, and the pool dissipated after a few days.

In general, film badge readings were low. Only 842 (3 percent) of the 25,399 badged participants had an exposure greater than 0.5 roentgens (R). Of these, 56 exposures were over 3.0 R: 2 Army, 4 Navy and Navy civilians, 49 Air Force, and 1 other civilian. The established JTF 8 Maximum Permissible Exposure (MPE) was 3.0 R.

The two Army men with over 3.0 R exposure served with the unit that decontaminated the aircraft involved in cloud sampling and as such were authorized an MPE of 20.0 R. All the Air Force personnel over 3.0 R were associated with cloud sampling (crew, maintenance, sample removal, or decontamination) and were also authorized an MPE of 20.0 R before the operation started. The highest total exposure recorded in this group was 17.682 R; this was also the highest for the entire operation. There were 19 other Air Force exposures over 10.0 R.

The Navy personnel recording over 3.0 R were on USS Sioux (ATF-75), which was involved in collecting samples of weapon debris from the radioactive pool of water created by the underwater SWORDFISH shot. This group was allowed an MPE of 7.0 R.

Evidence exists that many of the badges worn by personnel during DOMINIC were defectively sealed and recorded density changes due to moisture, light, and heat in addition to nuclear radiation. A 1979-1980 reevaluation of 1,349 DOMINIC I film badges showed that 45 percent exhibited some damage related to light, heat, and age due to defective wax seals. Environmental damage was observed on 98 percent of the badges, which had a developed density equivalent of over 0.4 R (gamma). These findings show, for example, that one-third of the higher USS Princeton (LPH-5) exposures should actually read zero. The lack of any known activity during DOMINIC I that would result in exposures over 3.0 R except for Sioux and the high correlation between environmental damage and high dose readings indicate most of these readings are higher than the exposure actually received. Nevertheless, all personnel have been assigned the recorded exposure reading in records maintained by the Navy.

One of the Thor rockets being launched at Johnston Island with a nuclear payload burned on the launch pad. The high explosives in the nuclear warhead detonated spreading alpha contamination around the launch complex. It took several weeks to decontaminate and rebuild the launch complex. Stringent personnel safety measures were enforced during the cleanup. No one received significant contamination from this accident.

DOMINIC I exposures are summarized in the following table.

DOMINIC I Personnel Exposures

Organization	Number Badged	Number of Exposures (R) 0	0-1	1-3	Over 3	High (R)
Army	628	306	301	19	2	3.539
(%)		49	48	3	<1	
Navy	16,420	7,365	8,705	346	4	4.150
(%)		45	53	2	<<1	
Air Force	2,702	1,182	1,375	96	49	17.68
(%)		44	51	4	<2	
Marine Corps	589	209	376	4		2.29
(%)		35	64	<1		
DOD Agencies	350	140	209	1		1.37
(%)		40	60	<<1		
Other Government, Contractors, and Foreign	4,620	2,041	2,555	23	1	7.15
(%)		44	55	<1	<<1	
Total	25,309	11,243	13,521	489	56	17.68
(%)		44	53	2	<1	

Collective exposure was about 5,000 man-R and overall mean exposure was slightly less than 0.2 R.

PREFACE

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

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

In late 1977, the DOD began a study that provided data to both the CDC and the VA on potential exposures to ionizing radiation among the military and civilian personnel who participated in the atmospheric testing 15 to 30 years earlier. In early 1978, the DOD also organized a Nuclear Test Personnel Review (NTPR) to:

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

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

The information from which this report was compiled was primarily extracted from planning and after-action reports of Joint Task Force 8 (JTF 8) and its subordinate organizations. What was desired were documents that accurately placed personnel at the test sites so that their degree of exposure to the ionizing radiation resulting from the tests could be assessed. The search for this information was undertaken in archives and libraries of the Federal

Government, in special collections supported by the Federal Government, and by discussion or review with some participants.

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

JTF 8 exposure records had been microfilmed by the Reynolds Electrical and Engineering Company, Inc. and were used.

The work was performed under RDT&E RMSS B350079464 U99 QAXMK 506-09 H2590D for the Defense Nuclear Agency by personnel from Kaman Tempo. Guidance was provided by Mr. Kenneth W. Kaye of the Defense Nuclear Agency Biomedical Effects Office.

TABLE OF CONTENTS

		Page
FACT SHEET		1
PREFACE		5
LIST OF ILLUSTRATIONS		15
LIST OF TABLES		21
Chapter		
1	OVERVIEW	23
	Introduction	23
	Purpose	23
	Historical Perspective	23
	Report Organization	26
	Nuclear Tests and Radiation Exposures	27
	Experimental Program	29
	Weapon Development	29
	Yield Measurements	29
	Diagnostic Measurements	30
	Effects Experiments	31
	Test Sites	31
	Christmas Island	31
	Johnston Island	39
	Joint Task Force 8	43
	Joint Task Force 8 Headquarters	44
	Scientific Task Units	47
	Task Unit 8.1.1	47
	Task Unit 8.1.2	48
	Task Unit 8.1.3	48
	Task Unit 8.1.4	48
	Task Unit 8.1.5	48

TABLE OF CONTENTS (continued)

Chapter		Page
1 (continued)	Task Unit 8.1.6	48
	Task Unit 8.1.7	49
	Joint Task Group 8.3 (Navy)	49
	Joint Task Group 8.4 (Air Force)	49
	Task Unit 8.4.1	52
	Task Unit 8.4.2	53
	Drop and Diagnostic Element	53
	Air Control Element	53
	Aeronautical Systems Division Effects Element	53
	Helicopter Element	53
	Documentary Photography Element	53
	Weather Reporting Element	53
	Reconnaissance Element	53
	Task Unit 8.4.3	54
	High-Altitude Element	54
	Medical Test Element	54
	Calibration Test Element	54
	Task Unit 8.4.4	54
	Joint Task Group 8.5 (AEC Support)	56
	Task Unit 8.5.1 (H&N)	56
	Task Unit 8.5.2	58
	Task Unit 8.5.3	58
	Joint Task Group 8.6 (Johnston Island Base Command)	58
	Task Unit 8.6.1	58
	Task Unit 8.6.2	58
	Task Unit 8.6.3	58
	Task Unit 8.6.4	58
	Task Unit 8.6.5	59
	Task Element 8.3.9.6	59
	Task Unit 8.5.1	59

TABLE OF CONTENTS (continued)

Chapter		Page
1 (continued)	Joint Task Group 8.7 (Christmas Island Base Command)	59
	Temporary Task Groups	61
	Joint Task Force 8 Manning Summary	61
2	RADIOLOGICAL SAFETY	64
	Radiological Safety Organization and Tasks	64
	Hazards Control Center (Branch)	64
	Hazards Evaluation Branch	64
	Fallout Plotting Center	64
	Radsafe Branch	65
	Joint Task Group 8.3 (Navy)	66
	Joint Task Group 8.4 (Air Force)	68
	Joint Task Group 8.5 (AEC Support)	70
	Joint Task Groups 8.6 and 8.7 (Base Island Commands)	70
	Joint Task Groups 8.8 and 8.9	70
	Offsite Radiological Safety	70
	Radiological Safety Standards	71
	Radiological Safety Equipment	72
	Radiological Safety Training	75
	Radiological Safety Facilities	75
	Christmas Island	75
	Johnston Island	75
	Hawaiian Islands	75
	Dosimetry Program	77
	Pre-Event Safety Measures	78
	Hazard Zones	78
	Search Operations	81
	Air Operations	81
	Naval Operations	82
	Joint Task Force 8 Safety Committee	83
	Fallout Prediction	83

TABLE OF CONTENTS (continued)

Chapter		Page
2 (continued)	Weather Prediction	83
	Offsite Radiation Monitoring	85
	Canton Island	86
	Malden Island	86
	Penrhyn Island	86
	Palmyra Island	86
	French Frigate Shoals	86
	Radiation Protection Equipment Modification	87
	Evacuation and Reentry	87
	Protective Clothing	87
	Special Badging for Sampler Activities	91
	Checklists	93
	Rehearsals	94
	Nuclear Device Safety	95
	Postevent Safety Measures	96
	Christmas Island	96
	Johnston Island	97
	Cloud Tracking	100
	Cloud Sampling	103
	Sample Recovery and Return	104
	Personnel Decontamination	104
	Aircraft Decontamination	105
3	DOD EXPERIMENTAL PARTICIPATION	110
	Christmas and Johnston Island Numbered Projects Involving the Department of Defense	111
	Unnumbered Christmas Island and FISHBOWL Experiments that Involved the Department of Defense	130
	Numbered SWORDFISH Projects that Involved the Department of Defense	133
	Unnumbered SWORDFISH Experiments Involving the Department of Defense	138
	FRIGATE BIRD Experiments Involving the Department of Defense	138

TABLE OF CONTENTS (continued)

Chapter		Page
4	WEAPON DEVELOPMENT TEST OPERATIONS	140
	Christmas Island Airdrops	140
	ADOBE	147
	AZTEC	147
	ARKANSAS	147
	QUESTA	150
	YUKON	150
	MESILLA	150
	MUSKEGON	150
	ENCINO	155
	SWANEE	155
	CHETCO	155
	TANANA	155
	NAMBE	161
	ALMA	161
	TRUCKEE	161
	YESO	161
	HARLEM	161
	RINCONADA	166
	DULCE	166
	PETIT	166
	OTOMI	166
	BIGHORN	166
	BLUESTONE	172
	SUNSET	172
	PAMLICO	172
	Johnston Island Airdrops	172
	ANDROSCOGGIN	178
	BUMPING	178
	CHAMA	178
	CALAMITY	178
	HOUSATONIC	178

TABLE OF CONTENTS (continued)

Chapter		Page
5	FRIGATE BIRD	184
	Introduction	184
	Organization and Responsibilities	185
	Safety Planning	188
	Operations	191
6	SWORDFISH	196
	Introduction	196
	Department of Defense Task Group Support	196
	Test Objectives	198
	Test Site Selection	199
	Test Array	199
	Test Preparations	200
	Safety Planning	201
	Test Operations	204
7	FISHBOWL -- HIGH-ALTITUDE EVENTS	218
	Concept of High-Altitude Tests	218
	Surface and Aircraft Stations	218
	Launch Missiles	221
	Organization and Personnel	224
	Navy Participation	225
	Air Force Participation	225
	Operations	227
	BLUEGILL	227
	STARFISH	228
	STARFISH Prime	229
	BLUEGILL Prime	232
	Operations Pause	233
	Launch Pad Decontamination	233
	Replanning the Operation	236
	BLUEGILL Double Prime	241
	CHECKMATE	241

TABLE OF CONTENTS (continued)

Chapter		Page
7 (continued)	BLUEGILL Triple Prime	242
	KINGFISH	247
	TIGHTROPE	247
8	U.S. ARMY PARTICIPATION IN OPERATION DOMINIC	252
9	U.S. NAVY PARTICIPATION IN OPERATION DOMINIC	261
	Joint Task Force 8 Organizations	264
	Commander Joint Task Group 8.3 Headquarters	264
	Task Unit 8.3.9 (Special Operations Unit)	264
	Navy Laboratory and Research Organizations	264
	Navy Ships	269
	Naval Air Units	316
	Other Naval Units and Organizations	318
10	U.S. AIR FORCE PARTICIPATION IN OPERATION DOMINIC	320
11	U.S. MARINE CORPS PARTICIPATION IN OPERATION DOMINIC	341
12	DEPARTMENT OF DEFENSE, ATOMIC ENERGY COMMISSION, OTHER GOVERNMENT, CONTRACTOR AND FOREIGN PARTICIPATION IN OPERATION DOMINIC	344
	Introduction	344
	Department of Defense Agencies	344
	Atomic Energy Commission Organizations	348
	Other Government Organizations	349
	Contractors	349
	Very Important Persons	355
	Foreign Personnel	355
	Other	355
13	SUMMARY OF PERSONNEL EXPOSURES	357
BIBLIOGRAHY AND REFERENCES		362

TABLE OF CONTENTS (continued)

		Page
APPENDIX A	RADIOLOGICAL SAFETY DOCUMENTS	379
APPENDIX B	LIST OF CODES USED IN THE DOMINIC CONSOLIDATED LIST OF EXPOSURES	395
APPENDIX C	TERMS, ABBREVIATIONS, ACRONYMS, AND UNITS	403

LIST OF ILLUSTRATIONS

Frontispiece: Shot TRUCKEE cloud, Operation DOMINIC I

Figure		Page
1	The Central Pacific.	32
2	Christmas Island.	33
3	A-Site scientific instrumentation station on Christmas Island.	34
4	Joint Operations Center area at Christmas Island.	36
5	Royal Air Force transport framed by U.S. Navy WV-2 at Christmas Island airfield.	36
6	Christmas Island harbor area showing pipe for Army Engineer pipeline construction.	37
7	U.S. Marine Corps airfield fuel-dispensing system set up on Christmas Island for the DOMINIC operation.	37
8	Christmas Island airfield (WB-50 aircraft in foreground).	38
9	Military Air Transport Service passenger terminal at Christmas Island.	38
10	Johnston Atoll and Johnston Island, 1962.	40
11	Johnston Island photographed from an aircraft preparing to land from the west, 1962.	41
12	Johnston Island facilities, looking west.	42
13	Aerial view of Johnston Island showing a large antenna used for a scientific project and other facilities used during DOMINIC.	43
14	Overall command structure.	45
15	Organization of Headquarters Joint Task Force 8.	46
16	Joint Task Group 8.3 personnel participation during DOMINIC.	50
17	Joint Task Force 8 manning.	62
18	Headquarters, Joint Task Force 8 functional radiological safety organization.	65
19	Locations of radiological safety stations manned by U.S. Public Health Service personnel and boundaries of danger areas.	71

LIST OF ILLUSTRATIONS (continued)

Figure		Page
20	Pod is swung over berm and placed in hot cell with crane on Johnston Island during DOMINIC.	76
21	Christmas Island and Johnston Island danger areas.	79
22	Johnston Island danger area as a function of altitude.	80
23	Joint Task Force 8 weather organization.	84
24	Modified M-boat (LCM) for handling radioactive pods returned to Johnston Island, Operation DOMINIC.	88
25	Personnel being evacuated from Johnston Island before a test shot.	89
26	Personnel in protective clothing inspect contaminated launch stand during DOMINIC.	90
27	A pod lifted from the sea is held against the side of USS Grapple (ARS-7) as personnel check for radiation.	92
28	Laboratory personnel receive a rocket nosecone sampler delivered to Christmas Island by retrieving H-21 helicopter.	93
29	Radioactive pod with flotation bag still attached is guided into sling in M-boat following DOMINIC shot.	98
30	Pod is delivered to Johnston Island by helicopter during DOMINIC.	99
31	Sampler aircraft is guided into restricted area for sample removal.	101
32	Pilot prepares to leave sampler B-57 via a platform on forklift, Johnston Island.	101
33	Filter with radioactive particulates from DOMINIC, BUMPING carried from B-57 sampler to lead cave.	102
34	Radioactive filter in lead cave is rolled using long pole before being placed in lead pig, Johnston Island.	102
35	Weapon debris sample shipment in shielded containers being checked at Hickam AFB for radioactivity.	103
36	Interior of clean side of dressing decontamination tent at Johnston Island.	105
37	Crews prepare to decontaminate a B-57 sampler after crew and sample removal at Naval Air Station, Barbers Point.	106
38	Scrubdown of B-57 sampler, Naval Air Station, Barbers Point.	107
39	Washdown of B-57 sampler, Naval Air Station, Barbers Point.	108
40	Final check after B-57 decontamination, Naval Air Station, Barbers Point.	109

LIST OF ILLUSTRATIONS (continued)

Figure		Page
41	Airdrop target raft with service personnel aboard.	141
42	Cloud from DOMINIC, YUKON as viewed from Christmas Island.	142
43	Sampling track and radiation pattern in the DOMINIC, BLUESTONE cloud at 45,000 feet (13.7 km).	144
44	Ship positions, ADOBE.	148
45	Ship positions, AZTEC.	149
46	Ship positions, ARKANSAS.	151
47	Ship positions, QUESTA.	152
48	Ship positions, YUKON.	153
49	Ship positions, MESILLA.	154
50	Ship positions, MUSKEGON.	156
51	Ship positions, ENCINO.	157
52	Ship positions, SWANEE.	158
53	Ship positions, CHETCO.	159
54	Ship positions, TANANA.	160
55	Ship positions, NAMBE.	162
56	Ship positions, ALMA.	163
57	Ship positions, TRUCKEE.	164
58	Ship positions, YESO.	165
59	Ship positions, HARLEM.	167
60	Ship positions, RINCONADA.	168
61	Ship positions, DULCE.	169
62	Ship positions, PETIT.	170
63	Ship positions, OTOWI.	171
64	Ship positions, BIGHORN.	173
65	Ship positions, BLUESTONE.	174
66	Ship positions, SUNSET.	175
67	Ship positions, PAMLICO.	176
68	Ship positions, ANDROSCOGGIN.	179
69	Ship positions, BUMPING.	180
70	Ship positions, CHAMA.	181
71	Ship positions, CALAMITY.	182

LIST OF ILLUSTRATIONS (continued)

Figure		Page
72	Ship positions, HOUSATONIC.	183
73	DOMINIC, FRIGATE BIRD operational area showing launch and impact hazard areas, trajectory hazard sector, and ship locations.	189
74	FRIGATE BIRD Polaris launch viewed from helicopter; USS Maddox (DD-731) in foreground.	192
75	FRIGATE BIRD Polaris launch viewed from USS Maddox (DD-731).	193
76	FRIGATE BIRD cloud viewed through the periscope of USS Carbonero (SS-337), DOMINIC.	194
77	Coracle used for DOMINIC, SWORDFISH.	200
78	Positions of the DOMINIC, SWORDFISH task group elements at shot time.	205
79	DOMINIC, SWORDFISH ASROC rocket missile launch from USS Agerholm (DD-826).	208
80	DOMINIC, SWORDFISH spray dome and plume with USS Agerholm (DD-826) in foreground.	208
81	DOMINIC, SWORDFISH base surge.	210
82	DOMINIC, SWORDFISH foam patch at about 6 minutes after burst.	210
83	Position of DOMINIC, SWORDFISH foam patch and base surge 5 minutes after detonation.	211
84	DOMINIC, SWORDFISH early postshot maneuvers of USS Razorback (SS-394), USS Agerholm (DD-826), USS Anderson (DD-786), and USS Hopewell (DD-822).	212
85	Thor on launch pad, DOMINIC.	219
86	Earth's magnetic field.	220
87	Nike-Hercules used for launch of DOMINIC, TIGHTROPE.	222
88	Strypi missile with Recruit boost . used for DOMINIC, CHECKMATE.	223
89	Array of instrument rockets used during Operation DOMINIC at Johnston Island.	224
90	Debris that fell on Johnston Island from the first DOMINIC, STARFISH launch.	229
91	Aircraft in the air array for DOMINIC, STARFISH Prime.	230
92	Ship positions, DOMINIC, STARFISH Prime.	231
93	Thor launch pad for BLUEGILL Prime on Johnston Island viewed from the northeast looking almost downwind.	232

LIST OF ILLUSTRATIONS (continued)

Figure		Page
94	Thor pad after BLUEGILL Prime fire on Johnston Island.	234
95	Cleanup of Thor pad following BLUEGILL Prime fire on Johnston Island.	234
96	Initial radiological survey of the Thor launch pad following DOMINIC, BLUEGILL Prime.	235
97	Thor launch pad contamination levels after 2 weeks of decontamination efforts.	237
98	Inspection of Thor engine parts following BLUEGILL Prime fire on Johnston Island.	238
99	Loader moves contaminated soil near Thor launch pad during cleanup operations on Johnston Island.	238
100	Workers dispose of protective clothing before showering when leaving Thor launch pad cleanup area on Johnston Island.	239
101	Workers cleaning up Thor launch pad receive nose-swipe tests for inhaled contaminants.	239
102	Thor launch pad contamination levels on 23 November 1962 after DOMINIC.	240
103	Aircraft array for DOMINIC, CHECKMATE.	242
104	Ship positions, DOMINIC, CHECKMATE.	243
105	Aircraft array for DOMINIC, BLUEGILL Triple Prime.	245
106	Ship positions, DOMINIC, BLUEGILL Triple Prime.	246
107	Aircraft array for DOMINIC, KINGFISH.	248
108	Ship positions, DOMINIC, KINGFISH.	249
109	Aircraft array for DOMINIC, TIGHTROPE.	250
110	Ship positions, DOMINIC, TIGHTROPE.	251

LIST OF TABLES

Table		Page
1	DOMINIC detonations, 1962.	24
2	Joint Task Force 8 Headquarters manning statistics, DOMINIC.	47
3	Joint Task Force 8 Headquarters detachments (military), DOMINIC.	48
4	Ship participation summary, DOMINIC.	51
5	U.S. Navy and U.S. Marine Corps aircraft, DOMINIC.	52
6	Military unit manning levels (DOMINIC).	56
7	Pacific locations used in DOMINIC.	57
8	Base island command manning levels (DOMINIC).	60
9	Average population at Johnston and Christmas islands during DOMINIC.	63
10	Joint Task Force 8 Radsafe Branch activities at various locations, DOMINIC.	66
11	Maximum Permissible Limit criteria for DOMINIC.	73
12	Radiological safety equipment and supplies, DOMINIC.	74
13	Preshot checklist for DOMINIC, AZTEC (Christmas Island).	94
14	Organizations scheduled to participate in experimental programs, DOMINIC.	112
15	Aircraft participation in DOMINIC, Christmas Island tests.	146
16	Planned aircraft participation for Johnston Island airdrops, DOMINIC.	177
17	Positions of task group ships at shot time relative to surface zero, DOMINIC, SWORDFISH.	206
18	Positions of aircraft relative to surface zero, DOMINIC, SWORDFISH.	207
19	Personnel exposures on USS Sioux (ATF-75) during Project 2.1, DOMINIC, SWORDFISH.	217
20	Ship participation in DOMINIC, FISHBOWL tests.	226
21	Planned Air Force aircraft participation for DOMINIC, FISHBOWL shots.	227
22	Air Force aircraft participation in DOMINIC, BLUEGILL.	228
23	DOMINIC personnel exposures, U.S. Army organizations.	253

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LIST OF TABLES (continued)

Table		Page
24	DOMINIC personnel exposures, U.S. Navy organizations.	265
25	DOMINIC personnel exposures, U.S. Air Force organizations.	321
26	Example of sampler pilot badge system, Air Force 1211th Test Squadron, DOMINIC.	329
27	Sampler pilot exposure in Johnston Island phase, Air Force 1211th Test Squadron.	330
28	Exposure control system for airmen in 1211th Test Squadron.	331
29	Summary of exposures, Air Force 1211th Test Squadron.	332
30	Exposure data for Air Force personnel associated with the Johnston Island Base Command.	334
31	Exposure data for Air Force weather units.	335
32	Strategic Air Command units participating in DOMINIC.	337
33	Summary of Air Force exposure data.	340
34	DOMINIC personnel exposures, U.S. Marine Corps organizations.	342
35	DOMINIC personnel exposures, Department of Defense, Atomic Energy Commission, other government, and contractor organizations.	345
36	DOMINIC personnel exposures.	358

CHAPTER 1

OVERVIEW

INTRODUCTION

Operation DOMINIC I was the designation for a series of atmospheric nuclear weapon tests conducted by the United States at several Pacific Ocean locations in 1962. These are listed in Table 1. The United States resumed underground nuclear weapon testing in September 1961 after the U.S.S.R. resumed atmospheric nuclear testing in the same month. From 15 September 1961 to 4 November 1962, the United States conducted 100 nuclear tests and then stopped all testing in the atmosphere. Of these 100 tests,* 36 were the Operation DOMINIC shots in the Pacific. The Nevada Test Site (NTS) atmospheric shots during this period were designated DOMINIC II.

Purpose

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

Historical Perspective

On 1 November 1958, the United States began a unilateral moratorium on nuclear tests. The moratorium was linked to the issues of nuclear disarmament and the political struggle between the United States and the U.S.S.R. as well as concerns over the increasing levels of worldwide radioactive fallout. When this moratorium began, three nations, the United States, the U.S.S.R., and the United Kingdom, had nuclear weapons. When the moratorium ended in 1961, France joined this group.

For approximately 2 years before the moratorium, the United States and the Soviet Union maneuvered for technological and political position by alternately testing and declaring unilateral suspensions of testing. The Soviets conducted

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* All 100 shots were also designated as either a part of Operations NOUGAT or STORAX, depending upon whether the tests took place in the 1962 Federal Government Fiscal Year (1 July 1961 - 30 June 1962) or the 1963 Federal Government Fiscal Year (1 July 1962 - 30 June 1963), respectively.

† Subsequently in this report, all references to DOMINIC will be to the Pacific phase.

Table 1. DOMINIC detonations, 1962.

Date	Test Name	Yield[a] and Remarks
Spring-Summer 1962 -- Weapon Development Airdrops South of Christmas Island (except as noted)		
25 Apr	ADOBE	Intermediate
27 Apr	AZTEC	Intermediate
2 May	ARKANSAS	Low megaton range
4 May	QUESTA	Intermediate
6 May	FRIGATE BIRD	Polaris proof-test, airburst in Christmas Island Danger Area
8 May	YUKON	Intermediate
9 May	MESILLA	Intermediate
11 May	MUSKEGON	Intermediate
11 May	SWORDFISH	ASROC proof-test, low-yield underwater burst 370 nmi (686 km) southwest of San Diego
12 May	ENCINO	Intermediate
14 May	SWANEE	Intermediate
19 May	CHETCO	Intermediate
25 May	TANANA	Low
27 May	NAMBE	Intermediate
8 Jun	ALMA	Intermediate
9 Jun	TRUCKEE	Intermediate
10 Jun	YESO	Low megaton range
12 Jun	HARLEM	Intermediate
15 Jun	RINCONADA	Intermediate
17 Jun	DULCE	Intermediate
19 Jun	PETIT	Low
22 Jun	OTOWI	Intermediate
27 Jun	BIGHORN	Megaton range
30 Jun	BLUESTONE	Low megaton range
8 Jul	STARFISH	FISHBOWL shot, 1.4 MT at 400 km over Johnston Island
10 Jul	SUNSET	Intermediate
11 Jul	PAMLICO	Low megaton range
Autumn 1962 -- Conducted in the Johnston Island Danger Area		
2 Oct	ANDROSCOGGIN	Intermediate-yield airdrop
6 Oct	BUMPING	Low-yield airdrop
18 Oct	CHAMA	Low megaton range airdrop
19 Oct	CHECKMATE	FISHBOWL shot, low-yield, tens of kilometers over Johnston Island
25 Oct	BLUEGILL	FISHBOWL shot, submegaton, tens of kilometers over Johnston Island
27 Oct	CALAMITY	Intermediate-yield airdrop
30 Oct	HOUSATONIC	Megaton range airdrop
1 Nov	KINGFISH	FISHBOWL shot, submegaton, tens of kilometers over Johnston Island
3 Nov	TIGHTROPE	FISHBOWL shot, low-yield, tens of kilometers over Johnston Island

Note:

[a]Low yield -- less than 20 KT; intermediate yield -- 20 to 1,000 KT.

Source: Announced United States Nuclear Tests, NVO-29 (Rev. 1), Office of Public Affairs, U.S. Department of Energy, Nevada Operations Office, January 1980.

test series beginning in late August 1957 and in September 1958. The United States began test series HARDTACK I in the Pacific during April 1958 and series HARDTACK II in Nevada during September 1958. The United States also conducted ARGUS, a high-altitude series, in the South Atlantic Ocean in August and September 1958. The British tested in the Christmas Island area in both 1957 and 1958.

American, British, and Soviet delegates began the Conference on Discontinuance of Nuclear Weapons Tests in Geneva on 31 October 1958. On the following day, the United States initiated a unilateral 1-year suspension of nuclear testing, as President Eisenhower had proposed between HARDTACK I and II. Two days later the Soviet Union completed the test series begun in September.

Little progress was made in 1959. In August, the United States extended its 1-year moratorium through the end of 1959. The United Kingdom agreed to honor the extension and the U.S.S.R. announced that it would conduct no tests unless the Western nations did so first. On 29 December the United States announced an end to its moratorium, effective 31 December, but with a promise not to resume testing without advance public notice.

On 3 January 1960, the Soviet Premier pledged that the Soviet Union would not resume testing unless the Western nations started first. In February, the U.S. President proposed a treaty banning all atmospheric tests and those underground tests powerful enough to register above 4.75 on the Richter earthquake scale. The French exploded a 60-KT atomic bomb on a tower in the Sahara Desert on 13 February. On 19 March the Soviet Union agreed to the President's proposal, provided that tests smaller than the 4.75 threshold would be uncontrolled for an indefinite time. The main issue for the Geneva conference was now the duration of a test treaty.

A summit conference to negotiate a treaty between the United States and the U.S.S.R. was set for May 1960 in Paris, but was ended abruptly on 16 May by the Soviets.

November 1960 brought the election of a new U.S. President who continued the moratorium. The test-ban talks in Geneva resumed in March 1961; however, negotiations again were slow. On 31 August, the U.S.S.R. abruptly announced plans to resume nuclear testing in the atmosphere and then exploded a nuclear device at the Semipalatinsk test range in Central Asia the next day. This began an extensive test series that included more than 30 shots, among which were an enormous 58-MT explosion (the largest ever fired) and high-altitude tests. Tests were conducted in the Arctic at Novaya Zemlya as well as Semipalatinsk; the testing continued into November.

The Secretary of Defense recommended to the President that the DOD and the Atomic Energy Commission (AEC) be allowed to prepare for atmospheric and high-altitude nuclear tests. The President tried to restrict the U.S. response to underground shots at the NTS. U.S. testing recommenced with a 2.6-KT event on 15 September, detonated in a tunnel at NTS. The President approved planning for atmospheric tests on 10 October, but he did not approve DOMINIC until 2 March 1962.

Johnston Island had been used in 1958 for rocket-borne, high-altitude nuclear tests and was available for this kind of testing for DOMINIC, but weapon development shots posed a more difficult problem. These could not be conducted off Johnston Island because they would interfere with the extensive preparations required for the high-altitude shots. The area that had been developed and used for large atmospheric tests, the atolls of Enewetak and Bikini in the Marshall Islands, was no longer available. Enewetak had been kept in a ready-to-test condition until 1960 when it had been turned over to the Air Force for its missile development programs. This area could have been recovered from the Air Force, but the United States was quite sensitive to the fact that the Marshalls were held by the United States as a Trust Territory, and the reintroduction of nuclear tests into the area would expose the United States to a great deal of unfavorable criticism (New York Times, 12/3/61).

Airdrops of nuclear devices over the open sea were considered, but the presence of a nearby base was obviously desirable. In December, the use of British-owned Christmas Island was mentioned in the public press (New York Times, 12/15/61). Its use was agreed upon at a conference between the President and the Prime Minister in early 1962, and public announcement of the agreement was made in February 1962. In return for the use of Christmas Island, the British were allowed to participate in the underground nuclear test program, then being conducted at the NTS.

Report Organization

Subsequent sections of this overview chapter discuss the form of experimental nuclear weapon test programs with emphasis on the potential radiation exposure of participating DOD personnel. Experimental activities are considered first without particular reference to the geographic location of the testing and then are related to the limitations on such activities when they were conducted at Christmas Island, Johnston Island, or in the open sea. Those portions of the experimental programs with heaviest DOD participation are emphasized.

The chapter concludes with a description of Joint Task Force 8 (JTF 8), the organization that conducted Operation DOMINIC, and indicates how the DOD elements within JTF 8 functioned.

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

Chapter 3 focuses on the role of the DOD in the experimental program of DOMINIC in general, leading to a discussion of the DOD operations for the test events in particular in Chapters 4, 5, 6, and 7. Chapter 4 discusses the weapon development shots, both at Christmas Island and Johnston Island; Chapters 5 and 6 present the Navy tests, FRIGATE BIRD and SWORDFISH, respectively; and Chapter 7 covers the high-altitude shots at Johnston Island, designated the FISHBOWL events.

Chapters 8 through 11 report participation by the Army, Navy, Air Force, and Marine Corps, respectively. Chapter 12 summarizes the participation of other government agencies and contractors. A listing of participating units

and a statistical characterization of their personnel exposures are included in these chapters. Personnel exposures are discussed in general in Chapter 13.

NUCLEAR TESTS AND RADIATION EXPOSURES

Nuclear testing before 1961 usually consisted of the unconfined detonation of nuclear devices (usually not weapons) in the atmosphere. The devices might be placed on a platform or a barge on the surface, placed atop a tower, supported by a balloon, dropped from an airplane, or flown on a rocket. On occasion, devices were detonated underwater or buried in the earth or in underground tunnels and shafts.

In theory, personnel could be exposed either by the radiation emitted at the time of explosion and for about 1 minute thereafter -- usually referred to as initial radiation -- or by the radiation emitted later (residual radiation). Initial radiation is part of the violent nuclear explosion process itself; to be close enough for initial radiation exposure would place an observer within the area swept by lethal blast and heat waves.

The neutron component of initial radiation did indirectly contribute to the possibility of personnel exposure. Neutrons are emitted in large numbers by nuclear weapon detonations. Neutrons have the property of altering certain nonradioactive materials so that they become radioactive. This process, called activation, occurs with atoms of sodium, silicon, calcium, manganese, and iron, as well as other common materials. The process affects the metal casing of the device, the test tower, and earth materials. Activation products thus formed are added to the inventory of the radioactive products formed in the detonation process. The radiation emitted by this inventory is referred to as residual radiation.

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

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

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

In a nuclear airburst, such as the airdrop test devices in DOMINIC, the central core of intensely hot material, or fireball, does not touch the surface, and the bomb residues (including the fission products, the activation products resulting from neutron interaction with device materials, and unfissioned uranium and/or plutonium) are vaporized. These vapors condense as the fireball rises and cools, and the particles formed by the condensation are small and smoke-like. They are carried up with the cloud to the altitude at which its rise stops, usually called the cloud stabilization altitude. Spread of this material then depends on the winds and weather. If the detonation is small, the cloud stabilization altitude will be in the lower atmosphere and the material will act like dust and return to the Earth's surface in a matter of weeks. Essentially all debris from bursts with yields equivalent to kilotons of TNT will be down within 2 months (Reference A.5). Areas in which this fallout material will be deposited will appear on maps as bands following the wind's direction. Larger detonations (yields equivalent to megatons of TNT) will have cloud stabilization altitudes in the stratosphere (above about 10 miles [16 km] in the tropics). Radioactive material from such altitudes will not return to Earth for many months and its distribution will be much wider. Thus, airbursts contribute little potential for radiation exposure to personnel at the testing area. However, there may be some residual, short-lived radiation coming from activated surface materials under the burst, if the burst altitude is sufficiently low for neutrons to reach the surface.

Underwater nuclear detonations are muffled by the great mass of water that surrounds them. The initial nuclear radiation is absorbed by the water surrounding the device and the intense heat vaporizes the water near the burst, forming a bubble beneath the surface of the water that expands as the energy released in the explosion works against the mass of water. This expansion continues until the energy is expended, at which point the bubble begins to collapse as it rises toward the surface. Depending upon the depth of the burst and the size of the bubble (which in turn depends on the yield, or total energy release, of the explosion), the bubble may break the surface of the water near its fully expanded size or smaller. Some radioactive products are vented into the air as the bubble breaks the surface, but most of the device debris remains trapped in the volume of water that collapses on the bubble. This volume of water is usually referred to as the radioactive pool and is the primary source of potential radiation exposure for individuals participating in the tests.

When a detonation takes place high above the Earth's surface, the very thin air absorbs the initial radiation only slightly. Thus, radiation can travel great distances at very high altitudes. Downward toward the Earth's surface, however, the air becomes progressively more dense and the initial radiation from a high-altitude burst is attenuated and absorbed long before it reaches the surface of the Earth. For a burst above the atmosphere, the altitudes at which the radiations are virtually stopped are 35 to 55 miles (56 to 88 km) for X-rays, 15 miles (24 km) for neutrons and gammas, and 35 miles (56 km) for beta particles.

The possibility of exposure from early fallout during a high-altitude burst is also virtually nonexistent. In a high-altitude detonation, the device debris is dispersed into the stratosphere or higher. This is above the height where weather, which might act to bring the radioactive device debris to Earth, is

formed. Consequently, there is no likelihood that the suspended material will descend quickly enough to expose personnel in the vicinity of the surface zero. Such device material remains in the upper atmosphere about 6 months. During this period, most of the radionuclides produced by the detonation will have decayed to low levels by the time they descend to Earth, with two notable exceptions. Isotopes of strontium and cesium, Sr^{90} and Cs^{137}, take longer to decay than the time required for their deposition. The major radiological concern about high-altitude bursts arises from the radiation from these radionuclides in the delayed fallout.

EXPERIMENTAL PROGRAM

Central to the test series was the experimental program. This program and its requirements dictated the form of the test organization and the detail of personnel participation. DOMINIC's experimental program incorporated two aspects, the first of which was the development of the weapons themselves and the second involved the measurement of the explosive and radiation effects. Unlike earlier nuclear test series, the DOMINIC test operations supporting each aspect were, in large part, separate.

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

Weapon Development

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

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

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

Construction, instrumentation placement, and data recovery for the photo-optical yield determinations did not usually require personnel to be in areas with a potential for exposure to radiation. Cameras and light detectors need only a clear field of view of the burst point and enough breadth of view to encompass the fireball. Camera placement did not involve personnel at times and places of high radiation levels. Film recovery generally did not involve

high exposure potential, as the photo stations were usually at ranges and in directions not heavily contaminated by fallout.

Sampling of device debris, however, necessitated exposure to high levels of radioactivity. The technique used in DOMINIC and most atmospheric tests was to fly aircraft with collectors directly through portions of the radioactive (or mushroom) cloud, although on some DOMINIC shots, rockets were also used in an attempt to collect samples. About 90 percent of the fission debris was usually considered to be in the upper portion of the mushroom cloud (Reference A.5). Several aircraft were used to obtain a representative sample. Aircrews were exposed to the radiation emitted by the radioactive particles in the cloud as they flew through. Aircraft flying these sampling missions picked up significant amounts of radioactive material on their surfaces, posing additional and continuing radiation exposure of the aircrews as they returned to base, as well as of decontamination ground crews. Samples collected were radiologically "hot" and required special handling as they were taken from the aircraft and prepared for shipment to laboratories in the United States for analysis.

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

Weapon diagnosticians used sophisticated techniques to follow the processes that occur during the device explosion. Detectors and collectors were run up to, and sometimes inside, the device case so that the radiation being sampled could be directly channeled some distance away and there be recorded by instrumentation designed to survive the ensuing blast.

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

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

The airdrop tests precluded such measurements and attendant exposures. The weapon laboratories used instrumentation on aircraft and the surface stations to collect the diagnostic data.

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

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

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

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

Effects Experiments

Experiments were conducted at nuclear tests to acquire information on the effects of the detonations on military systems and were of two types. The first were measurements of how the nuclear burst altered the environment in which the military system operated, and the second were observations of the performance or survival of the military equipment or system itself during and following direct exposure to the detonation. Potential for radiation exposure of participants conducting these experiments was greater if the experiment was closer to surface zero and required recovery soon after burst time. Almost all of the DOMINIC effects measurement experiments had very little exposure potential.

TEST SITES

Christmas Island

Christmas Island is an atoll lying 2° north of the equator, approximately 1,200 nmi (2,224 km) south and slightly east of Hawaii (Figure 1). It derives its name from the date on which it was visited by the English navigator, Captain Cook (Christmas Eve, December 24, 1777). The island is approximately 30 nmi (56 km) long and varies in width from 5 to 15 nmi (9 to 28 km). A large portion is covered by saltwater and fresh-water lagoons; nevertheless, its land mass is considered the largest of all of the world's isolated atolls. The island is a large sand and coral mass originally covered in part by scrub growth. Figure 2 is a map of Christmas Island. The lettered sites refer to locations for activities in the British nuclear tests, but the same nomenclature and sites were used during DOMINIC. Figure 3 shows A-site, an important location on the southeast side of the island.

Some 400 coconut plantation workers lived in two small villages, one near Port London and the other at Poland on the opposite side of the lagoon, both on the northwestern end of the island. Vegetation consisted of coconut palms, shrubbery, and grasses. No large animals inhabited the island, but there were a few jerboas, small rat-like creatures. Lizards and land crabs were numerous.

The climate of Christmas Island is typically tropical marine. Temperature changes are slight, ranging from 70° to 90°F (21° to 32°C). Rainfall is

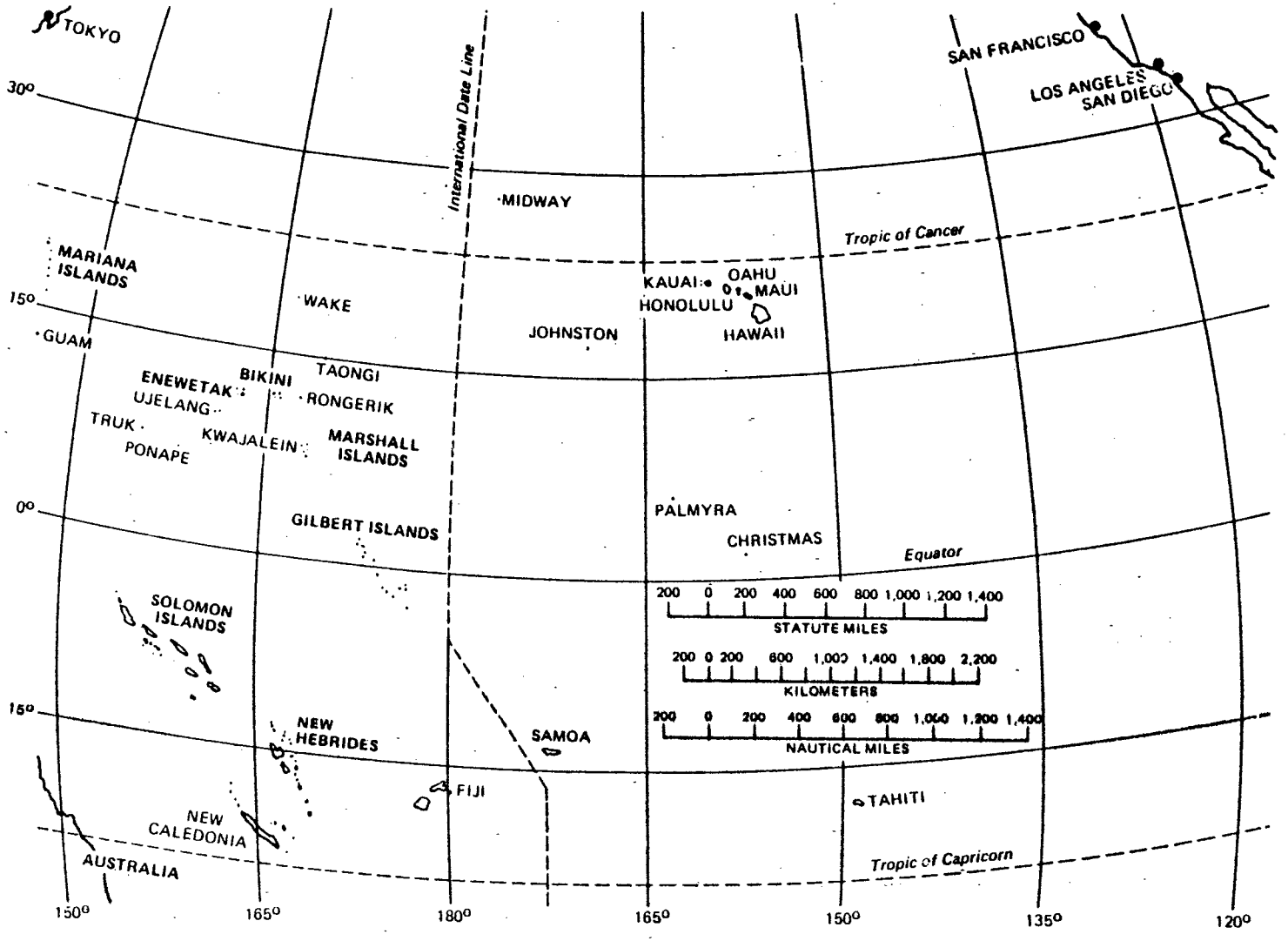


Figure 1. The Central Pacific.

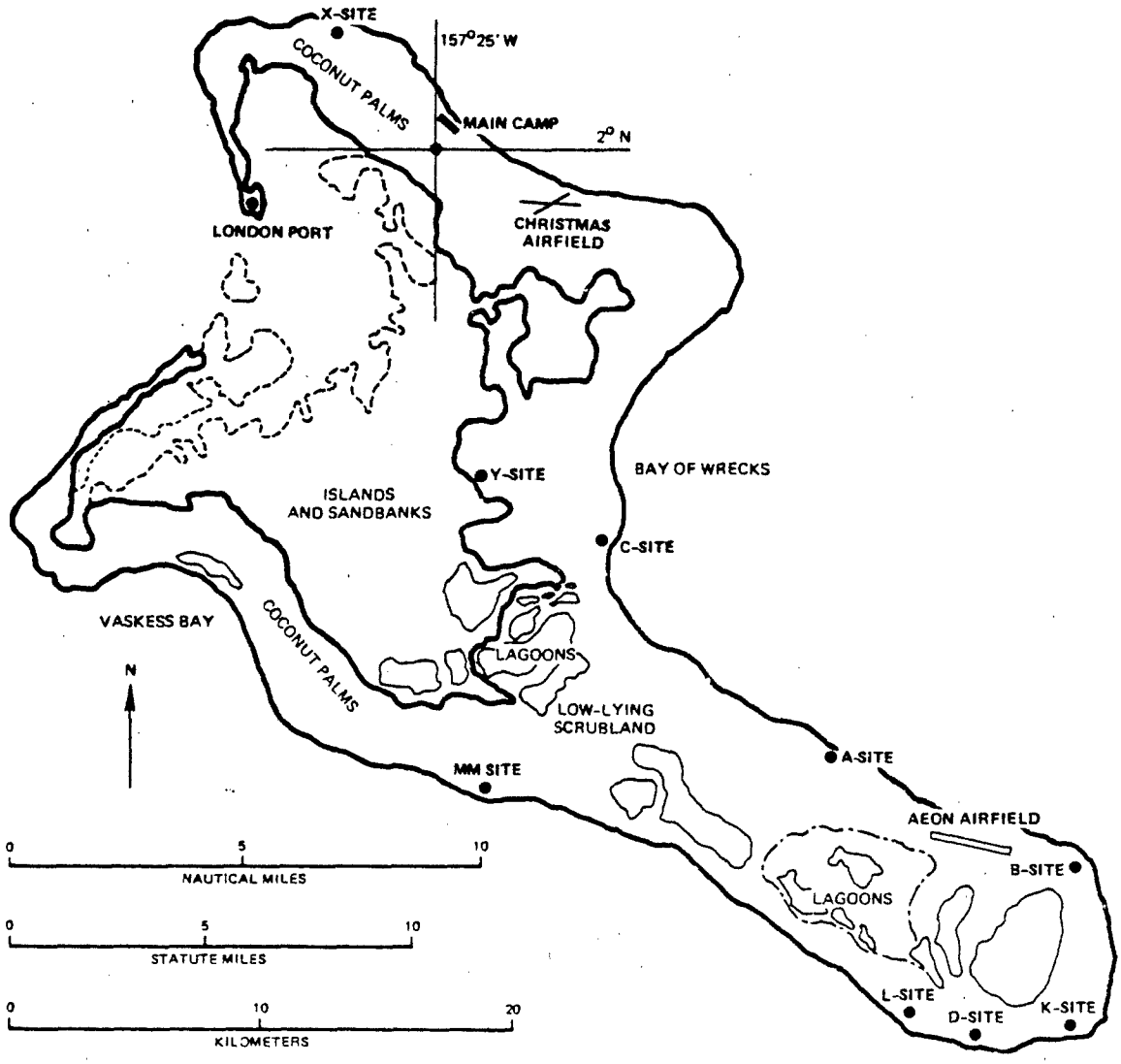


Figure 2. Christmas Island.

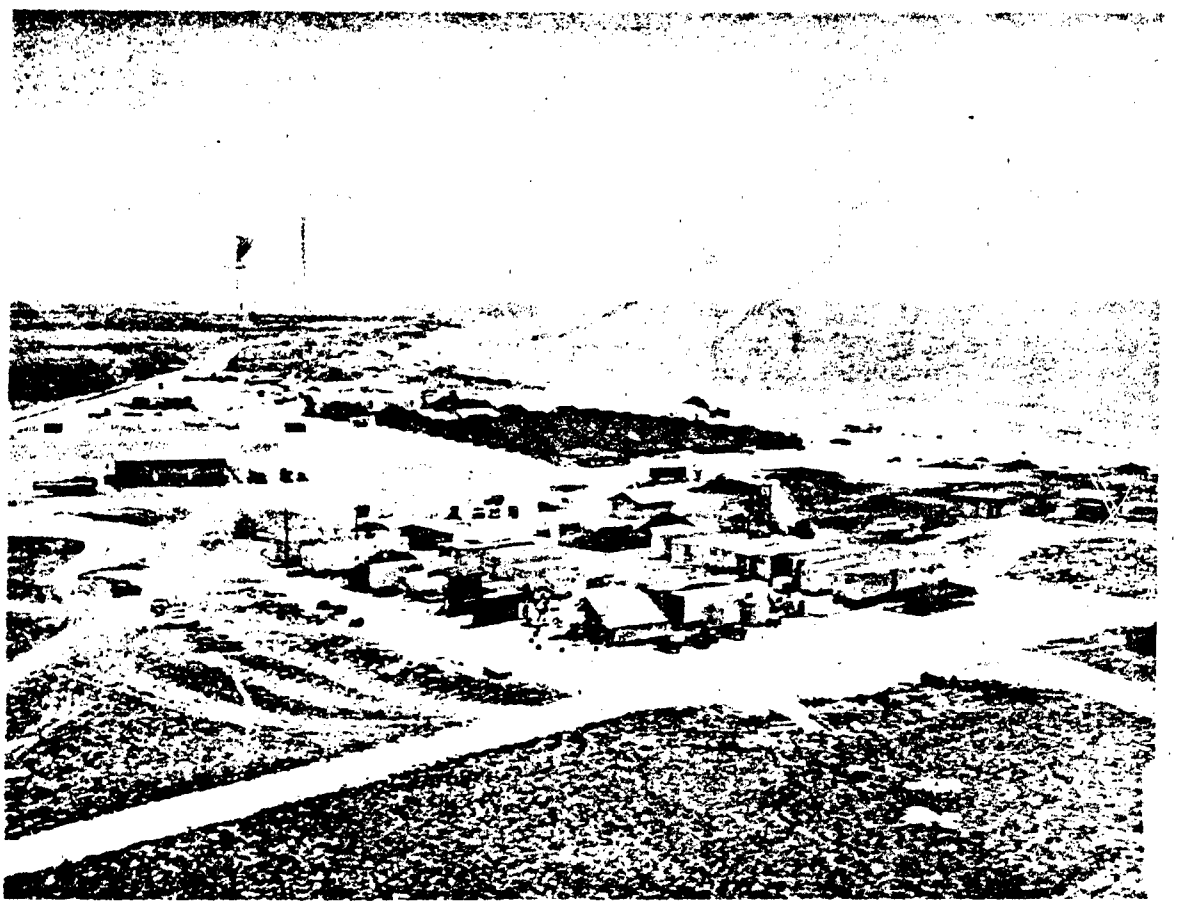


Figure 3. A-Site scientific instrumentation station on Christmas Island, DOMINIC.

moderate with a rainy period in the spring (9 inches in April to 1 inch in June). Cloud cover correlates with rainshowers; low cumulus clouds tend to increase in the morning hours before sunrise. Cloud bases range from 1,500 to 2,000 feet (458 to 610 meters), with tops about 5,000 feet (1.5 km) except during rainshowers. During showers the cloud tops range between 8,000 and 14,000 feet (2.4 and 4.2 km), but in thunderstorms they rise to 40,000 feet (12.2 km). High cirrus clouds at 35,000 to 40,000 feet (10.7 to 12.2 km) are generally present. The spring winds are persistent easterly tradewinds up to 15,000 feet (4.6 km). Between 15,000 and 50,000 feet (4.6 and 15.3 km), the winds are steady west to northwest (Reference C.1.M).

The island had been used by the United States early in World War II as a U.S. airbase. Nearly 10,000 U.S. personnel were stationed there at one time. Following World War II, the extensive U.S. installation was gradually abandoned and fell into disrepair when the last small portion of the U.S. island garrison was finally withdrawn in 1948.

In 1955 the United Kingdom started a buildup to use Christmas Island and its vicinity as a nuclear test area. They found that most of the U.S. installations were no longer usable and installed their own runways, port facilities, camps, and technical areas. Their nuclear tests took place in 1957 and 1958. During the moratorium, they reduced their garrison but still retained about 300 to 400 military personnel to operate the airbase and port and to carry out essential housekeeping activities. A Resident Commissioner from the Gilbert and Ellice Island Commission Office of the United Kingdom Colonial Service had political responsibility for Christmas Island and certain other smaller islands in the surrounding waters.

A joint JTF 8-United Kingdom team surveyed the Christmas Island facilities in December 1961. The main runway was in excellent shape, as was a small emergency runway. Parking space at the main airfield was adequate. Facilities at the main airfield for servicing aircraft were very limited and were not sufficient for projected operations. The airfield decontamination pad was in good shape and in an ideal location, except that water had to be hauled to it. The personnel decontamination building with adjacent laundry for contaminated clothing was adequate.

Housing accommodations were sufficient for approximately 500 people in the port area and 2,500 people in the main camp area. The Joint Operations Center (JOC) was located about 1 mile (1.6 km) from the main camp ($2^{o}N$, $157^{o}W$) and had approximately 20,000 ft^2 of office space (Figure 4). The entire area was in very good condition. The existing British medical staff consisted of two doctors. No dental facilities were available except for an X-ray machine. The Royal Air Force (RAF) routinely made two trips per week to Hickam AFB on Oahu for transport of personnel and supplies (Figure 5), although most supplies were delivered by sea. The RAF sprayed almost daily for insects. This kept the island practically insect-free. The island road net from the port to the main airfield was in good condition, as was the road to the southern tip of the island. The island telephone system was in very poor shape, except between the port and the main airfield. Helicopter pads were located at several places around the island.

Construction at Christmas Island required by DOMINIC included installation of about 30 miles (48.3 km) of petroleum-oil-lubricant (POL) pipeline and two fuel-storage and -dispensing systems at the main airfield. Two water-distillation plants, three first-aid stations, and a telephone system were also required. Figure 6 shows the harbor area as the pipe was readied for use, and Figure 7 shows the fuel tanks set up for the dispensing system. Maintenance and refurbishment was needed on most existing facilities since they had not been used since 1958.

Figure 8 is a photograph of the airfield area at Christmas Island showing WB-50 aircraft in the foreground. In the far left of this photo is the tail section of an Army light plane, probably an L-13. Figure 9 shows the military passenger terminal for DOMINIC at Christmas Island, which was operated by the Military Air Transport Service (MATS) of the U.S. Air Force.

For DOMINIC, the first stage of the radsafe program was a preoperational survey. The survey was conducted on Christmas, Fanning, Washington, and the



Figure 4. Joint Operations Center area at Christmas Island, DOMINIC.

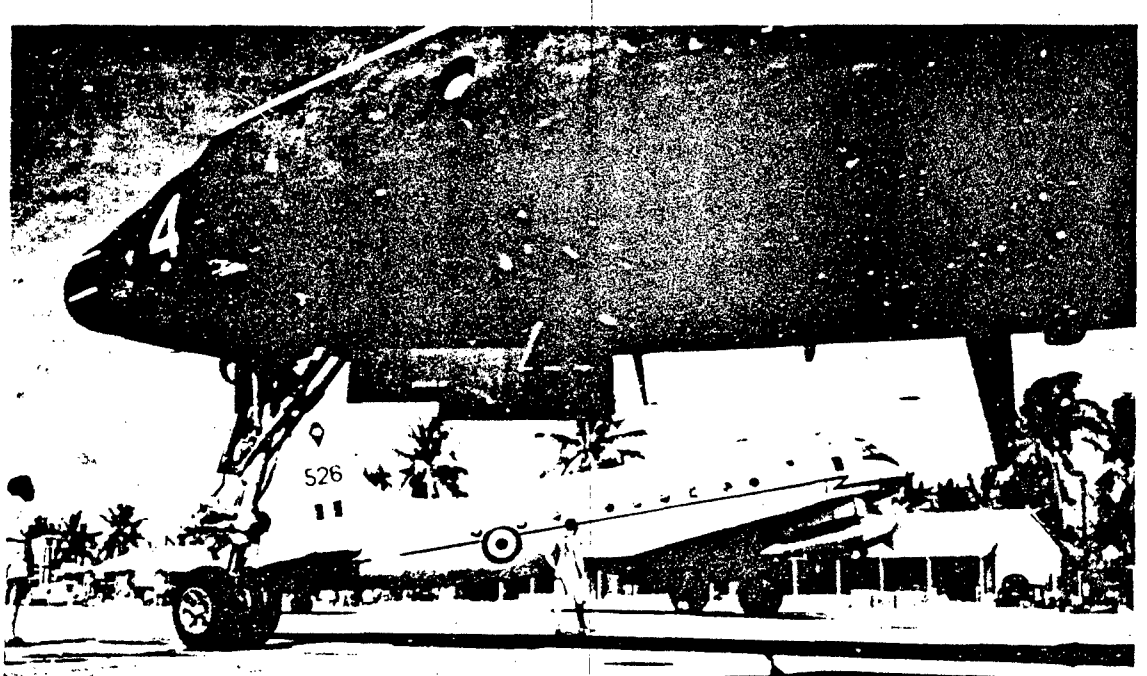


Figure 5. Royal Air Force transport framed by U.S. Navy WV-2 at Christmas Island airfield, DOMINIC.

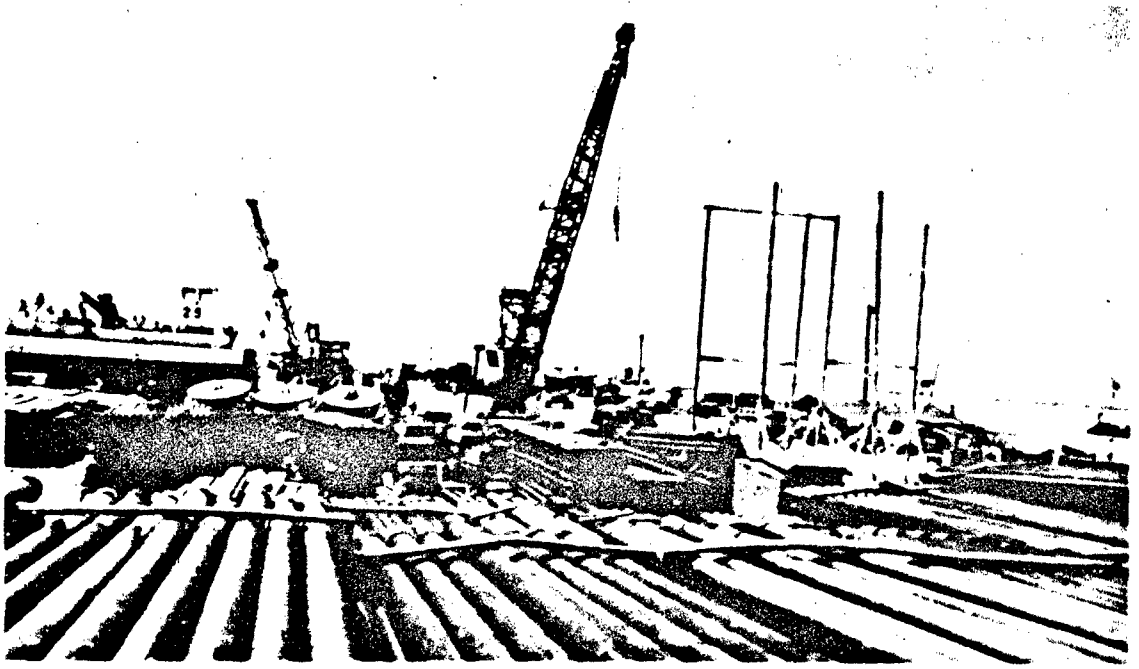


Figure 6. Christmas Island harbor area showing pipe for Army Engineer pipeline construction, DOMINIC.



Figure 7. U.S. Marine Corps airfield fuel-dispensing system set up on Christmas Island for the DOMINIC operation.

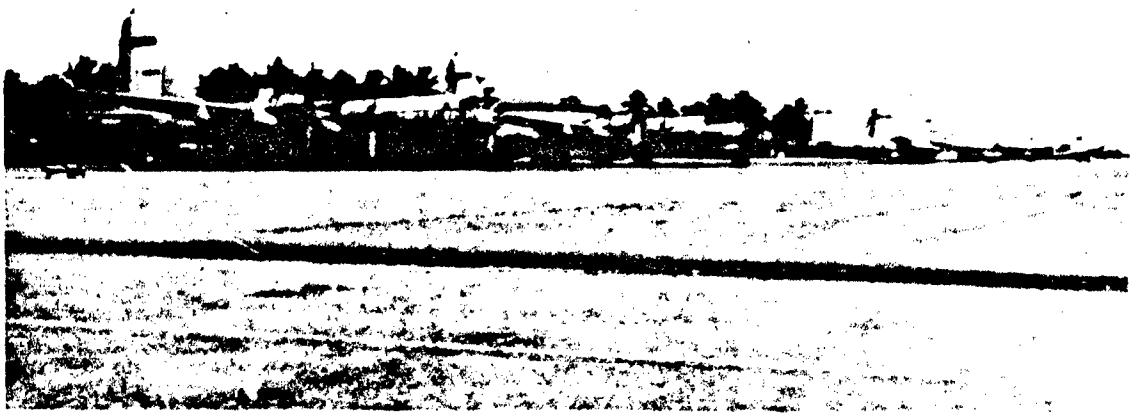


Figure 8. Christmas Island airfield (WB-50 aircraft in foreground), DOMINIC.



Figure 9. Military Air Transport Service passenger terminal at Christmas Island, DOMINIC.

Hawaiian islands, as well as on Samoa, by personnel from the Radiation Biology Laboratory of the University of Washington. These personnel were under AEC contract and collected samples of various soils, foodstuffs, and water. During the United Kingdom testing, Christmas Island was used as a base for nearby air-drop shots as well as a base for the tethered balloon shots. In addition, the islands had been exposed to some fallout from the U.S. tests in the Marshalls through 1958 as well as from the more recent Russian tests in 1961. At Samoa, samples of tuna fish were collected from boats that caught fish in the Christmas Island area. Well water samples were taken from Christmas, Fanning, Washington, and the Hawaiian islands. Milk from Hawaii was tested, and fruits and vegetables from Christmas, Fanning, Washington, and the Hawaiian islands were sampled. The results revealed nothing significant. Although some radioactive elements were detected, their concentrations were extremely low (Reference C.1.N, p. B-18).

Johnston Island

Johnston is an atoll (although rarely referred to as such) about 780 nmi (1,445 km) west-southwest of Hawaii. It has only two islands: Johnston Island, about 6,000 feet (1.8 km) long and 1,200 feet (366 meters) wide; and Sand Island, which is smaller. Its reef forms a half-circle with a 7.5-mile (12-km) diameter. The islands lie within a mile of each other on the northern portion of the reef. Figure 10 is a map of Johnston Atoll with Johnston Island inset. The collective area of both islands is only 320 acres (130 hectares), most of which is Johnston Island. Almost all of the Johnston Island surface area was covered with runway, taxi strip, and other buildings and structures directly supporting the airfield operation. Figure 11 shows Johnston Island in 1962 as seen by an aircraft preparing to land from the west.

Johnston has been a possession of the United States since the acquisition of Hawaii in the 19th century. It was used as a base during World War II. In 1958 it was an Air Force base, but was only used for an emergency landing field and as a base for the operation of navigation aids. Earlier in the decade it had been a regular stop for MATS trans-Pacific flights. In 1958, during Operation HARDTACK, it was used as a base for the launch of two missiles that carried nuclear warheads to high altitudes for detonation to test effects on radar and communications.

The weather at Johnston is tropical except it is somewhat drier and has less frequent cloud cover than atolls closer to the equator. The wind system has trade winds from the east from the surface to about 20,000 feet (6.1 km) altitude, winds from the west from 20,000 to 50,000 feet (6.1 to 15.3 km) altitude, and winds from the east up to the stratosphere.

Facilities on Johnston Island were generally adequate but crowded (Figure 12) for JTF 8 operations, except for the lack of an aircraft decontamination area. Joint Task Group (JTG) 8.5 constructed a primitive one at the west end of the runway; however, it was not needed during DOMINIC. Since additional communications equipment was needed at Johnston Island, JTG 8.5 installed worldwide countdown communications, a scientific cable plant, an AEC communications center, and expanded the telephone system. A recovery area for missile pods was also established on the south side of the runway.

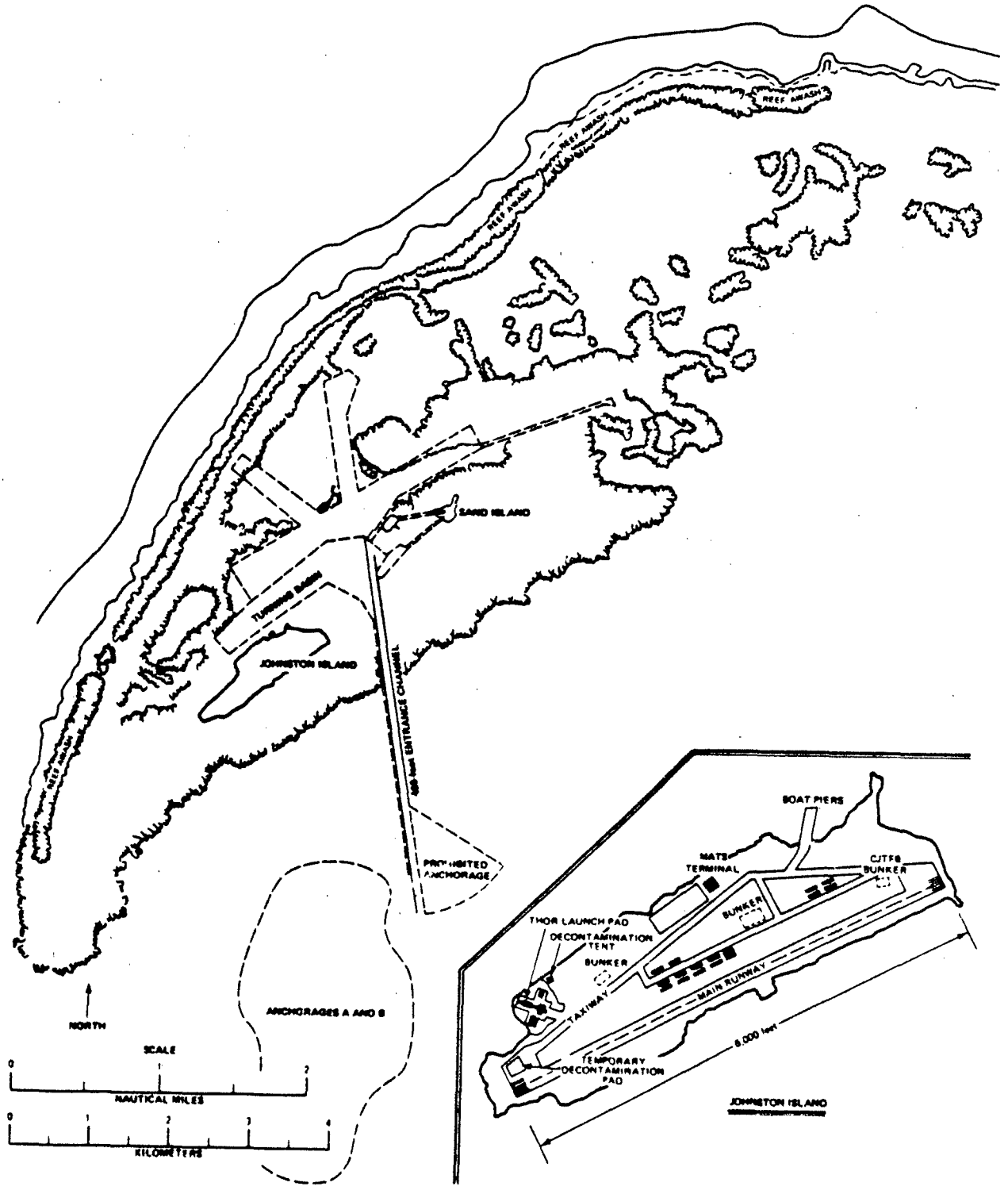


Figure 10. Johnston Atoll and Johnston Island, 1962.

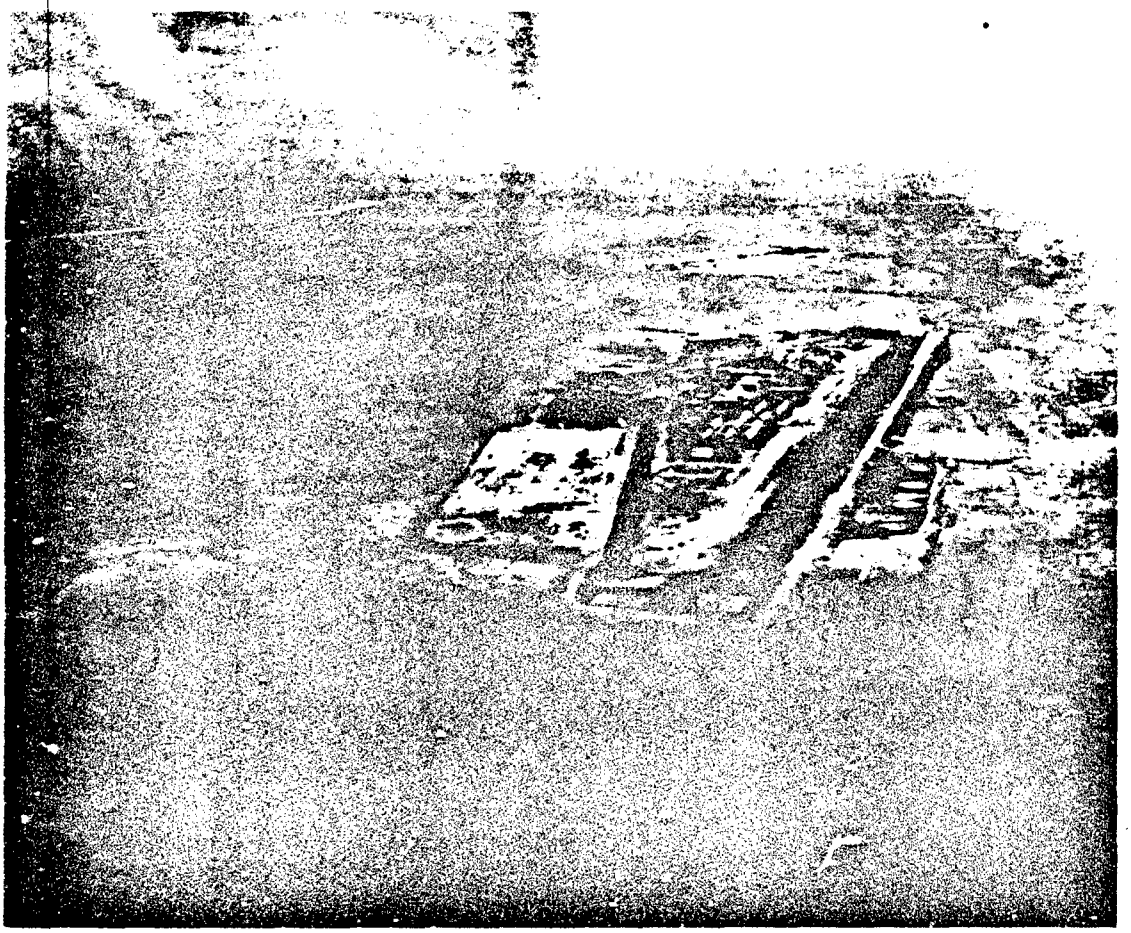


Figure 11. Johnston Island photographed from an aircraft preparing to land from the west, 1962.

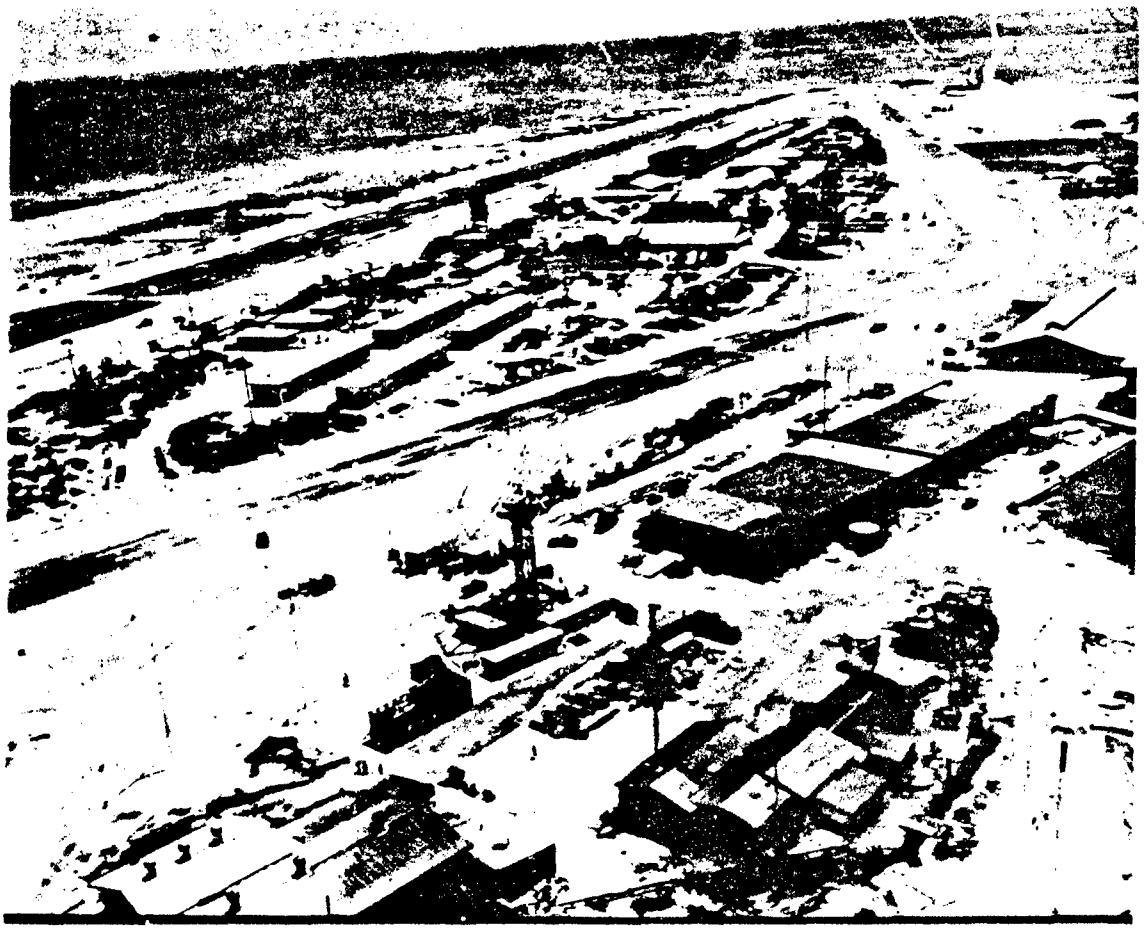


Figure 12. Johnston Island facilities looking west, 1962.

Figure 13 is an aerial view of Johnston Island showing a large antenna used for a scientific project and other facilities used for DOMINIC. It also shows the Military Sea Transportation Service (MSTS) ship, USNS Range Tracker (T-AGM-1), docked at the pier and several other vessels at the small boat dock. Range Tracker was at Johnston Island throughout the DOMINIC series.

JOINT TASK FORCE 8

The organization that had conducted prior U.S. Pacific tests, Joint Task Force 7 (JTF 7), had been dissolved during the moratorium. The Joint Chiefs of Staff (JCS) established a new organization designated JTF 8 to conduct the DOMINIC series. The task force had to overcome serious logistic and administrative problems in reconstructing a test organization. On 21 October 1961, JCS assigned the Defense Atomic Support Agency (DASA) the task of planning for the atmospheric tests to be carried out under control of JTF 8.

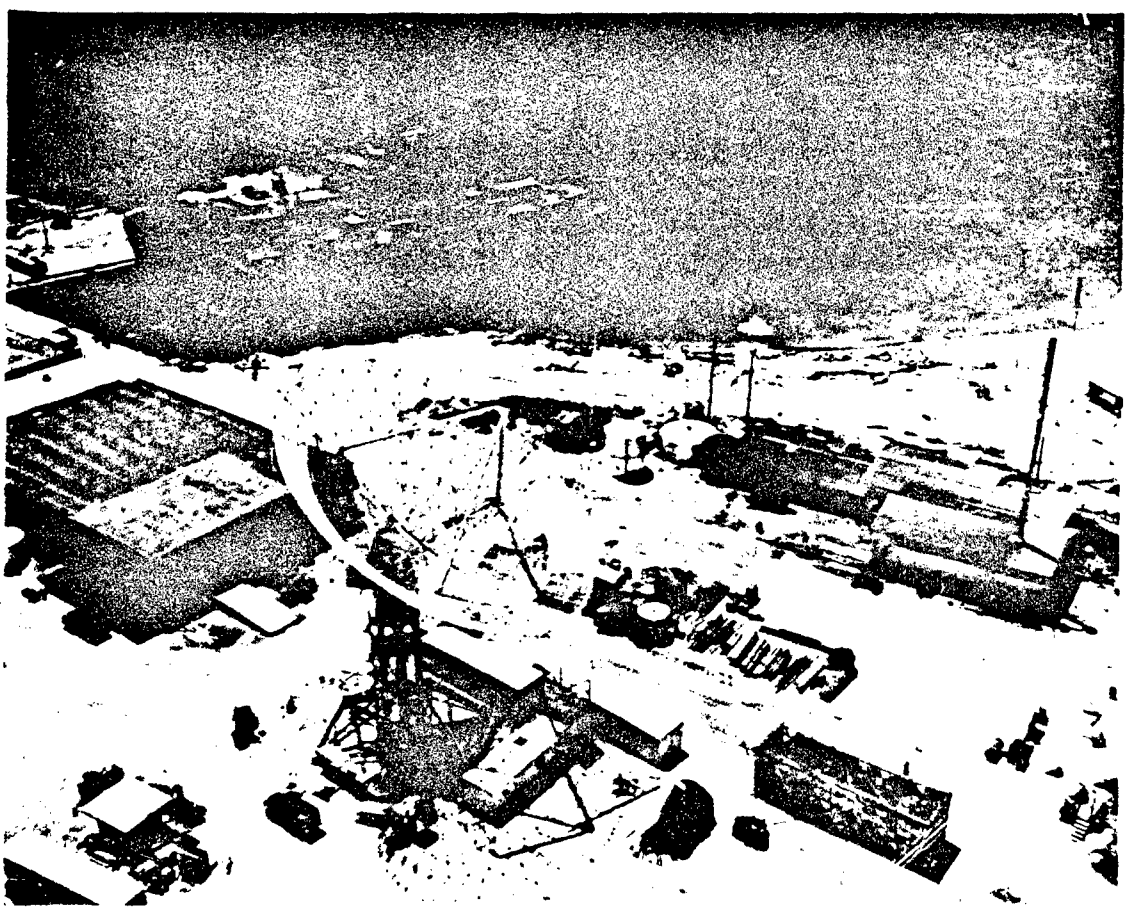


Figure 13. Aerial view of Johnston Island showing a large antenna used for a scientific project and other facilities used during DOMINIC.

JTF 8 was organized in a way similar to prior test organizations. It incorporated elements of the military services and their contractors, elements of the AEC and its contractors, and other governmental agencies in its structure. Commander JTF 8 (CJTF 8), an Army officer, was appointed by the JCS.

Figure 14 shows the complexity of this organization. CJTF 8 was responsible to both the JCS and the AEC Chairman. Through the Chairman of the Military Liaison Committee, differences between the AEC and the DOD were resolved. CJTF 8 had three deputy commanders: one was from the Navy and also commanded the Navy task group (JTG 8.3); another was from the Air Force and commanded the Air Force task group (JTG 8.4); the third deputy was an AEC civilian and directed all the scientific activities. There was no JTG 8.1 or JTG 8.2. In the pre-moratorium Pacific test organizations, the first task group was always the scientific organization and the second task group was the Army support group. In DOMINIC, the scientific task group existed as a large staff directly subordinate to the AEC civilian deputy. The Army support group's activities in prior tests had been mainly involved with the garrisoning of Enewetak Atoll. This was not necessary for tests at Christmas and Johnston islands; therefore, there was no formal Army task group. Army personnel did participate, however, and were present in several different organizations. The base support task group (JTG 8.5) was predominantly manned by Holmes & Narver, Inc. (H&N) personnel under contract to the AEC. This same contractor had provided these services in all the Pacific tests in the 1950s.

The base commands for Johnston Island and for Christmas Island, JTG 8.6 and JTG 8.7, respectively, had personnel from all the services. Two special task groups (JTG 8.8 and JTG 8.9), predominantly Navy, were formed from JTG 8.3 for the SWORDFISH and FRIGATE BIRD events, respectively.

The resulting JTF 8 organization was typical of interagency establishments at the Federal level. It worked because of past experience and because it met the realities of the situation. The realities were that tests were being conducted to develop nuclear weapons, an activity limited by law to a civilian agency, the AEC. Planning for the tests had to be completed in a very short time. One of the locations was owned by the United Kingdom (Christmas Island), while the other was owned by the United States (Johnston Island) and operated by the Air Force. Only the U.S. military establishment could provide the logistic and security resources required by an operation conceived and executed in such a short time.

Joint Task Force 8 Headquarters

The organization of Hq JTF 8 is shown in Figure 15. Shown are the three principal deputies, the six principal staff functions (J-1 through J-6), and the four special staff areas. Under the Assistant Chief of Staff for Operations and Plans (J-3) are two organizations related to radiological safety: the Radsafe Branch and the Hazards Evaluation Center (Branch). Personnel from all the services were contained in this headquarters element. This element is further discussed in Chapter 2.

Most Hq JTF 8 personnel were located at Christmas Island in the Joint Operations Center (JOC), which was the operational site for Hq JTF 8 Main. Hq JTF 8

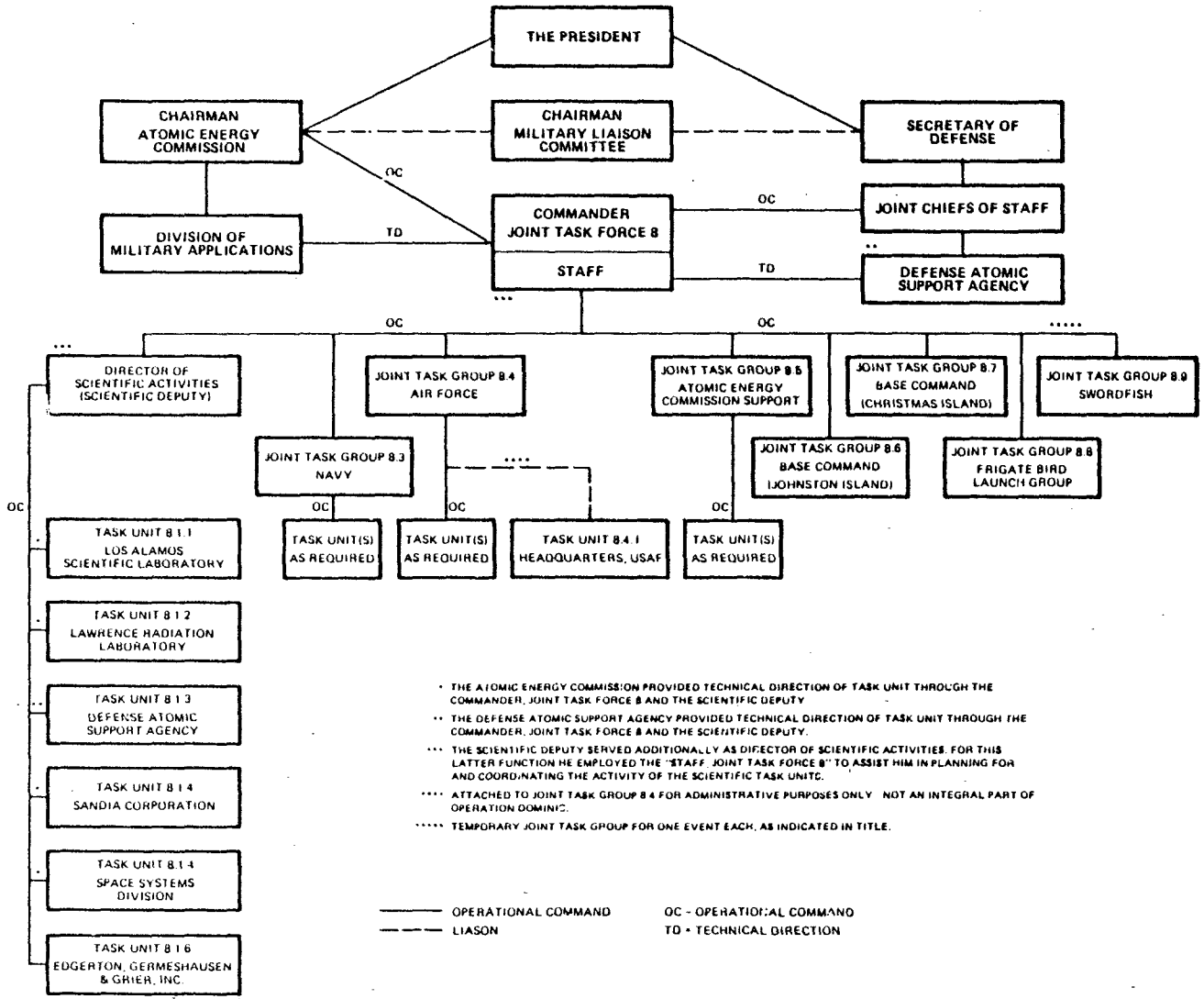


Figure 14. Overall command structure, DOMINIC.

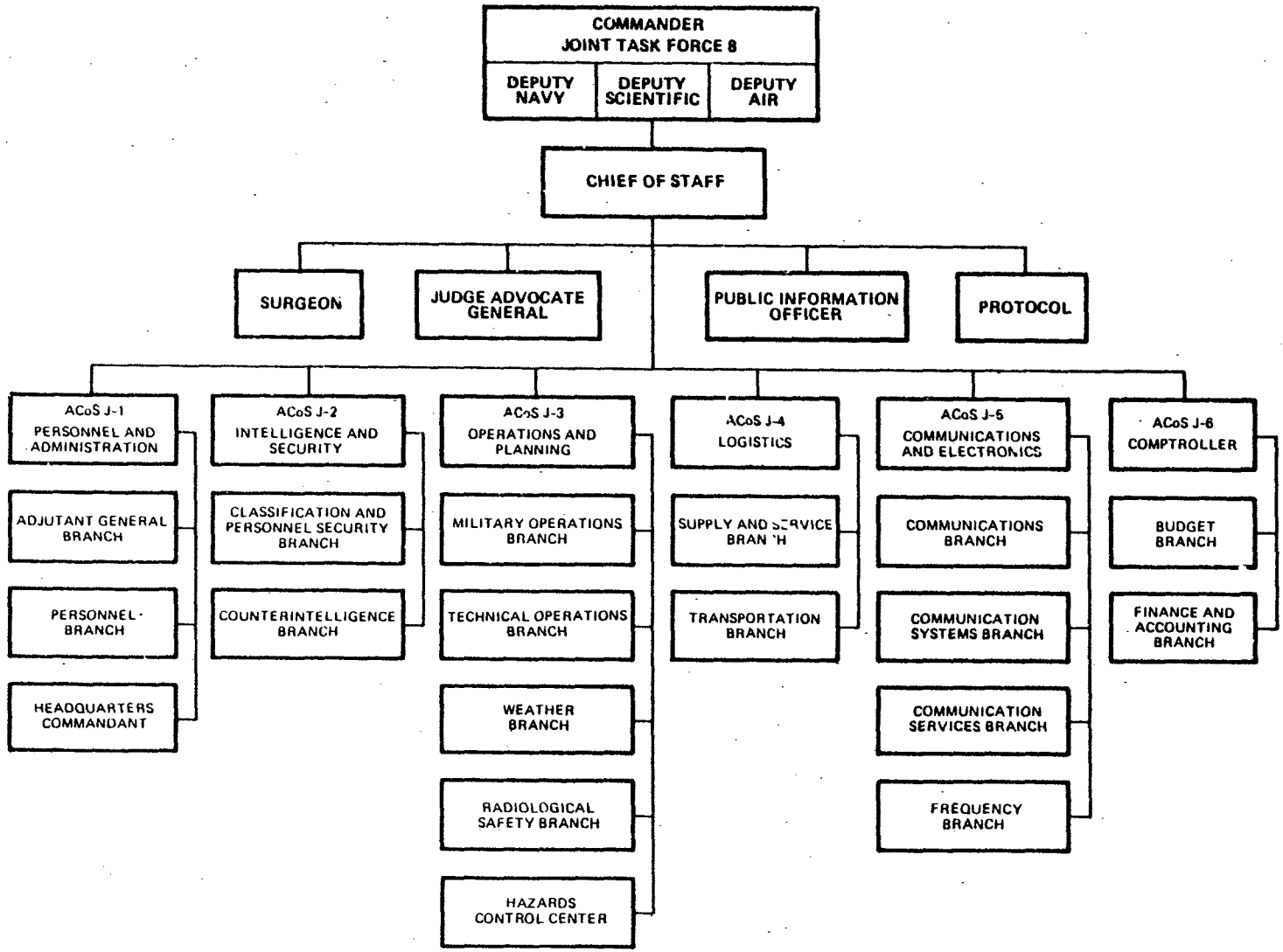


Figure 15. Organization of Headquarters Joint Task Force 8.

Forward was located on Johnston Island. Hq JTF 8 Rear was located in Washington, D.C., and other JTF 8 representatives were based at Hawaii. Table 2 summarizes the manning statistics for Hq JTF 8. Table 3 contains a breakdown by location. In Table 3 the statistics for JTF 8 Main were obtained by subtracting the totals for the other locations from the 15 June 1962 figures in Table 2 (Reference C.1.I, pp. A7 and A8).

Scientific Task Units

Seven task units (TU) carried out the scientific activities. Together they functioned more or less like a task group under the scientific deputy to CJTF 8, although there was no formal scientific task group designation.

TASK UNIT 8.1.1. This unit was manned by 145 civilian personnel from the Los Alamos Scientific Laboratory (LASL). These personnel carried out diagnostic measurements for LASL weapon development activities. Most of TU 8.1.1 was located on Christmas Island. Individuals moved from place to place in the operational area and were aboard ships and aircraft from time to time.

Table 2. Joint Task Force 8 Headquarters manning statistics, DOMINIC.

	Permanent		Temporary		
Period Ending	Officers	Enlisted	Officers	Enlisted	Total
30 Nov 1961	25	25	--	---	50
31 Dec 1961	31	36	--	1	68
31 Jan 1962	53	62	16	25	156
28 Feb 1962	59	74	24	63	220
31 Mar 1962	60	74	38	93	265
30 Apr 1962	61	74	38	93	266
31 May 1962	61	72	38	108	279
15 Jun 1962	61	74	38	109	282
30 Jun 1962	60	73	39	105	277
31 Jul 1962	60	73	16	68	217
31 Aug 1962	59	71	11	43	184
30 Sep 1962	58	72	19	68	217
31 Oct 1962	58	73	21	69	221
30 Nov 1962	56	73	7	35	171
31 Dec 1962	55	72	4	12	143

Source: Reference C.1.I.

Table 3. Joint Task Force 8 Headquarters detachments (military), DOMINIC.

Location	Officers	Enlisted
JTF 8 Rear, Washington, D.C.	8	28
JTF 8 Representatives, Pearl Harbor	8	10
JTF 8 Forward, Johnston Island	11	14
JTF 8 Main[a], Christmas Island	72	131

Note:

[a]Derived by subtracting the totals for Rear, Representatives, and Forward from Table 4.

Source: Reference C.1.I.

TASK UNIT 8.1.2. Manned by 410 personnel from the Lawrence Radiation Laboratory (LRL), TU 8.1.2 performed diagnostic measurements for LRL weapon development activites. Like the LASL personnel, they were mostly on Christmas Island but moved about also.

TASK UNIT 8.1.3. This DOD unit from DASA Field Command (which managed several experiments to determine the military effects of nuclear detonations) comprised about 130 personnel from all the services. This unit was organized into five task elements (TE): TE 8.1.3.1 was located at Johnston Island, TE 8.1.3.2 at Hickam AFB, TE 8.1.3.3 at Christmas Island, TE 8.1.3.4 at Viti Levu in the Fiji Islands (but later at Tutuila in American Samoa), and TE 8.1.3.5 was at Sandia Base (Kirtland AFB) in New Mexico.

TASK UNIT 8.1.4. This unit assisted both AEC weapon development laboratories (LASL and LRL) and the DOD in modifying nuclear devices. It numbered 318 civilian personnel from Sandia Corporation. These personnel also supported LASL (TU 8.1.1) and LRL (TU 8.1.2) diagnostics experiments and the DASA (TU 8.1.3) experimental measurements. They were located at Hawaii, Christmas Island, and Johnston Island. They also moved from place to place.

TASK UNIT 8.1.5. This was an Air Force unit from Space Systems Division, Air Force Systems Command, numbering up to 128 personnel. This unit procured Air Force missiles and associated equipment for the high-altitude (FISHBOWL) shots. They were based at Johnston Island and fired the Thor missiles used to loft three of the test devices in the high-altitude shots of DOMINIC.

TASK UNIT 8.1.6. A civilian unit of 183 personnel from Edgerton, Germeshausen, and Grier, Inc. (EG&G), TU 8.1.6 provided the timing and firing signals for the nuclear detonation, when required, and also gave technical support to other JTF 8 units. They were primarily located on Christmas and Johnston islands.

TASK UNIT 8.1.7. This Army unit of 81 personnel from the Second Missile Battalion at Fort Bliss, Texas, was added to the JTF 8 organization in late August 1962. It was located at Johnston Island and fired the Nike/Hercules missiles during the FISHBOWL tests.

Joint Task Group 8.3 (Navy)

The Navy task group exercised operational control over all ships participating in DOMINIC. These included U.S. Coast and Geodetic Survey (USC&GS) vessels, the U.S. Army Ship (USAS American Mariner), and MSTS and commercial ships.

In addition to manning the temporary task groups for the Polaris firing (JTG 8.8) and the antisubmarine rocket (ASROC) test (JTG 8.9), the Navy task group participated in the following activities during DOMINIC:

Danger area surveillance	Weather
Shipboard technical instrumentation	Target raft emplacement
Missile nosecone recovery	Search and rescue (SAR)
Missile instrument pod recovery	Island evacuation
Photography	Scientific projects
Logistics support	Radiological safety

Most personnel in JTG 8.3 were crewmembers aboard ships or small craft. However, several Navy organizations were based at Christmas, Johnston, and the Hawaiian islands, including Marine Corps aviation units.

Figure 16 illustrates JTG 8.3 personnel participation by month in DOMINIC. Tables 4 and 5 contain JTG 8.3 ship participation and aircraft participation information, respectively.

Joint Task Group 8.4 (Air Force)

The JTG 8.4 requirements for both aircraft and air support personnel were assembled from worldwide Air Force units. Almost no single Air Force organizational entity was the sole participant for a given JTG 8.4 activity (Reference C.1.C).

The Air Force task group numbered about 2,600 personnel from some 400 various organizations and from numerous commands, including the Air National Guard from Arkansas, California, Georgia, Kansas, Kentucky, Maine, Michigan, Missouri, Montana, Nebraska, Nevada, North Dakota, Oklahoma, Oregon, Pennsylvania, Tennessee, Vermont, Washington, West Virginia, and Wisconsin. Most of the participants, however, came from units stationed at Hickam AFB in Hawaii, the Air Force Special Weapons Center (AFSWC) and the 1211th Test Squadron at Kirtland AFB, and the 6th Weather Squadron (Mobile) at Tinker AFB. Many participating organizations had fewer than five men.

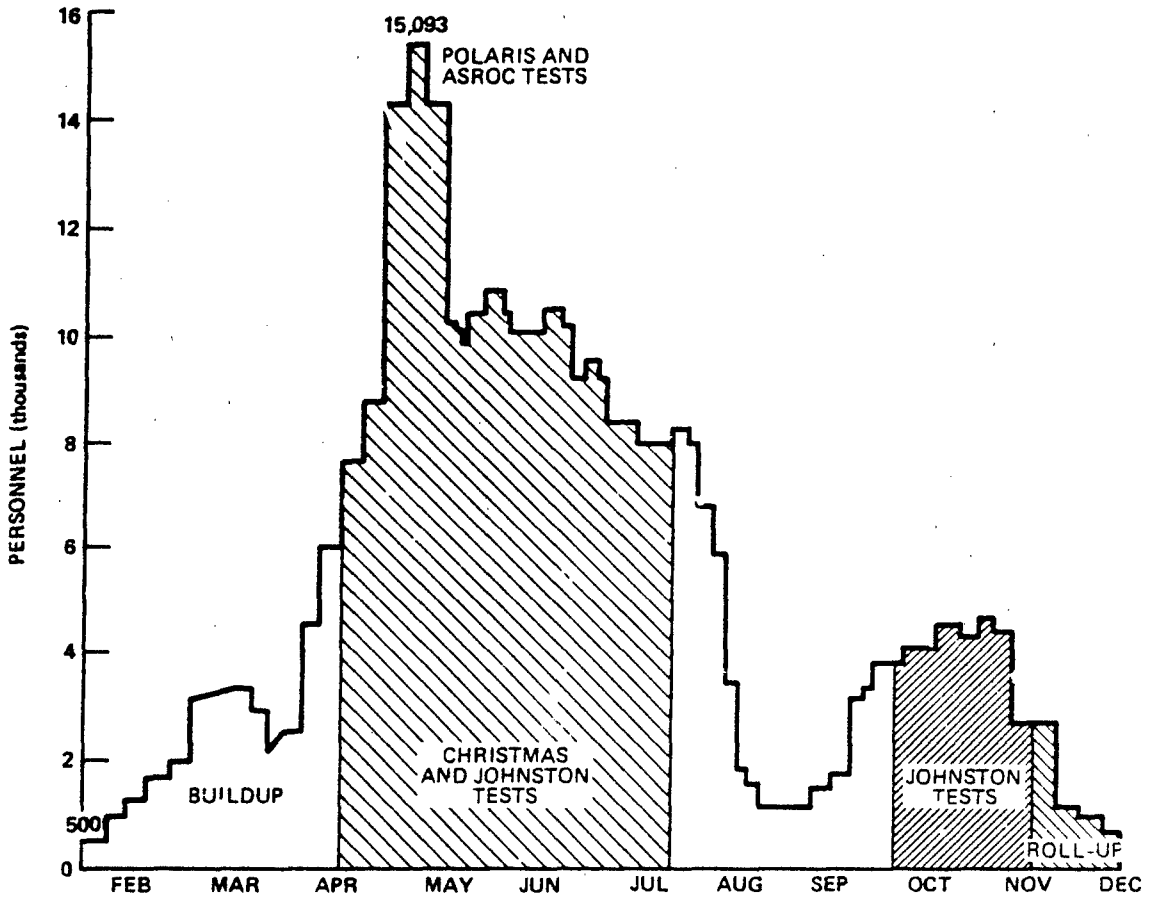


Figure 16. Joint Task Group 8.3 personnel participation during DOMINIC.

Table 4. Ship participation summary, DOMINIC.

	Christmas Island					Johnston Island				
	Buildup	Operations	Rollup	FRIGATE BIRD	SWORDFISH	Buildup	Summer Operations	Fall Operations	Rollup	Total[a]
Navy Ships										
AF	1									1
AKA			2							2
AO		4		1			3	1		5
ARS	2	2	1			5	2	1	1	6
ATF	6	2	1		6	4	8	2	3	15
AVM				1						1
CVS				1	1					1
DD		5		5	8		5	3		17
DER		4					3	3		5
DL							1	1		1
LPH							1	1	1	2
LSD	5	1	3		1	1	2			7
LST	4	3	4			5	2	2	5	9
MSC					1					1
MSO							2	3	1	5
SS				3	2					5
Total Navy	18	21	11	11	19	15	29	17	11	83
USC&GS	1				1					2
MSTS	4	3	3			1	2	5	3	6
USAS							1	1		1
Commercial		1	1					1	1	3
Grand Total	23	25	15	11	20	16	32	24	15	95

Note:

[a] Many ships participated in more than one of the operations, so that the sum of the indicated participation by the operation exceeds the total participation.

Code to Abbreviations: USC&GS -- U.S. Coast and Geodetic Survey; MSTS -- Military Ship Transportation Service; USAS -- U.S. Army Ship.

Source: Reference C.1.8.

Table 5. U.S. Navy and U.S. Marine Corps aircraft, DOMINIC.[a]

Type	Total	Christmas Island	Johnston Island (Summer)	Johnston Island (Fall)	ASROC	Polaris
AD-5W	6				6	6
A3D	2				2	
F8U	2		2			
HSS	16				16	16
HUL	2		2			
HUS	33		29	27	2	
P2V	53	27	34	26	11	10
R5D	2				2	
S2F	16				16	16
WV-2	4	1				3
Totals	136	28	67	53	55	51

Note:

[a]All aircraft provided by Commander in Chief, Pacific Fleet.

Source: Reference C.1.8.

The activities of JTG 8.4 were:

Device drops	Scientific projects
Weather	Cloud sampling
Airborne control	Communications
Airborne diagnostics	SAR
Airborne technical instrumentation	Cloud tracking
Radiological safety	Sample recovery
Effects	Documentary photography

The Air Force task group had four task units for the Christmas Island airdrops in DOMINIC. Later in the series, when more airdrops were added at Johnston Island, only two task units (8.4.3 and 8.4.4), based at Hickam AFB, were used by JTG 8.4 for the last part of DOMINIC. The four task units in JTG 8.4 for the first part of DOMINIC are described below (References B.4.11, C.4.1, C.4.3.1, and C.4.4.1).

TASK UNIT 8.4.1. This unit, a Hq USAF office at Christmas Island, provided coordination, liaison, and supervision of Hq USAF technical projects. The Hq

USAF projects involved numerous civilian contractors and agencies of each of the services. Project locations covered most of the Pacific area from Alaska to Australia.

TASK UNIT 8.4.2. This unit was frequently called the "Test Services Unit." This name was carried over from the Air Force unit that performed similar services in earlier series in the Pacific. It was based at Christmas Island and was composed of the elements summarized below.

Drop and Diagnostics Element. This element provided the two C-130 diagnostic aircraft, but not the B-52 drop aircraft, which were part of TU 8.4.4. The C-130s, SN 60-298 and SN 60-299, were from the Tactical Air Command (TAC) stationed at Sewart AFB, Tennessee. SN 60-298 supported LASL diagnostics, and SN 60-299 supported LRL diagnostics. They staged out of NAS Barbers Point, although for one Christmas Island event they operated from the island.

Air Control Element. This element operated five RC-121 aircraft (Nos. 128, 542, 543, 547, 550) primarily for airborne air control purposes, but they were also used for radar tracking, technical data, and communications. Aircraft and personnel were from the 552nd Airborne Early Warning and Control Wing, McClellan AFB, California, a unit in the Air Defense Command (ADC). The unit operated from Christmas Island, Hickam AFB, and Nandi International Airport in the Fiji Islands. The unit also assisted the National Aeronautics and Space Administration Project Mercury at Midway. During the Cuban missile crisis, near the end of October 1962, two aircraft were recalled to McClellan AFB.

Aeronautical Systems Division (ASD) Effects Element. This element provided two B-57 aircraft for weapon effects experiments (thermal radiation) at Christmas Island. ASD was based at Wright-Patterson AFB, Ohio.

Helicopter Element. Six H-21 helicopters from the 3635th Flying Training Wing, Stead AFB, Nevada, comprised this element and were used for local air transportation, SAR missions, and rocket sampler nosecone recovery. They were based at Christmas Island.

Documentary Photography Element. Two C-54 aircraft (Nos. 45-492 and 45-561) from Turner AFB, Georgia (1370th Photo Mapping Wing), made up this element. Its 63 personnel, all from the Air Photographic and Charting Service (APCS), came from the 1370th Wing, Lookout Mountain AFS, California; Ent AFB, Colorado; Orlando AFB, Florida; Westover AFB, Massachusetts; Barksdale AFB, Louisiana; and Vandenberg AFB, California.

Weather Reporting Element. This element collected and reported weather data using rawinsonde (instrumented balloon) techniques at Hickam AFB (known as Flight A), Tutuila in the Samoas (Flight B), Johnston Island (Flight C), Palmyra (Flight D), Christmas Island (Flight E), and Malden (Flight F). The 6th Weather Squadron, Tinker AFB, Oklahoma, was the central unit for the Weather Reporting Element.

Reconnaissance Element. This element was composed of two flights. The sampler flight flew cloud-sampling missions in 18 B-57 aircraft (11 B- or C- and 7 D-models). The sampler aircraft were loaned to the 1211th Test Squadron by

several commands, including the U.S. Air Force, Europe (USAFE). Crews were from the 1211th Test Squadron, Kirtland AFB. The Weather Reconnaissance Flight operated ten WB-50 aircraft from the AWS to collect weather data. Six aircraft were based at Christmas Island and four at Hickam AFB. Element strengths were 362 at Christmas Island and 248 at Hickam AFB on 31 May 1962. The 55th Weather Reconnaissance Squadron, McClellan AFB, was the central unit for the Weather Reconnaissance Flight.

TASK UNIT 8.4.3. This unit had three elements based at Hickam AFB.

High-Altitude Element. This element was composed of four flights, three from Strategic Air Command (SAC) and one from Air Force Systems Command (AFSC):

- Weather Flight -- Contained two U-2 aircraft from the 4080th Strategic Reconnaissance Wing, Laughlin AFB, Texas, that flew high-altitude weather photography missions for the FISHBOWL shots.
- Communications Flight -- Operated two KC-135 aircraft and two B-47 aircraft from SAC for communication experiments and UHF voice relay links in the FISHBOWL shots.
- Technical Flight -- Flew two KC-135 aircraft, one supporting Hq USAF projects and the other supporting TU 8.1.1
- AFSC Flight -- Flew three KC-135 aircraft in support of DOD effects experiments in the FISHBOWL shots.

Medical Test Element. This element provided five C-118 and five C-54 aircraft to support the retinal burn studies conducted by the Aerospace Medical Division, Brooks AFB, Texas, for DASA. The C-54s were from various Air Force commands, while the C-118s were from the Naval Air Transport Wing, Atlantic. Ten men from Naval Air Transport Squadron Six flew the C-118s.

Calibration Element. This element operated two KC-97 aircraft to calibrate the missile-tracking equipment installed at Johnston Island by Cubic Corporation. The Tennessee Air National Guard furnished a KC-97 and two aircrews; the second KC-97 was from the Georgia Air National Guard with two aircrews. California and Oklahoma National Guard units provided 16 additional personnel.

TASK UNIT 8.4.4. This unit, based at NAS Barbers Point, comprised the B-52 portion of the Drop and Diagnostics Element, but also did the maintenance on the C-130 diagnostic aircraft. The two B-52s (Nos. 56-013 and 56-620) dropped the nuclear devices. In addition, TU 8.4.4 assisted TU 8.1.4 in handling, mating, and loading the nuclear devices into the B-52s. One B-52 and crew was from AFSWC. The second was a SAC aircraft and had two crews during the course of DOMINIC. At least one of the crews was from the 4245th Strategic Wing, Sheppard AFB, Texas.

Upon completion of the Christmas Island airdrops, JTG 8.4 was disbanded and most of the aircraft returned to parent commands. Others, however, were retained in the proving grounds for the next phase of DOMINIC. Those returned to parent commands are as follows:

Aircraft	Parent Unit
C-54 Documentary Photography	MATS
WB-50 Weather Reconnaissance	MATS
RC-121 Controller and Radar	ADC
U-2 High Level Photography	SAC
1 C-135 Sample Return	MATS
1 C-118 Sample Return	MATS
2 H-21 Logistic Support	ATC
1 B-52 Drop and Backup	AFSWC
1 B-52 Drop and Backup	SAC
2 B-57 Sampler	MATS
4 B-57 Sampler	ADC
1 B-57 Sampler	USAFE
1 B-57 Sampler	AFSC
3 KC-135	AFSC
1 KC-135	SAC (retained at Kirtland)
2 C-130 Diagnostic	TAC (retained at Kirtland)

Then, because of added airdrop missions to complement the FISHBOWL shots, several aircraft were recalled and a new JTG 8.4 organization was established. The new organization was comprised of TU 8.4.3 at Hickam AFB, TU 8.4.4 at NAS Barbers Point, and JTG 8.4 representatives at Johnston Island.

The new TU 8.4.3 was composed of a Test Services Element (TE 8.4.3.1), a High-Altitude Element (TE 8.4.3.2), and typical staff sections such as Operations, Materiel, Safety, Communications, etc. (Reference C.4.3.1). Both TE 8.4.3.1 and TE 8.4.3.2 were made up of flights, each flight performing the same basic function as they did during the Christmas Island airdrops. Each flight also came from the same parent commands as before; basically only the numbers of personnel and aircraft were changed. TE 8.4.3.1 included the following flights and aircraft: Documentary Photography (one RC-54), Air Control (four RC-121s), Weather Reconnaissance (five WB-50s), Weather Reporting, Calibration (one KC-97), and Medical Effects (one SC-54 and six C-118s). TE 8.4.3.2 had the following flights: Weather (three U-2s), Communications (two B-47s), Technical (two KC-135s), and AFSC (three KC-135s).

TU 8.4.4 at NAS Barbers Point was organized into sections. The sections included Operations, Maintenance, Security, Communications, Weapons, Supply, and Instrumentation. The Operations Section was the flying part of the organization and had a B-52 Branch, a C-130 Branch, and a B-57 Branch. The B-52 Branch was responsible for airdrop of the nuclear devices and used aircraft No. 60-620. The C-130 Branch flew two C-130 diagnostic aircraft (Nos. 298 and 299). The B-57 Branch had the sampler aircraft (eight B-57s, all D-models). Radiological safety came under the B-57 Branch. The Maintenance Section had

corresponding maintenance branches; i.e., B-52, C-130, and B-57. As with the components in TU 8.4.3, those in TU 8.4.4 had basically identical prime functions as during the Christmas Island airdrops (Reference C.4.4.2).

Statistics on the manning levels for JTG 8.4 are contained in Table 6.

Table 6. Military unit manning levels (DOMINIC).

Period Ending (1962)	Joint Task Group					Task Unit			Totals
	8.3 (Shore)	8.3 (Ships)	8.4	8.6	8.7	8.1.3	8.1.5	8.1.7	
31 Jan	40	617	55	114	0	131	6	0	963
28 Feb	348	1,056	93	274	37	155	8	0	1,971
31 Mar	557	1,579	262	252	261	304	109	0	3,324
30 Apr	1,068	13,785	1,367	254	223	499	128	0	17,324
31 May	749	9,174	1,468	261	229	1,106	112	0	13,099
30 Jun	842	8,006	1,192	253	212	1,055	102	0	11,662
31 Jul	172	3,268	297	251	197	940	116	0	5,241
31 Aug	89	561	64	186	21	214	88	80	1,303
30 Sep	89	3,711	588	275	11	475	116	80	5,345
31 Oct	205	4,245	784	342	10	807	116	81	6,590
30 Nov	116	160	17	47	2	0	11	0	353
31 Dec	75	0	3	22	2	0	16	0	118

Source: Reference C.1.I.

Joint Task Group 8.5 (AEC Support)

JTG 8.5 was composed of civilian personnel under contract to the AEC (Reference C.1.E). It had three task units, two of which were attached and performed a part of AEC and JTF 8 scientific activities. Headquarters for JTG 8.5 was in Las Vegas, Nevada.

TASK UNIT 8.5.1 (H&N). Numbering over 2,000 contractor personnel, TU 8.5.1 provided support to JTF 8 in construction and renovation of facilities (buildings and equipment) to be used for DOMINIC. Their efforts involved almost every Pacific island where a DOMINIC site existed. Table 7 shows island locations used in DOMINIC. TU 8.5.1 had a Pacific Operations Branch at Honolulu and three sections at Christmas, Johnston, and Tutuila islands. TU 8.5.1 also installed the AEC communication networks at Christmas, Johnston, and the Hawaiian islands. At Christmas Island it provided security guards for seven guardposts, operated a structural fire department and a crash rescue fire department (buildings and aircraft, respectively), staffed a hospital and two first-aid

Table 7. Pacific locations used in DOMINIC.

Location	Element Participation					
	Headquarters Element[a]	Weather	Radsafe	Technical Project	Rocket Launch Site	EOD[b]
Christmas	X	X	X	X	X	X
Johnston	X	X	X	X	X	X
Fanning			X			
Washington			X			
Palmyra		X	X	X		
Hawaii		X		X		
Oahu	X	X	X	X		X
Kauai	X			X	X	
Fairbanks, Alaska				X		
Adak				X		
Shemya				X		
Attu				X		
Midway		X	X	X		
Japan				X		
Wake		X	X	X		
Okinawa				X		
French Frigate Shoals			X	X		
Philippines				X		
Guam				X		
Truk		X				
Ponape		X				
Kwajalein		X	X	X		
Darwin, Australia				X		
Majuro		X				
Guadalcanal				X		
Canton		X	X	X		
Viti Levu, Fiji			X	X		
Tutuila, Samoa		X	X	X		
Tongatabu			X	X		
Papeete, Tahiti			X			
Nuku Hiva, Marquesas			X			

Notes:

[a] JTF 8 Headquarters.

[b] Explosive Ordnance Disposal.

Source: Reference C.1.A.

stations, and provided many other services. These other services included operating the dining hall, the laundry, post office, barber shop, and stores. It also performed radsafe monitoring and hauled contaminated water from aircraft decontamination facilities to the disposal site.

At Johnston Island TU 8.5.1 also performed radsafe monitoring and provided the workers who decontaminated the Thor launch pad that became contaminated on 25 July 1962. It staffed a medical facility on Johnston Island and provided additional services similar to those on Christmas Island.

TASK UNIT 8.5.2. These 57 personnel staffed the JTF 8 Hazards Evaluation Branch and were knowledgeable in nuclear explosion effects. The unit was made up of personnel from Scripps Institution of Oceanography, LASL, LRL, Sandia, the U.S. Weather Bureau, and the U.S. Navy Hydrographic Office. It assisted in evaluating each scheduled detonation from a safety viewpoint to include fallout, air shock, thermal, nuclear radiation, and water waves (Reference C.1.A, pp. 18 and 19).

TASK UNIT 8.5.3 Six men from the University of Washington staffed this task unit, which performed extensive preoperational radiological sampling in the Pacific area. Samples of fish, other foodstuffs, and water were analyzed to establish baseline radiological conditions before DOMINIC detonations began and after the conclusion of DOMINIC (Reference C.1.N, p. 18).

Joint Task Group 8.6 (Johnston Island Base Command)

This task group was the base command that supported all elements of JTF 8 located on Johnston Island. Personnel from all the services and civilians were included in JTG 8.6. Uniquely, JTG 8.6 included units or detachments from the other joint task groups. This becomes clearer by a discussion of how its functions were carried out through seven task units, in addition to some temporary units that were assigned to it. JTG 8.6 maintained a staff that resembled a "mini-JTG 8" staff (Reference C.1.F).

TASK UNIT 8.6.1. The Air Force 6488th Air Base Squadron operated the Air Force Supply, Base Operations, Post Office, Base Exchange, Recreation Center, Officer and NCO Clubs, and Radio Station WVTV. Personnel from TU 8.6.1 also assisted TU 8.5.1 in operating the POL system, aircraft crash rescue detail, and various shops and plants.

TASK UNIT 8.6.2. The Air Force 1957th Communications Group, Detachment 1, operated the Base Communication Center, Pacific Air Force (PACAF) Commander's Voice Circuit, Air Traffic Control Tower, MARS Radio Station, and the base telephone system.

TASK UNIT 8.6.3. The Air Force 1502nd Air Transport Wing, Detachment 6, carried out all air terminal passenger and cargo activities.

TASK UNIT 8.6.4. The 1st Platoon of the 524th Military Police Company (Army) provided security, criminal investigations, vehicular traffic control, and the safeguarding of life and property.

TASK UNIT 8.6.5. The Helicopter Detachment of the 81st Transportation Company (Army) assisted in SAR missions, area surveillance out to 15 nmi (28 km) at sea, helicopter transportation, and calibration of scientific instruments.

TASK ELEMENT 8.3.9.6. This Navy unit, a part of JTG 8.3, was the Johnston Island Boat Group that provided water transportation and waterborne SAR missions.

TASK UNIT 8.5.1. H&N personnel in the Johnston Island section, with assistance from the Air Force, operated all base facilities not assigned to TU 8.6.1 or TU 8.6.2, namely, a dining hall, fire department, laundry, snack bar, and several shops and plants.

In addition to the above units, there were other service units under JTG 8.6 for short periods. The U.S. Army Corps of Engineers dredge, USAS Davidson, conducted dredging operations in March 1962. During tho same period the U.S. Navy Underwater Demolition Team 11 cleared the channel bottom and pier area. U.S. Navy Amphibious Construction Battalion 1 installed and operated fuel lines between the air terminal and offshore fuel barges from September through November.

Joint Task Group 8.7 (Christmas Island Base Command)

Personnel from all the military services and TU 8.5.1 civilians were represented in JTG 8.7. This task group performed many activities like those of JTG 8.6, but it was not organized into separate task units. The activities of TU 8.5.1 on Christmas Island are described above under TU 8.5.1 (Reference C.1.F).

JTG 8.7 had 11 functions:

Surgeon	Special projects (operations)
Chaplain	Communications
Provost Marshal	Bulk fuel detachment
Administration	POL
Disbursing	Post Office
Base Exchange	

Special Projects (Operations) was the Navy unit identified as TE 8.3.9.7, the Christmas Island Boat Group. These personnel participated in waterborne SAR missions and provided water transportation.

The Surgeon (JTG 8.7 Medical Officer) supervised two medical areas, dental and preventive medicine. Medical facilities for military personnel were staffed by the U.S. Army, Pacific. The same facilities were used for civilians, but were staffed by physicians, dentists, and aidmen under contract to TU 8.5.1 (H&N). Preventive medicine consisted of inspecting the dining hall and living quarters, human waste disposal, and testing the drinking water.

Personnel from all services and TU 8.5.1 (H&N) were used for POL support. POL management was a major problem for JTG 8.7 because of the different procedures and techniques among the services. The U.S. Marine Corps installed bulk fuel storage systems and the U.S. Army built a 29-mile (47-km) pipeline. Fuel requirements were submitted to the Naval Fuel Supply Center at Pearl Harbor. JTG 8.3 withdrew fuel for boats, vehicles, and vessels; JTG 8.4 withdrew fuel for aircraft and vehicles; JTG 8.5 withdrew fuel for vehicles. Fuel was also occasionally supplied to the British hosts.

Administration operated the mail and records section, staffed classified document control, and prepared travel orders (e.g., for sample courier officers). Twenty-four officers (who came from JTF 8 Headquarters and subordinate commands) were used as couriers for sample returns from Christmas Island.

Disbursing maintained approximately 900 Navy and Marine Corps pay records, 80 Air Force pay records, and 70 Army pay records, plus about 2,000 per diem payments per month to military and civil service (e.g., U.S. Public Health Service, DASA civilians) personnel.

The Provost Marshal was responsible for security. Personnel from the 524th Military Police Company (Army) and TU 8.5.1 (H&N) provided security guards.

Table 8 summarizes JTG 8.6 and JTG 8.7 manning.

Table 8. Base island command manning levels (DOMINIC).

Function	Joint Task Group 8.6 (Johnston Island)		Joint Task Group 8.7 (Christmas Island)	
	Officers	Enlisted	Officers	Enlisted
Commander and Aide	2	0	1	0
Deputy Commander, Protocol	2	1	---	---
Administration, Chaplain	3	6	3	2
Operations (including air)	1	84	---	---
Military Police Detachment	2	26	2	29
Medical	2	3	2	3
Communications	0	107	5	130
Postal	0	1	1	7
POL Operations	---	---	1	8
Bulk Fuel Detachment	---	---	2	49
Disbursing	---	---	1	10
Totals	12	228	18	238

Source: Reference C.1.I.

Temporary Task Groups

JTG 8.8 and JTG 8.9 were temporary task groups formed for FRIGATE BIRD and SWORDFISH, respectively, the special Navy events. The Navy Deputy to JTF 8 was appointed commander of both groups and used his staff from JTG 8.3 for the preparation of detailed operational plans and the coordination of participating JTF 8 elements and other naval forces under the operational control of CJTF 8. In this manner all participants reported to CJTF 8 through a single well-established and experienced subordinate headquarters. After SWORDFISH and FRIGATE BIRD, some units were released to their type commanders. Much of the initial planning was done by the JTF 8 staff, and throughout both operations CJTF 8 retained command control using 24-hour communications between the Christmas Island Command Post and the CJTF 8 flagship. These task groups are further discussed in Chapters 5 and 6.

JOINT TASK FORCE 8 MANNING SUMMARY

Figure 17 is a graphical illustration of the JTF 8 manning. This figure has curves for military personnel, various categories of civilian personnel, and the JTF 8 grand total as a function of time. The peak grand total in early May 1962 is shown as about 19,500. Table 6 contains statistics for those organizations that were predominantly military. JTG 8.3 was, of course, predominantly Navy, and JTG 8.4 was predominantly Air Force. Personnel in all services were in JTG 8.6, JTG 8.7 and TU 8.1.3, while TU 8.1.5 was Air Force and TU 8.1.7 was Army.

Table 9 contains statistics for the average population at Johnston and Christmas islands. These statistics pertain to DOMINIC participants and do not include, for example, the British and the native plantation workers on Christmas Island. Both Tables 8 and 9 show the large changes in manning levels during DOMINIC.

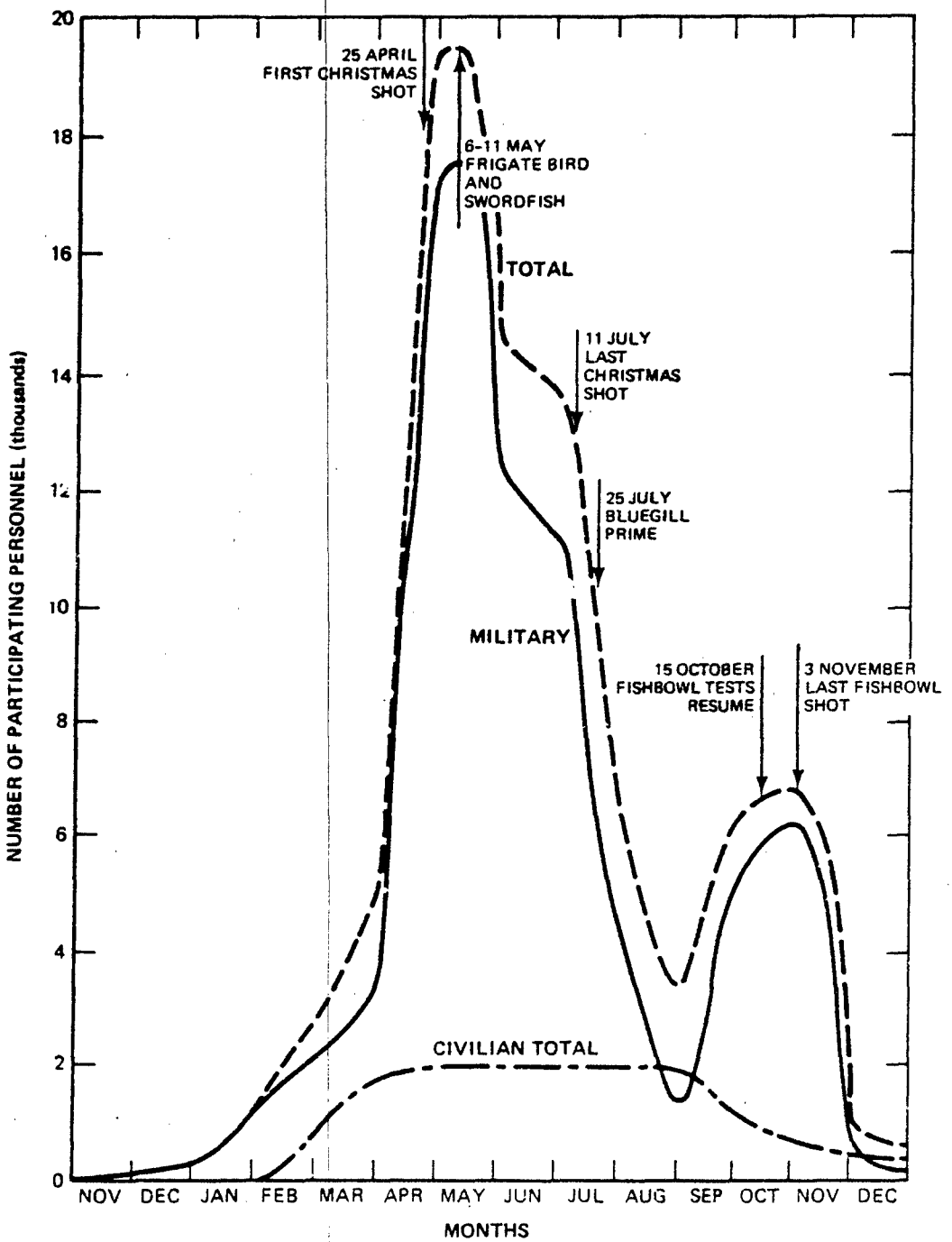


Figure 17. Joint Task Force 8 manning, DOMINIC.

Table 9. Average population at Johnston and Christmas Islands during DOMINIC.

Period	Johnston Island	Christmas Island
12 - 31 Jan 1962	105	Note a
1 - 28 Feb 1962	151	Note a
19 - 28 Feb 1962	Note a	37
1 - 31 Mar 1962	360	460
1 - 30 Apr 1962	441	1,350
1 - 31 May 1962	535	1,769
1 - 30 Jun 1962	565	1,475
1 - 31 Jul 1962	520	685
1 - 31 Aug 1962	311	68
1 - 30 Sep 1962	483	18
1 - 31 Oct 1962	793	16
1 - 30 Nov 1962	378	15
1 - 31 Dec 1962	115	15

Note:

[a]Data not available.

Source: Reference C.1.I.

CHAPTER 2

RADIOLOGICAL SAFETY

Annex J to Joint Task Force 8 (JTF 8) Operations Order 2-62, entitled Radiological Safety Operations, was the basis for all radiological safety (radsafe) operations in DOMINIC. Appendix A is a reproduction of this annex. The principles of Radiological Safety Operations had the concurrence of the military services and the Atomic Energy Commission (AEC). The most general rule established in this order was that the radiological safety of all task force personnel was the responsibility of commanders at all levels and that radsafe activities were to be performed through normal command channels.

RADIOLOGICAL SAFETY ORGANIZATION AND TASKS

The commander of JTF 8 (CJTF 8) had overall radsafe responsibility. His specific responsibilities included informing the Commander in Chief, Pacific (CINCPAC), if radiological problems developed outside the JTF 8 operations area, establishing and maintaining stations for offsite monitoring, and establishing and announcing the times and areas for safe task force operations following the detonations in the atmosphere. The radsafe organizations set up within the JTF 8 headquarters are discussed immediately below, followed by the radsafe activities of the several task units.

JTF 8 had a Task Force Hazards Control Center (Branch) and a Task Force Radsafe Branch. Both were under the operational control of the JTF 8 Assistant Chief of Staff for Operations and Plans (J-3). In addition, the JTF 8 Operations Order 2-62 established an offsite radsafe program that led to participation by the U.S. Public Health Service (USPHS), among others, in DOMINIC operations.

Hazards Control Center (Branch)

The Hazards Control Center (Branch) was composed of two units: the Hazards Evaluation Branch and the Fallout Plotting Center. Their functions are described below.

HAZARDS EVALUATION BRANCH. The Hazards Evaluation Branch predicted explosion effects and interpreted them in terms of potential hazards to populated areas within 1,500 nmi (2,780 km) of the detonation. It performed calculations to predict thermal, blast, and water wave effects ranges and conducted experiments to collect data (Reference C.1.A, p. 19). The branch was manned by personnel from Los Alamos Scientific Laboratory (LASL), Lawrence Radiation Laboratory (LRL), Sandia Corporation, U.S. Weather Bureau, Scripps Institution of Oceanography, and the Navy Hydrographic Office.

FALLOUT PLOTTING CENTER (FOPC). The FOPC plotted the predicted air and surface radiological exclusion (radex) area. Entry to a radex area was rigidly controlled. After each detonation, the FOPC plotted the actual air and surface radioactivity.

Radsafe Branch

The Radsafe Branch accomplished the remainder of the radsafe functions as shown in Figure 18. Table 10 lists the specific supporting tasks performed by the Radsafe Branch by location. The tasks of the Radsafe Branch were to (Reference C.1.N, p. A-1):

- Provide necessary equipment (clothing and instruments) for support of operations associated with contaminated areas and facilities
- Provide dosimetry service for JTF 8 and visitors to include issuing and processing film badges and maintenance of required records
- Operate a radiochemistry laboratory to support offsite radsafe monitoring stations
- Provide trained personnel to advise and assist task force personnel in their radsafe duties.

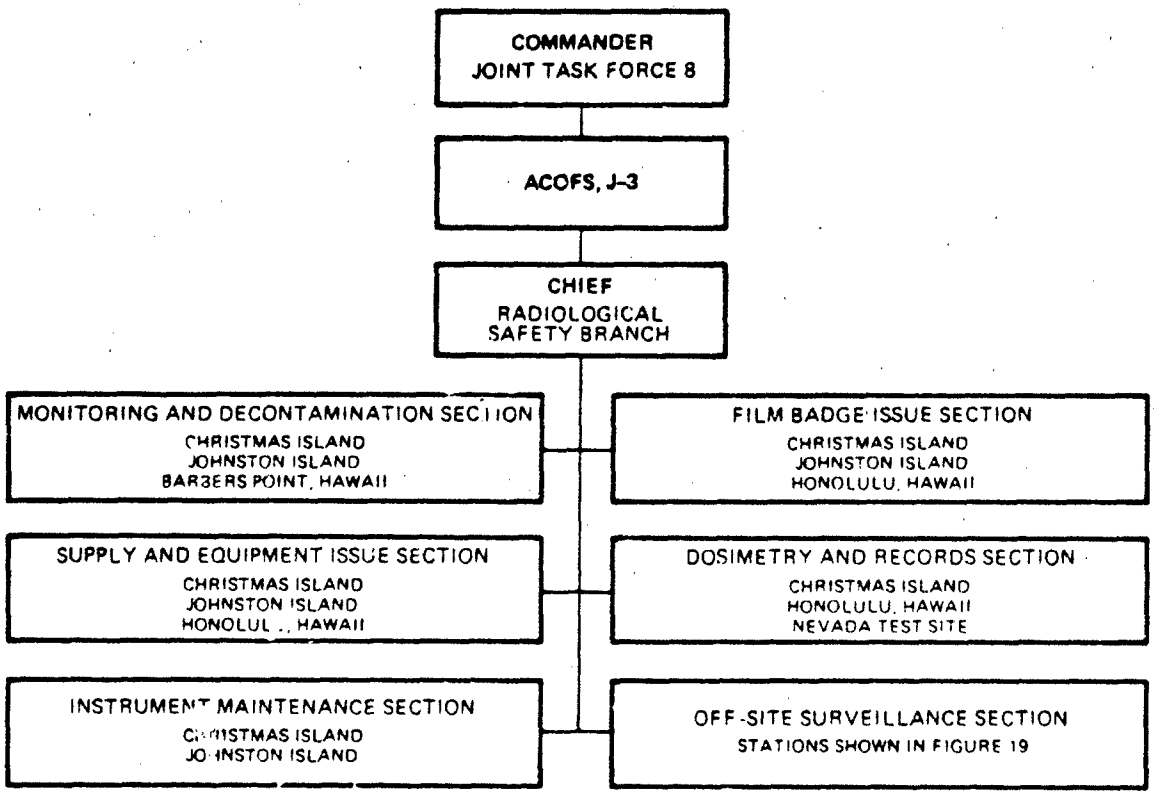


Figure 18. Headquarters, Joint Task Force 8 functional radiological safety organization, DOMINIC.

Table 10. Joint Task Force 6 Radsafe Branch activities at various locations, DOMINIC.

Location	Activities
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 Radiochemical analysis
NAS Barbers Point, Hawaii (2 Oct 62-3 Nov 62)	Aircraft decontamination Personnel and equipment decontamination
Nevada Test Site (15 Dec 62-30 Jan 63)	Photodosimetry

Source: Reference C.1.N, p. A-7.

Joint Task Group 8.3 (Navy)

Joint Task Group 8.3 (JTG 8.3) established its radsafe office in the Operations and Plans (N-3) Section of their headquarters. Requirements imposed by JTF 8 on JTG 8.3 included (Reference B.0.1, Annex J):

- Responsibility for radiological safety of all assigned and attached personnel
- Provision of monitors and decontamination crews aboard each ship
- Establishment and maintenance of radsafe centers as required for afloat operations

- Provision of Navy aircraft support for radiological surveys, cloud tracking, and other postshot radsafe operations
- Preparation of pertinent reports from radsafe reconnaissance and barrier patrol aircraft through the appropriate operations centers
- Establishment and maintenance of radsafe monitor and decontamination services for any aircraft and crew assigned to any element of JTF 8.

JTG 8.3 published its Operation Order 1-62 on 26 March 1962 (Reference B.3.2), which further detailed radsafe responsibilities within the Navy task group. This included specific procedures for handling the NAVMED 1432 (1-62) forms and a set of instructions on film badges to be explained to all JTG 8.3 personnel.

JTG 8.3 required film badges on four representative topside areas and the bridge of every ship and issue of DT60/PD dosimeters to crewmembers (Reference B.3.2, pp. E-1-2 and E-1-3).

The JTG 8.3 Op Order permitted no P2V aerial radiological missions to enter areas with an intensity over 3 R/hr under any circumstances. This plan recommended that P2V aircraft should begin turning away when intensity reached 0.003 to 0.004 R/hr. Inflight reports were required at least every half-hour and a special report was required when the intensity reached 0.010 R/hr (Reference B.3.2, p. E-6-1).

A set of radsafe instructions for recovery of scientific pods, missile nosecones, and target rafts was also included in the Op Plan. Under no circumstances were the pods to come in contact with skin because of predicted high beta radiation. All recovery work with target rafts required personnel to be dressed in complete protective clothing. The plan called for the sinking of any raft with an intensity of 10 R/hr or more. Although none neared this reading, some were sunk instead of being salvaged.

Recognizing the possibility of alpha contamination at Johnston Island, JTG 8.3 established criteria for Maximum Permissible Limits (MPL) of alpha contamination, a subject not addressed by the JTF 8 MPL. The MPL set by JTG 8.3 were in units of counts per minute per 55 cm^2 (CPM/55 cm^2). For vehicles and equipment, the MPL was 200 CPM/55 cm^2; for personnel outer clothing, including shoes, 500 CPM/55 cm^2; and for skin, underclothing, or respiratory protective devices, 100 CPM/55 cm^2 (Reference B.3.2, p. E-7-2).

Subsequent orders published by elements in the JTG 8.3 organization enforced both the JTF 8 criteria and the JTG 8.3 Operations Order 1-62 (References B.3.2, B.4.2, B.5.2, and B.6.2).

Because the underwater detonation, SWORDFISH, was expected to produce significant radioactive contamination in the vicinity of the burst, plans called for the complete evacuation from the danger area around the detonation site of vessels not directly participating in the operation.

Joint Task Group 8.4 (Air Force)

Radsafe planning by JTG 8.4 was based on the consideration that the primary radiation exposure potential would result from sampler aircraft penetrating nuclear clouds. Radiation could also expose sample-removal, aircraft decontamination, and aircraft maintenance personnel as they worked on contaminated aircraft.

Air Force planning for DOMINIC was done by the Air Force Special Weapons Center (AFSWC) at Kirtland AFB, New Mexico. Operation Plan Bluestraw,* with a comprehensive Radsafe Annex, was published in late 1961 (Reference B.4.1). Many of the radsafe features of this plan subsequently appeared in the JTF 8 radsafe plan. In January 1962 JTG 8.4 published DOMINIC Planning Directive 1-62 (Reference B.4.4), with a comprehensive radsafe annex. On 19 February 1962 Operations Plan 2-62 (Reference B.4.6) was published by JTG 8.4, which superseded previous documents.

Radsafe responsibilities assigned to JTG 8.4 by JTF 8 included (Reference B.0.1, Annex J):

- The radiological safety of all assigned/attached personnel
- Provision of aircraft support for cloud tracking and other postshot radsafe operations
- Establishment and maintenance of radsafe monitor and decontamination services for all aircraft and crews assigned to JTF 8 as required
- Provision of crews and monitoring services for the removal of radioactive samples collected by aircraft
- Operation of the Sample Return Compound
- Reporting air radiation intensities encountered on weather and cloud-tracking flights and at outlying weather stations
- Establishment and maintenance of radsafe centers as required; the Christmas Island Radsafe Center functions were to:
  - -- Perform radiological surveys as necessary
  - -- Perform radsafe instrument maintenance
  - -- Maintain personnel decontamination facilities
  - -- Maintain a Plutonium Decontamination Team.

JTG 8.4 established its Radsafe Office in the Headquarters Operations Section. It was placed under the control of the JTG 8.4 Radsafe Officer, who was an advisor to CJTG 8.4 on radsafe matters. The Radsafe Officer was responsible for setting radsafe policy, controlling the Air Force dosimetry program, radiological safety of samples aboard sample-return aircraft, dissemination of radex

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* Bluestraw was a code word for Air Force readiness plans to conduct atmospheric testing.

information, providing radsafe monitors for distinguished visitor flights, and training JTG 8.4 radsafe monitors (Reference B.4.14).

On Christmas Island, JTG 8.4 radsafe functions were accomplished by Task Unit (TU) 8.4.2. These included:

- Removal of gaseous and particulate samples from sampler aircraft and packaging and placing them aboard special sample-return aircraft
- Decontaminating aircraft at the decontamination pad using vehicles with high-pressure hoses
- Monitoring aircraft to ensure low enough radiation levels for flight or maintenance
- Operating the personnel decontamination facility and associated laundry for contaminated clothing
- Operating the JTF 8 Radsafe Center, including radiological surveys of Christmas Island, radsafe instrument maintenance, and the maintenance of a Plutonium Decontamination Team.

On Johnston Island, JTG 8.4 had fewer radsafe responsibilities. B-57 sampler aircraft routinely landed at Johnston Island after sampling the clouds from airdrop shots in that vicinity. The aircrews were processed through the personnel decontamination facility on Johnston Island. Although no aircraft decontamination was done on Johnston Island, the samples were removed, packaged, and returned to the mainland laboratories via special sample-return flights. Contaminated aircraft were left standing overnight to reduce radiation levels by natural decay and were then flown to Naval Air Station (NAS) Barbers Point, Hawaii, by the same crew for decontamination and maintenance (Reference C.1.N). Other than the B-57 samplers, there is no record of any aircraft contamination during DOMINIC.

On Oahu, Hawaii, JTG 8.4 operated from two bases: Hickam AFB and NAS Barbers Point. TU 8.4.3 was located at Hickam AFB and was responsible for weather reporting, communications, some Department of Defense (DOD) experiments, and calibrating missile-tracking equipment using equipment aboard C-97 aircraft. These aircraft and personnel were not exposed to radioactive contamination.

TU 8.4.4 was located at NAS Barbers Point and was responsible for dropping the 29 nuclear weapons from its two B-52s. For the five airdrops near Johnston Island in the fall of 1962, the two diagnostic C-130s and the eight sampler B-57s were also assigned to TU 8.4.4 at NAS Barbers Point. Rigid nuclear safety procedures were placed in effect for handling, mating, and loading the nuclear weapons on the B-52 drop aircraft. All procedures were approved, and written checklists were extensively used. The Air Force team was given a rigid inspection before the first nuclear weapon was dropped. LASL, LRL, and Sandia personnel supervised and assisted in these operations. Prearming and release control switches aboard the aircraft were locked and sealed. Emergency procedures required that the weapon be safed against any possible nuclear detonation and that it be jettisoned over water at least 10 nmi (18.5 km) from land, if possible (Reference B.4.14, Appendix 3, Annex E).

TU 8.4.4 established and operated aircraft and personnel decontamination centers at NAS Barbers Point for the B-57 sampler aircraft and crews, using men drawn from many elements of TU 8.4.4 to provide decontamination crews for the B-57 aircraft. Monitors checked the aircraft after they were decontaminated to ensure the safety of the maintenance personnel who worked on them. A radiation monitor accompanied all B-52 and C-130 flights to measure any radioactivity the aircraft might encounter. TU 8.4.4 issued and controlled the film badges for its assigned personnel and routinely returned them to the Honolulu Radiological Laboratory for processing. TU 8.4.4 also had personnel stationed on Johnston Island to remove particulate and gaseous samples from the B-57 sampler aircraft when they returned from cloud sampling.

Joint Task Group 8.5 (AEC Support)

Holmes & Narver (H&N) was the AEC contractor at Johnston Island responsible for staffing JTG 8.5. In addition to radsafe responsibility for assigned or attached personnel, JTG 8.5 was tasked by JTF 8 to assist the JTF 8 Radsafe Branch in providing radiological services for operations in contaminated areas, including personnel, instruments, and equipment. JTG 8.5 also made high-density goggles and disposable clothing available to all task groups.

On Johnston Island JTG 8.5 was responsible for surface radiological monitoring. It also constructed and operated the personnel decontamination tent on Johnston Island and constructed an aircraft decontamination facility (Reference B.0.1, Annex J).

Joint Task Groups 8.6 and 8.7 (Base Island Commands)

JTG 8.6 (Christmas Island) and JTG 8.7 (Johnston Island) were assigned no detailed radsafe functions other than the responsibility for all assigned or attached personnel. Since elements of JTG 8.3, JTG 8.4, and JTG 8.5 came under each base command, each inherited similar responsibilities.

Joint Task Groups 8.8 and 8.9

JTG 8.8 and JTG 8.9 were responsible for the Polaris missile shot and the SWORDFISH antisubmarine rocket (ASROC) shot, respectively. They had no added radsafe responsibilities, other than those in the basic JTG 8.3 Operations Plan 1-62 that covered radiological safety and was retained in effect for these two operations.

OFFSITE RADIOLOGICAL SAFETY

Through a Memorandum of Understanding, JTF 8 enlisted the assistance of the USPHS in establishing an extensive offsite radiological monitoring program (C.1.N). U.S. Public Health Service (USPHS) officers staffed a radsafe monitoring program on 19 inhabited islands around the Pacific Ocean. Under the terms of the memorandum, the USPHS also operated a fallout assessment center within Hq JTF 8. Figure 19 shows the radsafe stations.

The four primary stations were manned by USPHS officers, the six secondary stations were operated by task force project groups and weather groups. The

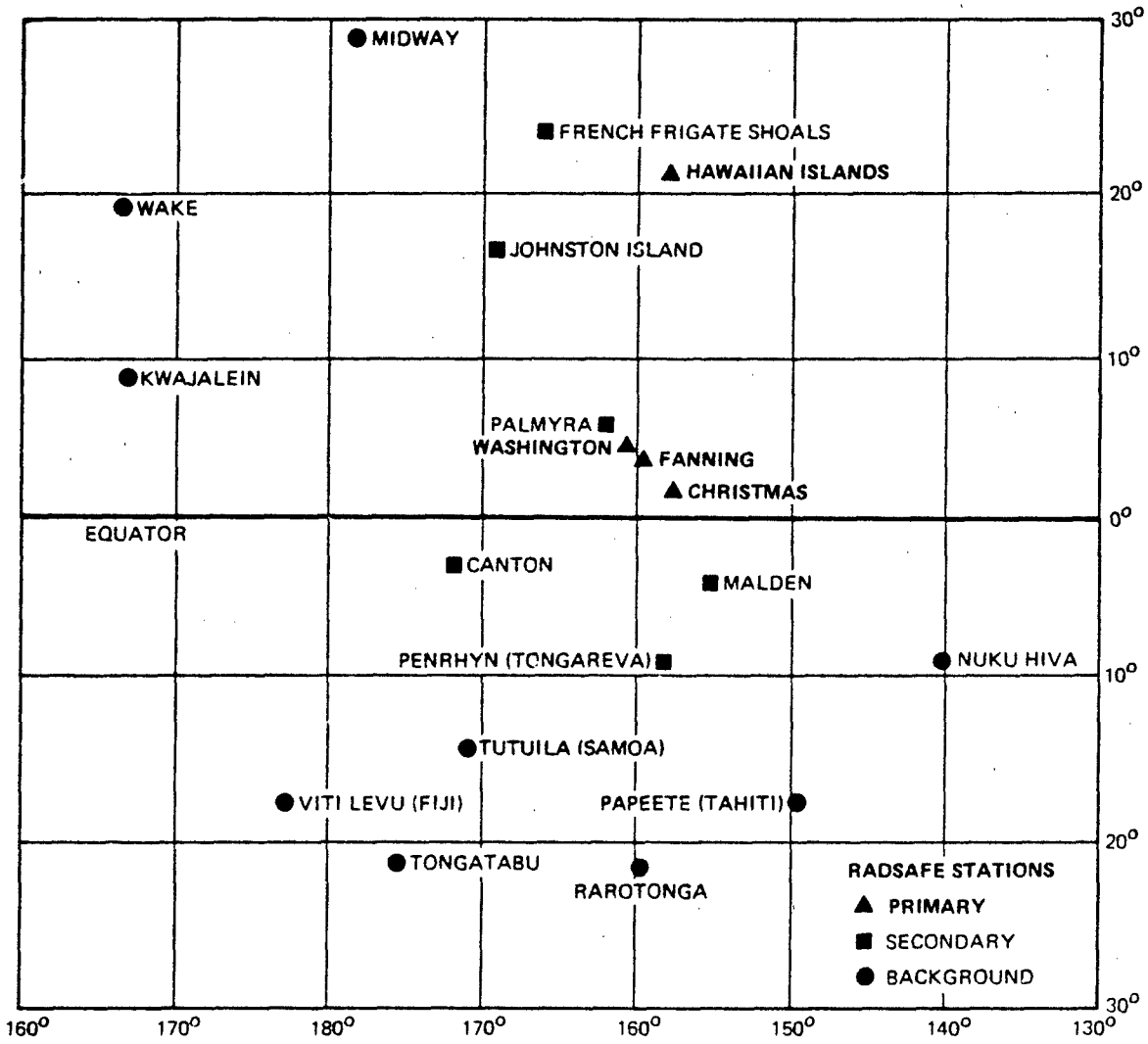


Figure 19. Locations of radiological safety stations manned by U.S. Public Health Service personnel and boundaries of danger areas, DOMINIC.

nine background stations were also operated by task force or weather groups, except for Tahiti and Nuku Hiva, which were operated by French personnel. A more complete discussion of this network is contained in the subsection describing the JTF 8 weather organizations ("Weather Prediction").

RADIOLOGICAL SAFETY STANDARDS

The National Council on Radiation Protection and Measurements (NCRP) was the primary U.S. professional organization concerned with radiation protection in the 1950s. NCRP had been in existence since 1929 under several different

names. It was not connected with or controlled by the Federal Government. The Government agency charged with recommending occupational and public whole-body exposure allowances was the Federal Radiation Council (FRC), established in 1958 by Executive Order 10831.

NCRP standards of 0.3 rem/week* (maximum), 3 rem/13 weeks, 12 rem/year (maximum), and an accumulated lifetime maximum of 5 rem (N-18)† were established in 1958 and were generally reflected in the standards adopted for the 1958 weapon test series. In 1960 the FRC set standards that differed from those of the NCRP in two minor respects. First, it did not recognize the 0.3 rem/week as a standard, but instead permitted 3.0 rem per 13 consecutive weeks. Second, it set an average annual standard of 5 rem/year while keeping the annual maximum of 12 rem/year. The NCRP revised its standards to agree with those of the FRC in 1971.

Maximum Permissible Exposures (MPE) were defined for DOMINIC personnel and, with two exceptions, the MPE were the same as the FRC standards. The first exception was a special MPE of 20 rem for aircrews, maintenance personnel, and sample recovery personnel associated with cloud-sampling aircraft. The second exception was an added restriction for any 18-year-old participants. Their MPE was 1.25 rem (compared to the FRC 3 rem) per 13 consecutive weeks. Personnel under 18 years of age were not allowed any exposure. In addition, the MPE for an emergency situation was set at 25 rem and for a grave emergency at 50 rem. Twenty-five rem was not to be considered limiting in a situation where lifesaving procedures were required, but the limits in that case were not spelled out.

A third was the after-the-fact exception: personnel aboard USS Sioux (ATF-75) were authorized a special MPE of 7.0 rem to complete their mission of collecting radioactive water samples following the underwater SWORDFISH test (Reference D.5, Appendix 1, p. 6). This authorization was made by CJTG 8.3 immediately after the first sample was collected.

Maximum Permissible Limits (MPL) were a set of rules for controlling radiological contamination in drinking water and air, for skin and hair, and for ships, aircraft, and vehicles. Table 11 is a summary of the JTF 8 MPL criteria.

RADIOLOGICAL SAFETY EQUIPMENT

Radiation detection instruments and equipment were obtained from the Nevada Test Site (NTS) or were purchased (Reference C.1.N). Table 12 contains a detailed list of the items acquired for use at the many different locations in the Pacific. H&N (TU 8.5.1) was the principal supplier through contract purchases. Instrument and equipment repair was accomplished at Christmas and

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* The term "rem" defines an absorbed dose, whereas the term "roentgen" (R) defines an exposure. Generally, badge readings (in roentgens) were used as a one-to-one measure of absorbed dose (rem) in the test series. In this report the exposure unit is generally used.

† Individual dose formula based on 5 rem times the individual's age (N) minus 18.

Table 11. Maximum Permissible Limit criteria for DOMINIC.

Personnel and Clothing	0.001 R/hr	(skin)
	0.002 R/hr	(underclothing)
	0.007 R/hr	(outer clothing)
Vehicles	0.007 R/hr[a]	(interior)
	0.007 R/hr	(outer surface measured at 5 to 6 inches)
Ships and Boats	No criteria for the operation. Decontaminate at the end of DOMINIC to 0.015 R/day (beta and gamma) and no detectable alpha.[b]	
Aircraft	0.007 R/hr	(interior)
	3 R/hr	(limit of cloud penetration for cloud-tracking aircraft)
Drinking Water	10^{-3} μCi/cc[c]	(beta/gamma emitters)
Air	10^{-7} μCi/cc	

Notes:

[a] 0.005 R/hr if measured by AN/PDR-27J instrument.

[b] Appendix 1, Annex J, Op Plan 2-62, paragraph 18(c) (reproduced in Appendix A of this report).

[c] A microcurie (μCi) is a unit of radioactivity meaning 3.7×10^4 disintegrations per second.

Source: Reference 8.0.1, Annex J.

Table 12. Radiological safety equipment and supplies, DOMINIC.

Quantity	Item
4	Sellers Injector Corp. Liquid Jet Cleaners with Lance and Discharge Hose
2	Gelman Air Sampler with Dry Test Meter
2	289 Tritium Monitor
2	T-329A Radiological Urinalysis Kit
2	T-336 Radiation Alarm
20	E500B Eberline Beta-Gamma Geiger Counter
4	GADORA-2 Eberline Gamma Dose Rate Meter
15	E112B Eberline Beta-Gamma Geiger Counter
2	FM-3G Eberline Alpha Floor Monitor
4,500	4.025 Density Goggles
2,000	4.5 Density Goggles
400	Pocket Dosimeter, Bendix Model No. 611 (0 - 5 R)
3	FD-2 Eberline Film Densitometer
2	FS-11 Eberline Film Badge Evaluation and Recording System
2	Cobalt-60 Calibration Source
1,000	Charg-a-Plate
1,200	Coveralls
1,000 pr	Canvas Booties
1,000	Poly Bags
500 rl	Masking Tape
1,000 pr	Gloves, Tarrif Issue
50	Respirators
50	Full-Face Masks
10	M-9 Chemical Corps Protective Masks
2	B-113 Electronic Tool Sets
50	Surgeons Caps
50	Hoods
1	Wound Monitor
25	RM-5 Eberline Radiation Monitors with R-1 Chart Recorder
2	PC-6 Eberline Scaler with SAC-2 and PC4-4 Detector Heads
2	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
15	MX5 Beta-Gamma Geiger Counter
100	AN/PDR-39 (T18) Gamma Survey Meter
4	AN/PDR-39 (T18) Gamma Survey Meter (modified for high-range [to 500 R/hr])
12	IM-108 Gamma Survey Meter
100	AN/PDR-27J Beta-Gamma Survey Meter

Source: Reference C.1.N, p. A-4.

Johnston islands by JTF 8 personnel, assisted by personnel from the Eberline Corporation.

RADIOLOGICAL SAFETY TRAINING

Personnel assigned to the JTF 8 Radsafe Branch had gained experience from previous test series and required little training. JTG 8.3 and JTG 8.4 conducted separate 1-week training programs for their radsafe personnel. Scientific task units and JTG 8.5 provided their own monitors for recovery and construction missions, respectively (Reference C.1.N, p. A-5).

RADIOLOGICAL SAFETY FACILITIES

Christmas Island

A photodosimetry section and a film badge program were established on Christmas Island. The section on the Dosimetry Program in this chapter discusses these activities in some detail. An aircraft decontamination pad at Christmas Island, which had originally been used by the British for the same purpose, was also established. A personnel decontamination facility and a contaminated clothing laundry were near the decontamination pad. In addition, facilities for repairing radsafe instruments, issuing radsafe equipment, and monitoring radiation at several locations were available (Reference C.1.N).

Johnston Island

Although an aircraft decontamination pad was constructed near the runway on Johnston Island, it was never used. Johnston Island radsafe facilities had the capability to repair radsafe instruments and issue radsafe equipment. Film badges were also issued at Johnston Island, but processing was done in Honolulu. A radiological monitoring station was also located on Johnston Island.

To support scientific measurements that required the recovery of radioactive missile pods from the sea, a special area was set aside at Johnston Island for the pods until they were turned over to scientists. This was designated a radex area and was located between two unused fuel storage tanks connected by an 18-foot (6.3-meter) high earth embankment. The fourth side of the area was open to the sea. This area was located on the south side of the runway and is shown in Figure 10. Three concrete wells, sunk into the earth embankment, were built to store the radioactive pods. Also, an open-top "hot" cell with a lead-shield front and a remote-handling device had been installed. Placement of a pod in a "hot" cell is shown in Figure 20. The delivery area (located between the tanks and the embankment) was covered with old mattresses to accommodate helicopter delivery of the pods after recovery at sea.

A personnel decontamination facility was established at Johnston Island after the aborted Thor missile launch and subsequent fire on 25 July produced local contamination. Details of this incident are given in Chapter 7.

Hawaiian Islands

In addition to film-badge issue and processing facilities, there was a radsafe supply capability at Hickam AFB. Personnel and aircraft decontamination

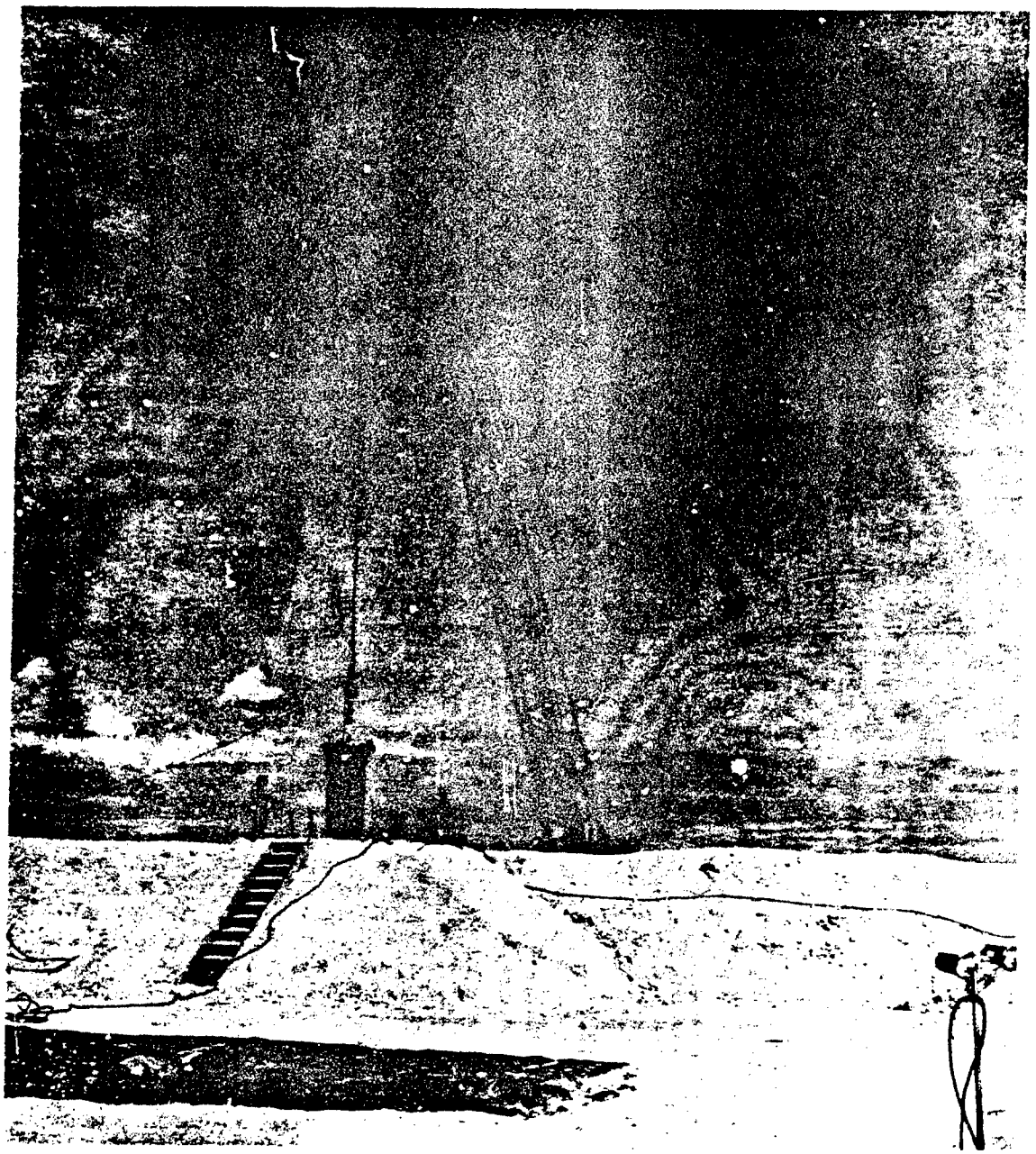


Figure 20. Pod is swung over berm and placed in hot cell with crane on Johnston Island during DOMINIC.

stations, as well as nuclear weapon storage and assembly facilities, were established at NAS Barbers Point.

DOSIMETRY PROGRAM

The purpose of the radsafe program was to limit the exposure of the participants to ionizing radiation. The basic radsafe regulation called for the creation of a "consolidated list of exposures" (Appendix 1, Annex J, Op Plan 2-62, paragraph 20[a]; reproduced in Appendix A of this report) to document radiation exposure of each individual. The "consolidated list of exposures" was also the means by which the task force communicated individual exposures to the participants' home stations so that proper entries could be made on individual medical records (Reference C.1.N).

The joint task force exposure records were based on the use of film badges. Table 12 shows that self-reading pocket dosimeters were available, but no case has been found in which a dosimeter reading was actually used to establish a personnel exposure. Pocket dosimeter readings were used for dose estimate until film results were available. Film badges were issued by the Radsafe Branch in the JTF 8 staff through their issue sections at Christmas, Johnston, and the Hawaiian islands. The program called for a badge to be issued to everyone entering the Christmas and Johnston island areas.

Film badges were also used to record other radiological data. Several badges were placed at specific locations aboard ships, on aircraft, and at many points on land throughout DOMINIC. Collection of film badges for processing was also administered by the Radsafe Branch.

The film badge used was a dental-X-ray-size packet like that used in Operation HARDTACK in 1958 and consisted of a DuPont 556 film packet containing two film components. The 508 film measured the 0.02- to 10-R range, and the 834 film covered 1 to 1,000 R. The entire packet was dipped in ceresin wax and then packaged in a rigid polyvinyl chloride case to provide environmental protection against moisture and normal handling. It was expected that the badge would last for longer than 90 days without loss of accuracy. This model badge had worked well in HARDTACK, but near the end of DOMINIC some exposure readings were obtained that were higher than expected. Analyses of an unidentified number of film badges showed damage. These analyses were performed because checks on the recorded exposures of the personnel who wore these badges indicated that based on their location and activities they should not have received such high exposures. The type of damage correlated with the effects of heat, light, and humidity. A 1980 study of some Navy personnel film badges has concluded that extensive damage to DOMINIC film badges occurred (Reference D.8).

Two photodosimetry sections, one at Christmas Island and the other at Honolulu, processed most of the badges. The standard technique was to develop the film and measure its density using an Eberline F-3 densitometer. The density reading was converted to an equivalent gamma exposure from a calibration curve. Calibration curves were obtained on a lot basis for film badges by exposing unused films in a lot to known radiation sources in laboratory conditions. The equivalent gamma exposure was then automatically punched into an

IBM machine card on which the name of the person who wore the badge and the badge number had been written. Exposures greater than 4 R were manually determined from a calibration curve. The process of setting up this card is detailed in the Christmas Island Radsafe Section Standard Operation Procedures (SOP) reproduced in Appendix A.

Normally, the photodosimetry section would open the film packet, but near the end of DOMINIC some 10,000 film badge packets were opened by JTF 8 Radsafe Branch personnel and sent to NTS for processing by the Radiological Safety Division of the operating contractor there. Reference C.1.N states that in the period 1 April to 1 November 1962 there were about 43,000 film badges processed for some 30,000 personnel (some personnel in the joint task force had several badges while others had only a single badge.)

After the equivalent gamma exposure had been punched on the IBM card by machine, the values were written on a 5- by 8-inch (5x8) "Accumulated Dosage Card" maintained for each individual participant.

In some cases a parallel record was maintained. This was the Navy form NAVMED 1432 (1-62), Personnel Exposure to Ionizing Radiation, which listed all personnel in a given unit, a ship usually, and showed their badge issues and resulting exposures. This form was apparently a standard Navy form whose purpose was to record exposures on the Navy ships on which some potential exposures to ionizing radiation were possible, such as ships' reactor propulsion units. In DOMINIC some non-Navy personnel were entered on NAVMED 1432 forms if they were, for example, civilian scientists performing an experiment that required them to be on a given ship for a considerable time. Not all Navy personnel had their accumulated exposures entered on both NAVMED 1432 and 5x8 cards.

From these two records, the 5x8 and the NAVMED 1432, the Reynolds Electrical Engineering Company (REECo) Radiological Safety Division at NTS prepared a list of exposures for JTF 8. The list was prepared in accordance with the requirement to prepare a "consolidated list of exposures" called for in the JTF 8 Radiological Safety Regulations, Appendix 1, Annex J, Op Plan 2-62, para. 20(a) (reproduced in Appendix A of this report). It has thus been designated the Consolidated List of Exposures in this report, although portions of it bear other labels. In earlier Pacific nuclear tests, such lists prepared by the various joint task forces have also been titled the Consolidated List of Exposures. The list shows the individual's name, his service number (ID number), his organization, and his total exposure. Final listings were produced in several forms: alphabetical (all of JTF 8), alphabetical by service, alphabetical by organization by service, nonreturned badges by numerical film badge number, and nonreturned badges in alphabetical order. This Consolidated List in its several forms, the 5x8 cards, and the NAVMED 1432 forms for DOMINIC exist in a microfilm file prepared by REECo, the prime support contractor that operates the NTS for the Department of Energy (Reference C.1.2).

PRE-EVENT SAFETY MEASURES

Hazard Zones

Figures 21 and 22 show the danger areas established around Christmas Island and Johnston Island for the nuclear tests. The odd shape of the Christmas

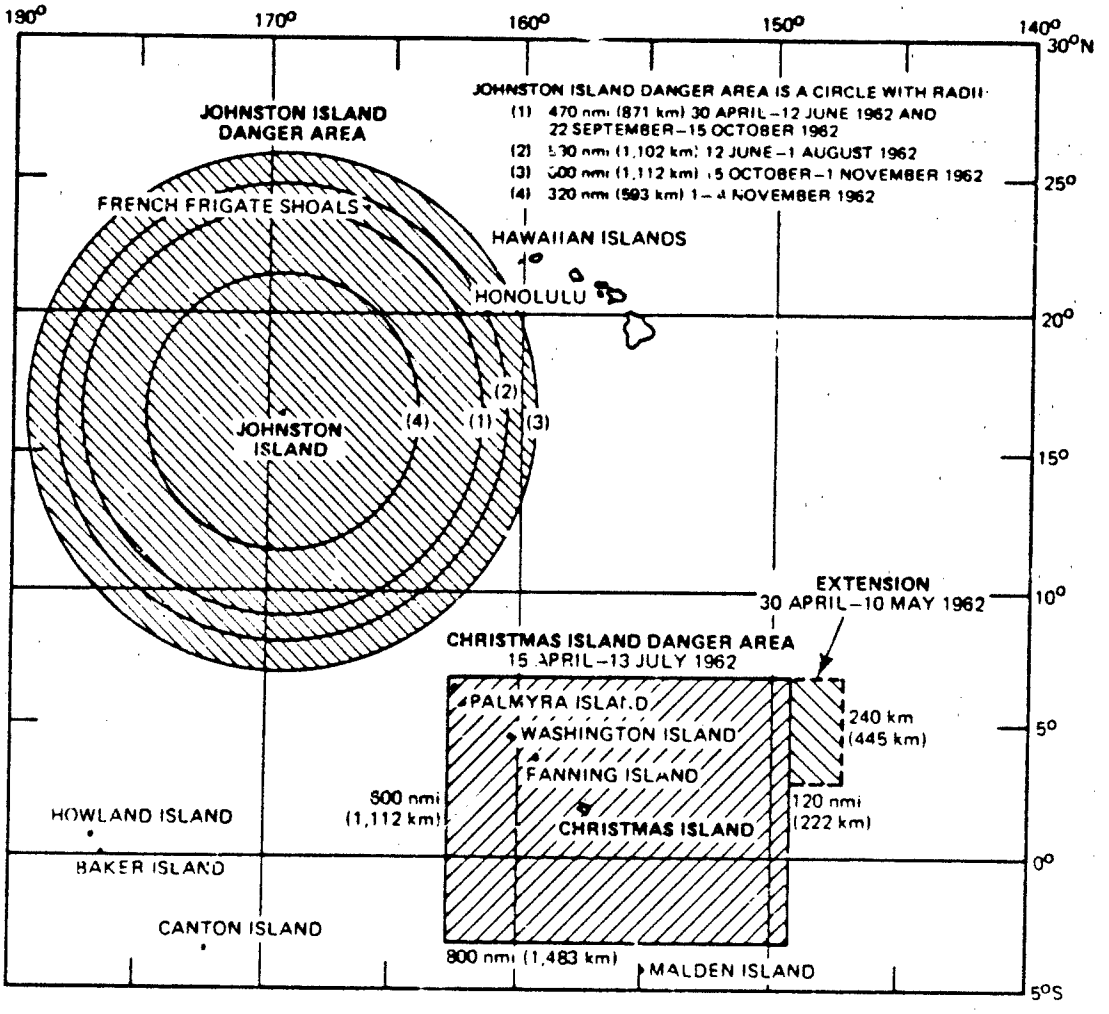


Figure 21. Christmas Island and Johnston Island danger areas, DOMINIC.

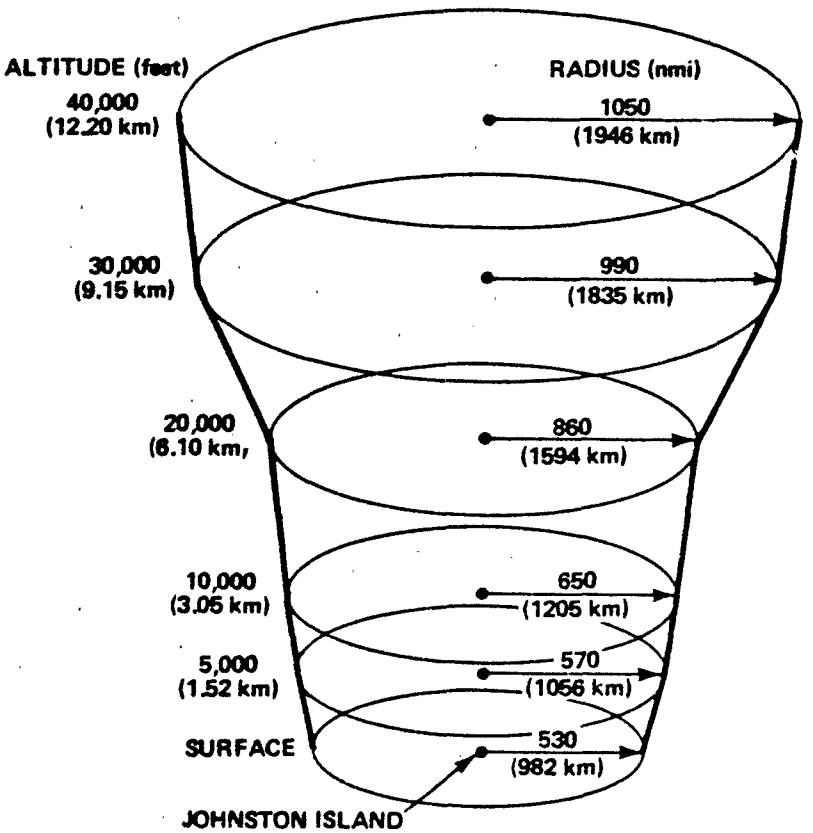


Figure 22. Johnston Island danger area as a function of altitude, DOMINIC.

Island danger zone was a result of the FRIGATE BIRD (Polaris) operations, which required an extension of the danger area to encompass the submarine-launched detonation point of the Polaris missile. These areas were patrolled by Navy P2V planes and destroyers in such a manner that there was calculated to be only one chance in a million that a vessel the size of an ocean fishing vessel or larger would not be detected (Reference C.1.A).

The locations and effective times for these danger areas were promulgated worldwide to civil and military air and maritime agencies through Notices to Airmen (NOTAM), and to mariners, to the Federal Aviation Agency (FAA), and other designated agencies by special advisories. After each shot air traffic was reestablished through these areas by standardized messages sent to Pacific military and civilian air control and NOTAM offices. Before the test series began, several conferences were held with FAA officials and briefings were given to local, national, and international air and surface commercial carriers. No confusion or complaint was recorded by any ship or airline throughout the entire test period. All requests for transit through the Christmas Island danger area were approved as none conflicted with the shots. Because the

Johnston Island danger area was more heavily traveled than the Christmas Island area, a modification was made in the Johnston Island danger area. The entire area outside a 150-nmi (278-km) diameter circle was kept open to air traffic until H-2 (H-4 for the first event), and public announcement of the detonations provided automatic reentry authority to commercial aircraft.

Search Operations

The Navy was responsible for searching the danger area (Reference C.1.A). At Christmas Island CTU 8.3.7 used 11 P2Vs based on Christmas Island and 3 surface ships to accomplish this task. One aircraft or ship observed Russian electronic intelligence ships southwest of the danger area at all times. On D-2 the aircraft made a rectangular-style search during daylight hours. On D-1 a thorough search of the area within 150 nmi (278 km) of surface zero was made. No unauthorized flights were ever reported. Ships were observed in or near the danger area a few times; however, they cleared the area quickly when notified of the situation by leaflets (printed in eight languages) dropped by the P2V aircraft.

At Johnston Island the Navy used surface and air units assigned to CTU 8.3.6. Destroyers were positioned in the northeast and northwest quadrants of the danger area to intercept ships entering the area along established shipping routes for the Tigerfish practice exercise. For STARFISH and subsequent events, two additional destroyers provided coverage in the southeast and southwest quadrants. Four P2V aircraft flew search tracks beginning on D-3. On each D-day an intensified search was conducted by five to six aircraft to assure that no undetected ships were in the danger area.

Air Operations

Air operations, except for search and surveillance, were controlled by CJTG 8.4 (Air Force) (Reference C.1.A).

At Christmas Island, control of the air array was accomplished from the JTG 8.4 Air Operations Center (AOC). CJTG 8.4 was in the JTF 8 Command Post and received detailed information on the air array from the AOC, the Airborne Air Operations Center (AAOC) in an RC-121 airplane, and from the Sandia radar plot located at A-site on Christmas Island. Timing and positioning of all aircraft were dependent on the position of the B-52 drop aircraft. The B-52 flew a 16-minute racetrack pattern at least three times before each drop, allowing flexibility since more 16-minute patterns could be added if weather conditions or other temporary problems delayed the drop. Land-based and airborne radar control (the RC-121 radar control aircraft participated in the first 13 events at Christmas Island) ensured proper positioning of all aircraft in the air array. The B-52 were based at NAS Barbers Point. All other aircraft were based on Christmas Island.

CTU 8.4.3 at Hickam AFB planned and controlled the air array for the Johnston Island missile shots. Control of the air operations was exercised from the AAOC in an RC-121 aircraft. There was also a small Navy air control group aboard USS Iwo Jima (LPH-2) as backup. All aircraft participating in the air array took off and returned to Hawaii except the P2V search aircraft under

Navy control, which flew from Johnston Island. Other participating aircraft operating below the equator, south of Johnston Island, took off from American Samoa or the Fijis and were not under the control of the AAOC. Control to and from the danger area at Johnston Island was provided through the normal FAA Air Route Traffic Control Centers channels in Hawaii. If communications were disrupted postshot, aircraft returning to Hawaii would relay their positions through the JTG 8.4 UHF relay B-47 aircraft positioned on a direct line between Johnston Island and Hawaii.

For the airdrop events at Johnston Island, CJTG 8.4 was located at Hickam AFB to control air operations. The AAOC on board the RC-121 was again used to control the air array and a second RC-121 was on hand as an alternate AAOC if needed. The JTF 8 Command Post on board USS Princeton (LPH-5) and the operations center at Johnston Island also monitored the aircraft array situation at all times. Each aircraft commander was responsible for positioning his aircraft. At his disposal were radar, beacons, and the tactical air navigation system on Johnston Island and Tern Island in French Frigate Shoals about halfway between Hawaii and Midway islands. Control of approaching aircraft passed from the normal Air Route Traffic Control Centers to the AAOC at the edge of the danger area and vice versa on return. For shot FRIGATE BIRD the B-57 samplers flew from Christmas Island and were controlled by an AAOC in an RC-121.

Naval Operations

Naval operations were controlled by CJTG 8.3, located on Christmas Island. CTU 8.3.6 on Johnston Island was given operational control of ships in that area (Reference C.1.A). Two special Navy task groups were formed during DOMINIC: JTG 8.8 for FRIGATE BIRD, and JTG 8.9 for SWORDFISH. CJTG 8.3 assumed command of each of these two groups while they were active. TU 8.3.4 was formed at the Naval Repair Facility in San Diego to prepare for the SWORDFISH event.

At Christmas Island JTG 8.3 had three destroyers, an LSD, fleet tugs, and salvage ships. Precise ship positioning for the shots at this island was not necessary as they were not measurement stations. Their duties consisted of search, surveillance, providing navigational aids, positioning the deep-sea moorings and target rafts, and servicing the target rafts. Control of the ship array and supply ships within the danger area was under TU 8.3.7, Christmas Island Operations Unit, which maintained the Navy Operations Center.

At Johnston Island TU 8.3.6 had six instrumented ships, designated S-1 through S-6. There was also a range safety ship (moored at the Johnston Island pier), an amphibious assault ship (a helicopter aircraft carrier), and four destroyers for surveillance. One destroyer, fleet tugs, and salvage ships were available for recovery; and there was a fleet oiler. In October 1962, three more instrumented ships were added (Reference C.1.A, p. 34). Control of shipping between shots was maintained by TU 8.3.6 from the range safety ship. Control of the ship array was from the amphibious assault ship during shots.

The FRIGATE BIRD event had two separate ship arrays 1,020 nmi (1,890 km) apart. At the launch site were the nuclear submarine, a guided missile ship, an aircraft carrier, and four destroyers. Near the impact site were two submarines and an air array of RC-121s, C-130s, a C-135, and several B-57 samplers.

Operating in the vicinity of surface zero during the SWORDFISH event were an oceanic research ship, two ocean fleet tugs, seven destroyers, a submarine, an aircraft carrier, and an LSD.

Joint Task Force 8 Safety Committee

For the Christmas Island airdrop events, JTF 8 established a Safety Committee to evaluate weather and other aspects of each shot. This committee then would recommend "go" or "postpone" to the task force commander. The committee chairman was the JTF 8 Scientific Deputy, and its members were senior scientists from LASL and LRL, plus a United Kingdom representative. The joint task force meteorologist was an advisor to the committee.

Fallout Prediction

Fallout, although important in DOMINIC, was less critical in the decision to "go" or "postpone" than it had been in previous Pacific shots. In previous Pacific tests at Enewetak and Bikini, fallout was a critical factor because the tests consisted of surface shots, and there were numerous task force personnel on the two atolls and native populations on several other atolls within 300 nmi (556 km). The bursts in all but one of the DOMINIC events (SWORDFISH, an underwater detonation) were at heights sufficient so that the explosions did not throw up significant amounts of surface material to be deposited elsewhere as radioactive fallout. Moreover, the two test areas for DOMINIC, Christmas and Johnston islands, were remote. Only three islands lie within 300 nmi (556 km) of Christmas Island: Fanning, Washington, and Palmyra islands, all of which are northwest. The nearest island to Johnston Island is French Frigate Shoals, over 400 nmi (741 km) distant, which held only task force personnel.

Among other information provided by JTF 8 Weather Central was a debris cloud trajectory forecast. This forecast provided cloud location by altitude (10,000, 20,000, 30,000, and 40,000, feet [3.0, 6.1, 9.2, and 12.2 km]) at three different times after detonation (12, 24, and 48 hours). This information was used by the FOPC in the JTF 8 Hazards Evaluation Branch to determine whether land areas would be subjected to fallout. It was also used to route airliners through the area once the event was executed (Reference C.1.M, p. 49).

Weather Prediction

Weather forecasting was critical for two separate aspects in the decision to go ahead with a test. It was the means by which fallout predictions were made; specifically, radioactive cloud drift for up to 48 hours after detonation. Secondly, the visibility in the area of the detonation was predicted. Much of the diagnostics depended on photography to obtain the needed data. Significant effort was put into determining cloud heights and locations in the shot area prior to detonation. The JTF 8 weather organization provided this information for all events except FRIGATE BIRD and SWORDFISH, the two Navy events. For these two events the Fleet Weather Facility, San Diego, augmented by the JTF 8 weather organization, provided this support.

The JTF 8 weather organization is shown in Figure 23. Three weather units were formed because of the widely separated operational areas in DOMINIC. The

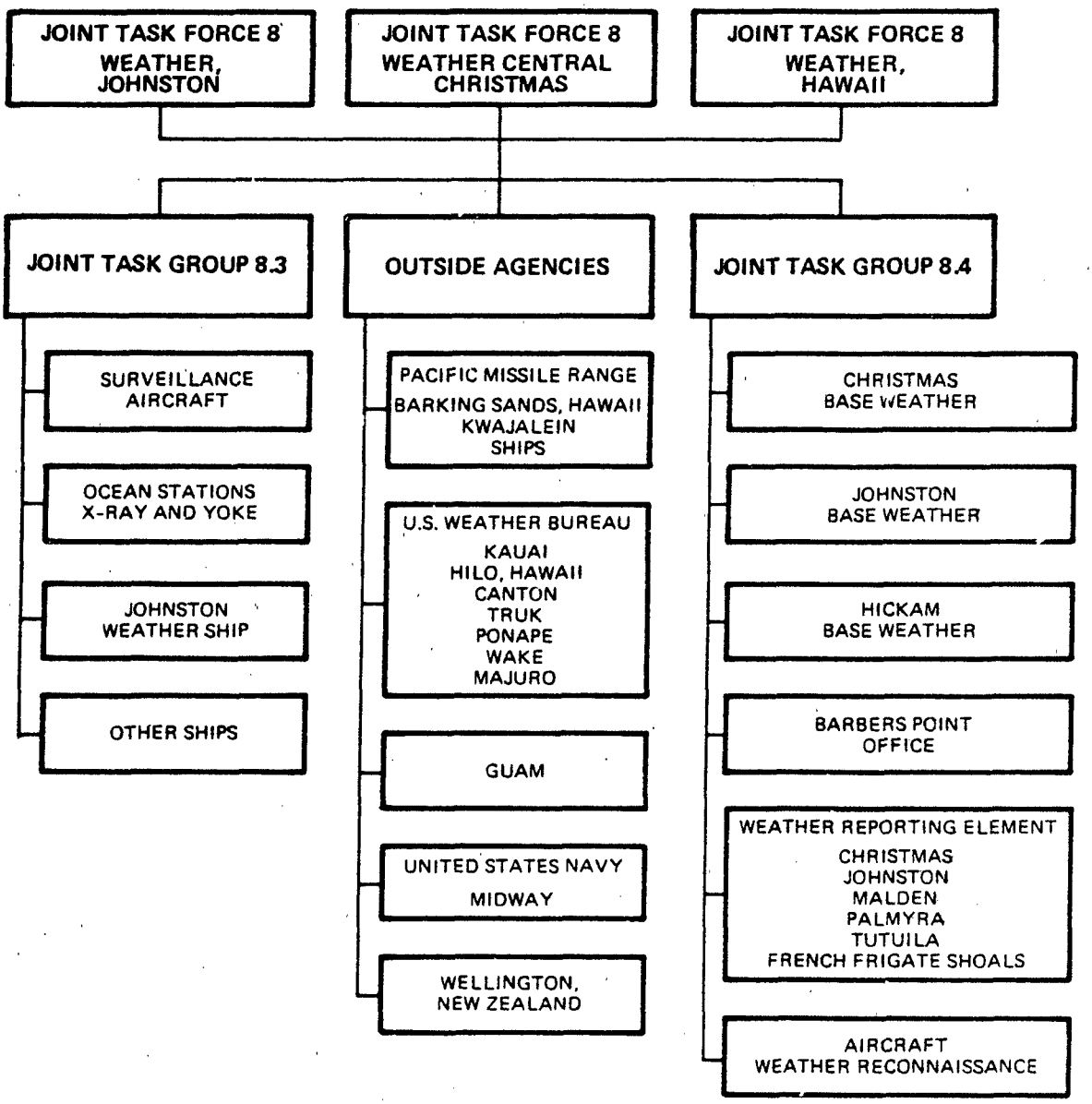


Figure 23. Joint Task Force 8 weather organization, DOMINIC.

Johnston Island unit provided forecasts for operations in that area and JTF 8 Weather Central provided Christmas Island area forecasts. The unit in Hawaii processed input from the high-altitude reconnaissance element using Air Force U-2 aircraft, expedited technical information from meteorological agencies in the Pacific, and prepared analyses and forecasts for the airdrops executed near Johnston Island late in the program. The stations at Christmas, Malden, and Tutuila were closed after the last airdrop in the Christmas Island area, and the French Frigate Shoals station was opened.

Included in the forecast were predictions of winds, clouds and other weather phenomena, density and pressure altitude, and radioactive cloud trajectory. Daily forecasts were prepared for the ensuing 24 hours. On the day preceding each shot, detonation time forecasts were also made 12, 6, and 2 hours prior to detonation.

Winds were forecast using the continuous-stream, isotach method at all three locations except for the low-level trade winds at Johnston Island. These were forecast using vertical time cross-section analyses of upper air reporting stations. Winds above 100,000 feet (30 km) were measured by rockets launched from Kauai and Johnston islands.

Clouds and weather were forecast using information from WB-50 weather reconnaissance aircraft and high-altitude U-2 aircraft. Clouds and local weather around the detonation point were an important factor in the decision to detonate or delay. Information from the WB-50s in the last hours was particularly important, and the base weather stations at both Christmas and Johnston islands had a direct communications link to these WB-50s. On Johnston Island, clouds were visually tracked during the last hour before missile shots.

Air density and atmospheric pressure were forecast using rawinsonde balloons. These values were used to set the baroswitches on the airdrop devices. The correct height of burst depended on these settings.

Cloud trajectory forecasting was accomplished using the wind charts at various altitudes, persistence, and climatology for the area in question.

For the high-altitude missile shots from Johnston Island, diagnostic experiments were balloon-launched from a ship near the island of Tutuila, well below the equator some 2,000 nmi (3,706 km) south of Johnston Island. The Johnston Island weather station prepared forecasts for this area 48 hours before the shot to give the ship sufficient time to move to the proper balloon-launch location based on the predicted winds.

Generally speaking, weather forecasting for DOMINIC was excellent. Only one event was postponed after the B-52 drop aircraft departed NAS Barbers Point. No incidents of commercial aircraft flying through the nuclear cloud residue occurred, nor were there any incidents of significant fallout on any land mass or manned vessel.

Offsite Radiation Monitoring

An extensive network of 19 stations was established to monitor fallout from DOMINIC in the Pacific region. The locations of the stations are shown in Figure 19. The USPHS directed the network from the Radiological Health Laboratory in Honolulu. To monitor radiological conditions on Oahu, laboratory personnel used an RM-5 continuous gamma monitor, an AN/PDR-27J survey meter, an air sampler, and a precipitation collector, but no fallout was detected. This laboratory analyzed samples collected on Oahu and at the other sites (Reference C.1.N). The laboratory provided backup dosimeter service for the organizations on Christmas Island. For the Johnston Island tests, it provided dosimetry service for the entire task force. Fanning and Washington islands

(located 148 and 222 nmi [274 and 411 km], respectively, northwest of Christmas Island) were important from a radsafe point of view and thus were designated as primary monitoring stations. Both stations had a full complement of RM-5s, AN/PDR-27s, and air sampler, precipitation collector, film badges, and communications equipment. Food and water samples were taken before and after the Christmas Island tests. A slight increase to 20 pCi/m^3* in air concentration occurred on 24 May 1962 on Fanning Island. An increase above background in precipitation occurred on Fanning from 26 June through 8 July, and on Washington Island from 14 to 21 May and on 14 July 1962.

Six stations at Canton, Malden, Penrhyn, Palmyra, Johnston, and French Frigate Shoals were designated as secondary monitoring sites because there was a fair probability that some measurable fallout might occur. Frequent visits to obtain water, vegetation, and food were made. Weekly reports were sent from these stations. Christmas and Johnston Island operations are discussed in this chapter under "Postevent Safety Measures."

CANTON ISLAND. Personnel from the U.S. Weather Bureau on Canton operated this monitor station. No fallout, other than worldwide fallout, was detected.

MALDEN ISLAND. Personnel from the JTG 8.4 weather group operated this monitor station. No fallout, other than worldwide fallout, was detected.

PENRHYN ISLAND. Personnel from the Geotechnical Corporation group supporting Hq USAF experiments operated this monitor station. Penrhyn received fallout in rain on 12 May 1962, which resulted in less than a 50-millirem dose to the adult thyroid from drinking the local cistern water.

PALMYRA ISLAND. The Geotechnical Corporation also operated this station. The island had measurable air concentrations on three dates: 43 pCi/m^3 on 17 May, 39 pCi/m^3 on 21 June, and 58 pCi/m^3 on 25 June 1962.

FRENCH FRIGATE SHOALS. Personnel from the 125th Signal Battalion (U.S. Army) operated this monitoring station. No fallout, other than worldwide fallout, was detected.

The nine background stations were remote from the test areas and were equipped primarily to document changes in the background radiation level. They were operated by a variety of agencies, depending on location, including JTG 8.4, Stanford Research Institute, 125th Signal Group (U.S. Army), U.S. Weather Bureau, U.S. Navy Weather Stations, and the French Government. Equipment at each site varied, all had AN/PDR-27s, most had RM-5s and film badges, and a few had air samplers and precipitation collectors. Only one of the nine background stations, Nuku Hiva, detected any local fallout, on which there was a measurable air concentration of 26 pCi/m^3 on 14 July 1962.

In summary, samples were taken on all four primary stations before DOMINIC started and again after the DOMINIC series was completed. The cistern water supply on Washington and Fanning islands showed a detectable increase above

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* Reported in micro-micro curies ($\mu\mu$Ci), but the unit currently used is picocuries (pCi).

background but the level was low. Soil samples and vegetation showed indications of fresh fission products; however, the residue was minimal. The entire off-island monitoring program demonstrated that there was no significant accumulation of radioactivity on the islands as a result of DOMINIC.

Radiation Protection Equipment Modification

The vast majority of equipment used in DOMINIC was standard military issue. The aircraft and ships were not designed to operate in a nuclear testing environment. Thus in certain instances it was necessary to modify equipment to protect personnel from the effects of the nuclear detonations.

Navy ships used to recover pods from the missile shots at Johnston Island were modified to handle the radioactive pods. The three fleet tugs were outfitted with cranes and hoists. The M-boat (LCM) used to transfer the pods to Johnston Island had a radiation shield added to protect the crew (Reference C.1.N, p. A-11) (Figure 24). Washdown systems were apparently present on all Navy ships for use in decontaminating deck areas if fallout was encountered. During SWORDFISH, ships used their washdown systems to carry off radioactive particles. Ships' deck logs also note washdown system activation at other times, but the presence of radioactivity was not recorded in these reports.

The JTG 8.4 B-57 sampler aircraft were modified at Warner Robbins AFB, Georgia, to install equipment for the collection of gaseous and particulate cloud samples (Reference C.1.C). Compressors for the collection of gaseous cloud samples as well as other equipment on the samplers were of the same type used in the 1958 HARDTACK series.

Evacuation and Reentry

Plans were made for evacuation of Christmas, Fanning, and Washington islands in the event of unusual wind shifts that could cause fallout on the islands; however, this never occurred. Before each shot, Christmas Island inhabitants who wished to be evacuated were taken aboard an LSD. The boat, however, remained anchored in the island's harbor. Musters, including the local inhabitants, were conducted before each shot at Christmas Island in accordance with Annex F, JTF 8 Op Plan 3-62 (Reference C.1.A).

For the high-altitude shots at Johnston Island, all but essential personnel were evacuated to Iwo Jima. Princeton replaced Iwo Jima after BLUEGILL Prime on 25 July and was used for evacuation operations thereafter. About 800 people were evacuated for each shot (Reference C.1.F, p. B-15). Task Element (TE) 8.3.6.5, Navy Evacuation Element, was responsible for evacuation and reentry operations at Johnston Island. It also provided berthing and messing facilities for evacuees and VIPs. Evacuation to the ship was by Marine helicopters and LCUs (Reference C.1.N). Transfer from the LCU to the deck of the ship was by an open-work cage, shown in Figure 25. Reentry took place on D+1.

Protective Clothing

The JTF 8 Radsafe Branch was responsible for ensuring that adequate protective clothing was available to all elements of the task force. Table 12

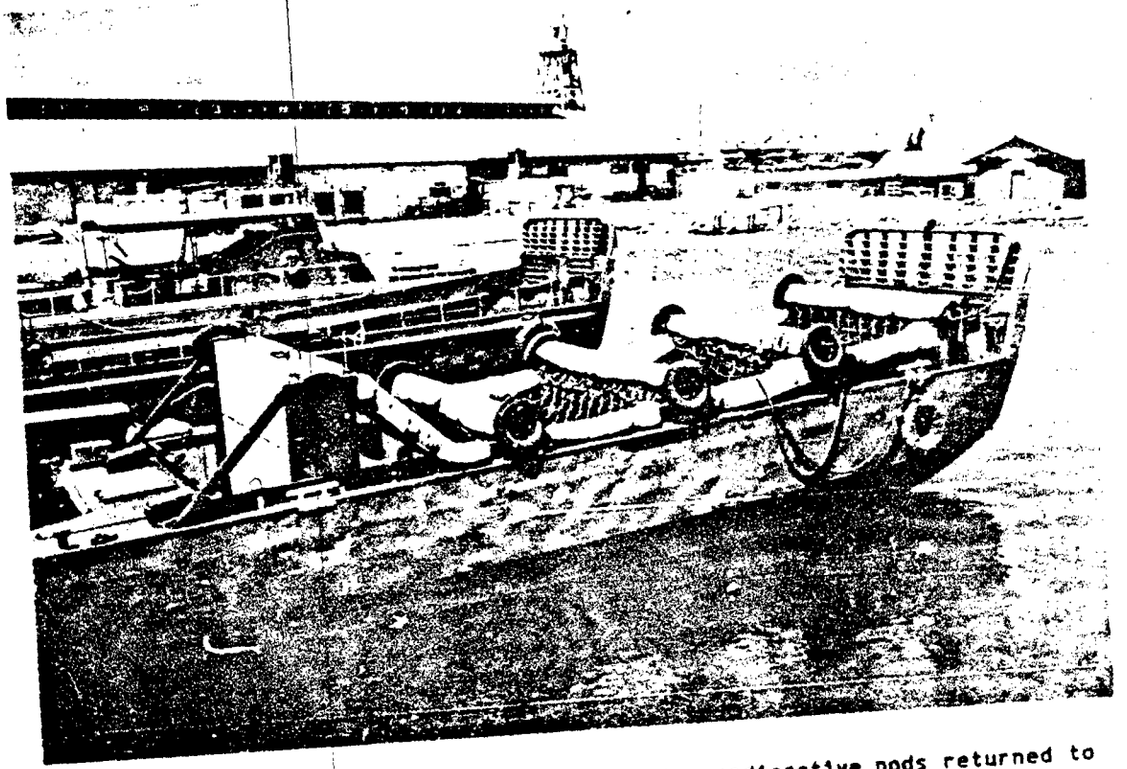


Figure 24. Modified M-boat (LCM) for handling radioactive pods returned to Johnston Island, Operation DOMINIC. Cargo net slings hold pods while crew is behind massive shield.

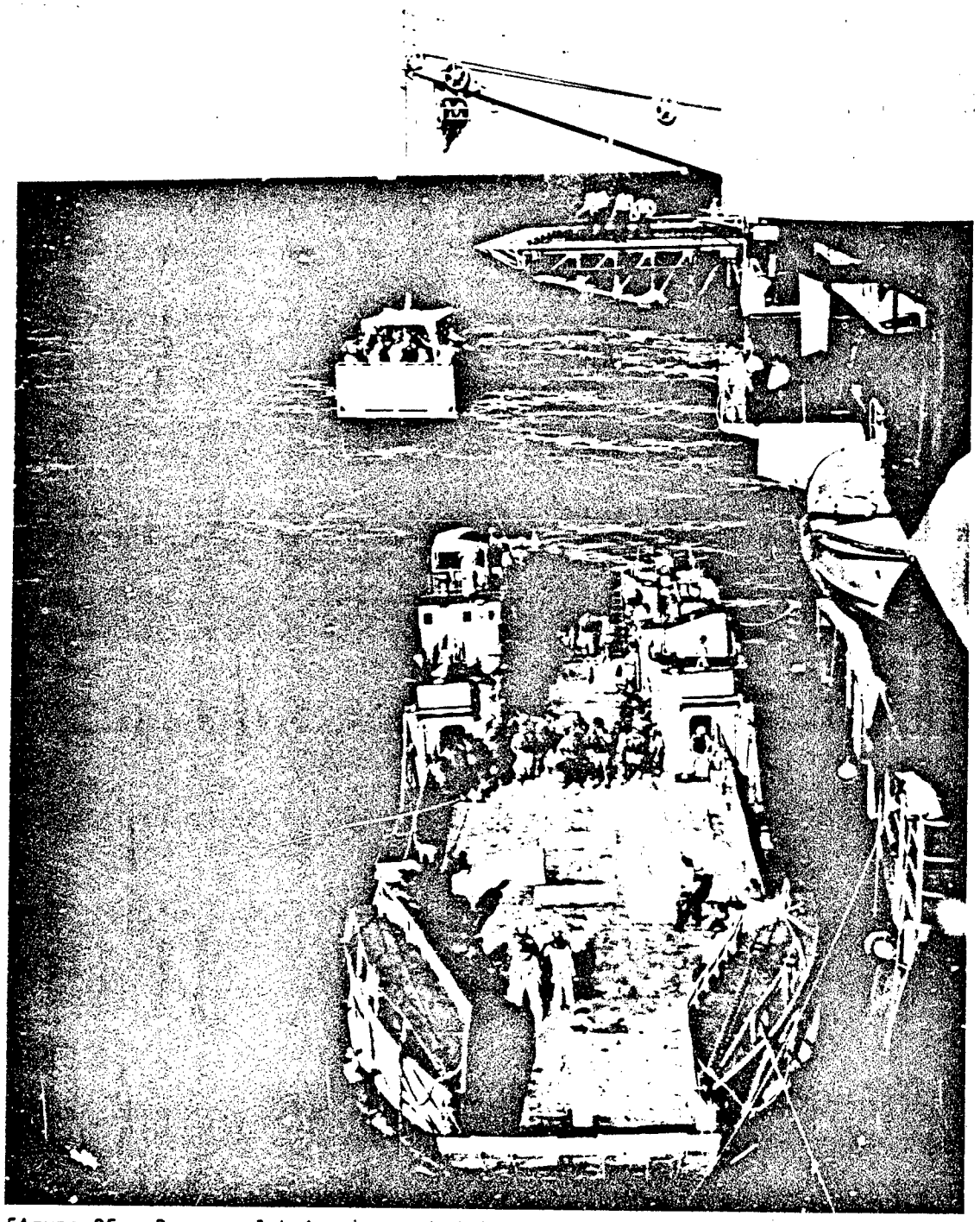


Figure 25. Personnel being evacuated from Johnston Island before a test shot. The cage is used to lift personnel from the LCU to the flight deck of the ship.

shows the amount of protective clothing obtained and other radsafe equipment obtained for DOMINIC. The Supply and Equipment Section of the Radsafe Branch had offices on Christmas, Johnston, and Oahu. Protective clothing was issued from these offices to the various elements of the task force as required (Reference C.1.N, p. A-6). This protective clothing was of cloth or plastic material with tight closures around the wrists, ankles, and neck. Head, hand, and foot coverings, and, in some applications, a respirator completed the suit. Figure 26 shows a pair of workers in complete protective suits, including respirators, while they worked on the cleanup of the Thor launch pad at Johnston Island. The function of the clothes was to trap radioactive particles in the cloth instead of allowing them to lodge on the wearer's skin. This made decontamination much easier and also prevented inadvertent transport of the radioactive particles to uncontaminated areas. Respirators were to prevent the inhalation of radioactive particles.

On Johnston Island the Disaster Control Team had a complete set of protective clothing for each member, including firefighters. On 25 July, a Thor missile burned and its nuclear warhead had to be intentionally destroyed on the

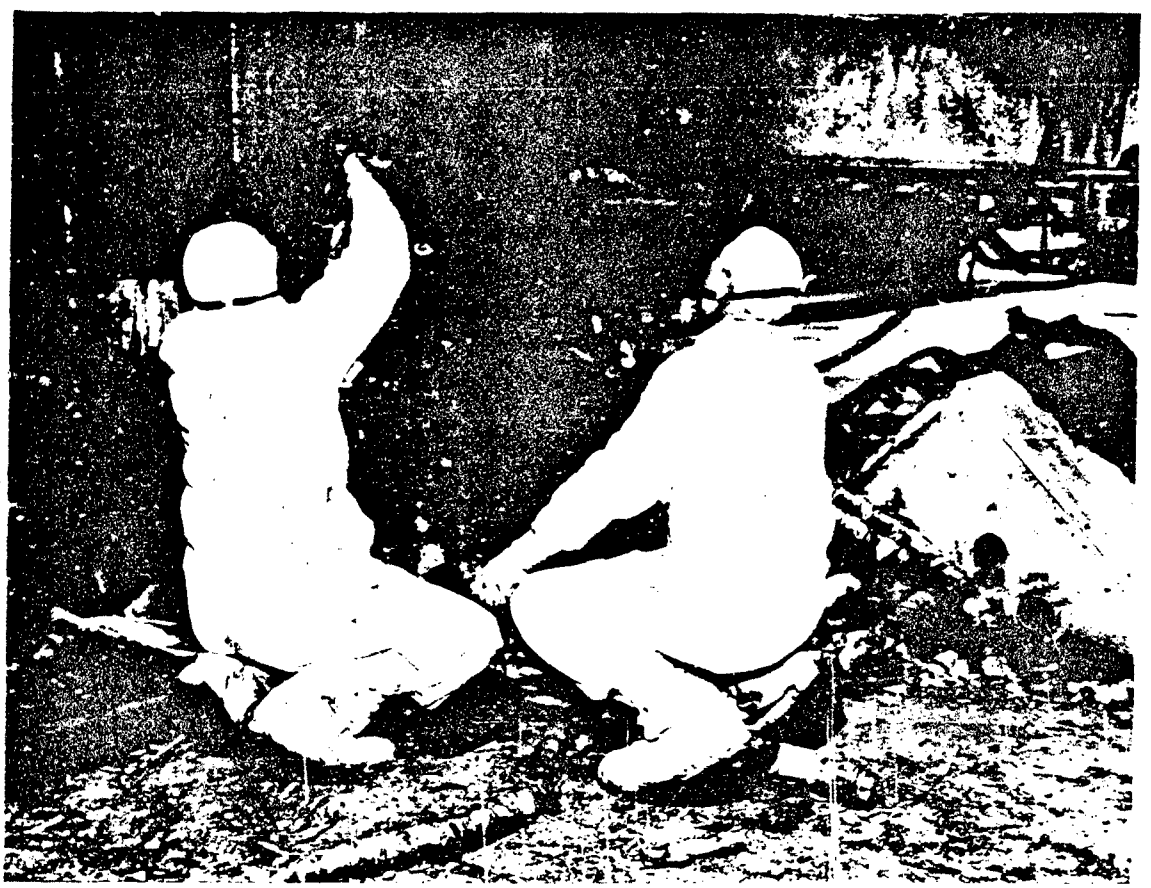


Figure 26. Personnel in protective clothing inspect contaminated launch stand during DOMINIC.

launch pad, causing extensive alpha contamination. The ensuing cleanup included soil removal, soaking soil with oil, scrubbing concrete surfaces with solvents and detergents, and painting. All workers involved in this decontamination wore protective clothing that had to be processed and reissued on a daily basis (see Figure 26).

Figure 27 shows a Navy fleet tug recovering a Thor missile pod from the ocean near Johnston Island. Recovery personnel are wearing protective clothing. Navy procedures required that personnel wear long sleeves, gloves, hats, long trousers, and overshoes during operations where there was a possibility of radiological contamination (Reference B.3.1, Appendix 3 to Annex E).

A report on Sioux water sample collection operations following SWORDFISH indicates that all 18 personnel on board were issued coveralls, gloves, and radsafe shoes or plastic booties in addition to film badges and pocket dosimeters. Additional supplies of protective clothing and foul-weather gear were immediately available (Reference D.5).

Navy personnel at NAS Barbers Point who were sent to retrieve nosecones from rockets fired at Barking Sands, Kauai, wore rubber gloves and film badges because of the possibility that the nosecones might have been radioactive (Reference C.2046, p. 463). Laboratory personnel recovering sampler rocket nosecones at Christmas Island also wore full protective clothing (Figure 28).

Over 6,000 high-density goggles were available for issue to persons who were to be in locations where the visible light from nuclear detonations could cause eye burns. The retinal burn hazard was continually stressed during DOMINIC; every plan and operation order discusses it in detail. Briefings before shots stressed this hazard and checklists included it as an item of importance. Warnings before each detonation were sounded to admonish personnel against inadvertently looking toward the detonation without goggles. Despite these precautions, two people received retinal burns from the BLUEGILL detonation (Reference C.1.L, p. 4-7).

Special Badging for Sampler Activities

Each member of the crews of sampler aircraft wore a mission film badge, which was worn only for the duration of any sampling operation. This badge was worn in addition to a permanent badge that was worn for a longer period. Depending upon the probable exposure to radiation, permanent badges were worn from 1 or 2 weeks to 1 or 2 months.

Nonflying personnel associated with sampler aircraft activites, such as sample recovery and aircraft decontamination and maintenance, were badged more frequently than most DOMINIC participants. These personnel did not wear a mission badge, as did the flyers, but instead wore a new badge every 7 to 10 days. For both groups, the returned film badge was processed in a day and the result was promptly recorded on the individual's 5x8 card. In this manner an up-to-date record of accumulated exposure was maintained.

Badges were placed in the crew compartments of the sampler aircraft. One was near the integron radiation exposure readout and another was elsewhere in



Figure 27. A pod lifted from the sea is held against the side of USS Grapple (ARS-7) as personnel check for radiation, DOMINIC.

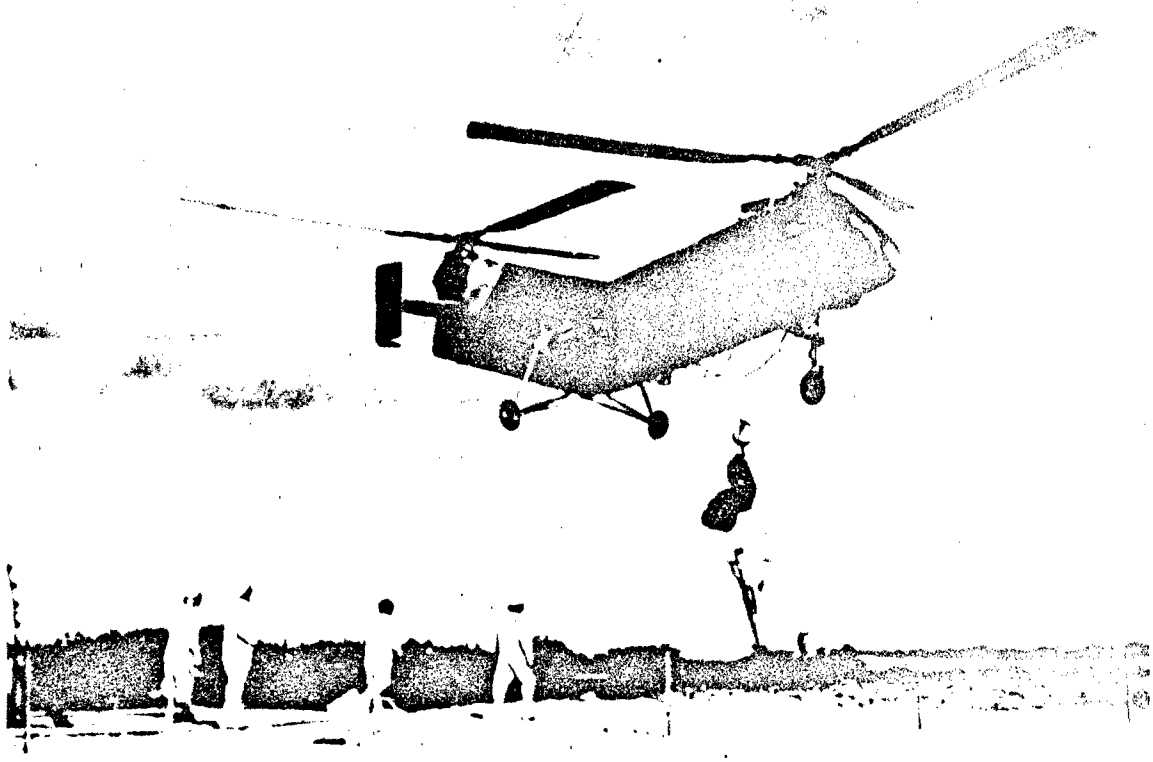


Figure 28. Laboratory personnel receive a rocket nosecone sampler delivered to Christmas Island by retrieving H-21 helicopter.

the cockpit. There is no evidence, however, that any of these badges were used for purposes of personnel dosimetry.

Checklists

JTF 8 used checklists extensively to coordinate and manage preparations for each shot. Checklists usually included several important postshot functions as well.

At Christmas Island, the checklists included surveillance of the danger area, musters, and verbal warning to island personnel prior to detonation. Table 13 is an abbreviated form of the checklist for shot AZTEC. The checklist actually contained 66 items; however, only a few items have been shown for illustration.

At Johnston Island similar checklists were used. Here the checklists also included experimental rocket safety and launch, Thor missile safety and launch, personnel evacuation to the aircraft carrier, search and recovery of missile pods, and reentry of personnel to the island on D+1.

Table 13. Preshot checklist for DOMINIC, AZTEC (Christmas Island).

Item No.	Day/Hour	Event	Responsible Agency
2	D-3/1500	Inform Commander Joint Task Group (CJTG) 8.3 of aerial/surface surface surveillance requirements for D-2	Commander Joint Task Force 8 (CJTF 8) (J-3 M11 Ops)
7	D-1/1000	D-1 Federal Aviation Agency (FAA) advisory sent (Report #4)	CJTF 8 (J-3 M11 Ops)
16	D-1/1830	Submit muster reports to JTF 8 Command Post	All task units and task groups
26	D-Day/H-4	B-52 aircraft takes off	CJTG 8.4
27	D-Day/H-2	Test site elements submit muster	A-site J-3 coordinator report thru J-3 coordinator
31	D-Day/H-2	Target area clear of vessels	CJTG 8.3
36	D-Day	H-1:00	Muster Report; Gilbertese UK Base Commander
44	D-Day/ H-5 min	Aircraft roported in proper position	CJTG 8.4
46	D-Day/ H-3 min	Warning siren; public address system announcement to place goggles and take other protective measures	CJTG 8.5
47	D-Day	Detonation	
55	D-Day/when available	Sample control aircraft in position at airborne station	(Pass to 8.1.1)
60	D-Day/H+3	Sample-return aircraft arrives	CJTG 8.4
62	D-Day/H+4	Christmas Island air traffic reopened FAA reentry advisory (Report #9)	CJTF 8 (J-3 Radsafe)
65	D-Day/when directed	Sample-return aircraft departs Christmas Island	CJTF 8 (J-3)

Source: Reference 8.8.3, Tab A, Appendix 2, Annex D.

Rehearsals

JTF 8 conducted rehearsals for the Christmas Island airdrops and for the Johnston Island missile launches.

The Christmas Island rehearsals were held between 10 and 21 April 1962. All ships, aircraft, equipment, and personnel were in their assigned locations. All communications that were to be used for live drops were operating on the

proper frequencies. Target rafts were emplaced at sea and the B-52 drop aircraft practiced drops with dummy bombs on 13, 16, and 21 April 1962 (Reference C.1.C, p. B-4).

The Tigerfish shot at Johnston Island was a Thor missile launch without the nuclear warhead. The primary purpose of this test was to determine if the instrument pods hung from the base of the Thor missile would work. Naval surface ships and Air Force aircraft participated to practice positioning within designated surface and air arrays, respectively. The range safety complex at Johnston Island also was checked out on this test (Reference C.1.A, p. 4).

Three rehearsals were held at Johnston Island (23, 26, and 29 May) before the scheduled launch of BLUEGILL on 1 June 1962. The RC-121 Airborne Air Operations Center (AAOC) was substituted for the Navy WV-2 AAOC for the 29 May rehearsal and proved to be much more satisfactory in controlling the air array. RC-121s were subsequently used as the AAOC for the Johnston Island airdrops as well as the missile launches. The B-52 aircraft made two practice drops in September 1962 preceding the first live airdrop in the Johnston Island area (Reference C.1.C).

Nuclear Device Safety

Nuclear safety was concerned with prevention of an accident that potentially could cause radioactive contamination. All airdrop devices were flown to NAS Barbers Point in Hawaii from the continental United States by the Air Force Logistics Command. Here they were stored, assembled, tested, and loaded on the B-52 drop aircraft for transport to the test area. The JTG 8.4 Test Aircraft Unit (TAU) device-handling and -loading personnel were given extensive training and evaluation by the Strategic Air Command Munitions Evaluation and Standardization Team prior to their operations at NAS Barbers Point. Actual handling, mating, and loading operations were done under the supervision of Sandia Corporation weapon engineers. Approved procedures and checklists were used for these operations (Reference C.1.A).

The crew of the B-52 drop aircraft was highly trained and skilled in airdrop operations, inflight device monitoring to prevent unauthorized arming or release, and inflight safing of the device if the mission had to be aborted (Reference C.1.A).

Jettison procedures for the nuclear device were established to ensure jettison in a safed condition only over open ocean areas more than 10 nmi (18.5 km) from the nearest land. While in flight with a device aboard, the B-52 was always under the surveillance of a navigational aid ship until it reached the drop area where it was picked up by the AOC, AAOC, or the Sandia Tracking Center on Christmas Island. An ordnance disposal team was always on standby alert when a B-52 departed NAS Barbers Point with a nuclear device (Reference C.1.A).

Each airdrop device was designed to detonate at a prescribed altitude high enough to ensure that the fireball would not touch the ocean surface. This prevented involvement of seawater with device debris, which would have led to local fallout. All devices were designed to automatically safe themselves and "dud" if, for some reason, they failed to detonate at or near the prescribed altitude (Reference C.1.A).

The missile-launch devices were transported from the weapon design laboratories in the continental United States to NAS Barbers Point by the Air Force Logistics Command. They were stored at Barbers Point until ready for use at Johnston Island. A radsafe representative was present at the Johnston Island airfield whenever nuclear devices for missile launch were moved on or off the island. Ordnance disposal personnel were assigned to Johnston Island for the entire period of high-altitude missile shots and were proficient in safing procedures for the various rockets, nuclear devices, and missiles. H&N personnel and laboratory weapon experts were also available for assistance (Reference C.1.A).

FRIGATE BIRD and SWORDFISH were conducted by the Navy using operational stockpiled weapons launched from fleet ships. Normal shipboard radsafe procedures were followed prior to launch.

POSTEVENT SAFETY MEASURES

Christmas Island

The USPHS established five radsafe monitoring stations on Christmas Island (Reference C.1.N): at the Main Camp, London Port, A-Site, D-Site, and Y-Site (see Figure 2). The first three sites were equipped with RM-5 continuous gamma monitors, AN/PDR-27J Geiger-Mueller survey meters (gamma plus beta), air samplers, and precipitation collectors. The other two sites had the RM-5s and AN/PDR-27Js; in addition, Y-Site was equipped with an air sampler on shot days. Before the first test, samples of water, coconut milk, green coconuts, fish, hermit crab, and lobster were collected. Film badges were issued to selected local inhabitants as well as JTF 8 personnel. Film badges were also placed in houses and trees in the village of London Port. Water, food, and environmental samples were periodically collected throughout DOMINIC and shipped to the Radiological Health Laboratory in Hawaii for analysis.

A postshot radiological survey of Christmas Island was conducted after every event. Two 2-man teams, each with two AN/PDR-27Js and two AN/PDR-39s, conducted ground surveys on all major roads between London Port, Y-Site, and D-Site (see Figure 2). One 2-man team with the same equipment conducted a helicopter sweep of the south and southwest coastal area between D-Site, MM-Site, and Paris. The teams were controlled by radio by the Radsafe Officer in the Joint Operations Center. Readings were taken until H+5.

The radioactive cloud was tracked by the JTF 8 Radsafe Branch using information received from the B-57 sampler aircraft. Information consisted of stabilized cloud-top altitude, cloud-base altitude, cloud location, and cloud movement. This information was used to advise aircraft in the area and by the FOPC.

An aircraft decontamination pad, a personnel decontamination facility, and a contaminated clothing laundry were activated in the vicinity of the main landing strip on Christmas Island. These facilities were operated by JTG 8.4. The aircraft were sprayed with water from a decontamination truck and the runoff collected in a large plastic-lined pool that was used as a holding tank. The holding tank contents were later pumped into a large tank truck and dumped into the ocean. JTG 8.4 was responsible for removing the radioactive cloud

samples from returning B-57s and placing them aboard waiting C-135s for return to the continental United States for analysis. One of twenty-four courier officers accompanied the samples from each of the 24 Christmas Island shots to the mainland.

After completion of the Christmas Island tests, film badges that had been placed on stake lines before the tests started were collected and processed, and exposures were recorded.

Johnston Island

There was one radsafe monitoring station at Johnston Island. The station accomplished air and precipitation monitoring, environmental sampling, and background monitoring (Reference C.1.N). All radsafe functions accomplished at Christmas Island, except photodosimetry, were also done on Johnston Island. Photodosimetry for Johnston Island was accomplished by the Radiological Laboratory in Honolulu.

Each Thor missile launch involved three pods that were ejected before the nuclear detonation, gathered data, and then were parachuted back to Earth. The pods were made radioactive by the detonation and required special handling. The Navy provided a destroyer, three fleet tugs, and six Marine helicopters to effect pod recovery after each shot. If the helicopters could snare the pods from the ocean, they would transport them to Johnston Island. The helicopters carried the pods slung externally; thus the crews were not exposed to radiation. Fleet tugs would recover the pods if the helicopters could not. A JTF 8 radsafe monitor with a radiac meter was stationed on each of the three tugs to assess the potential exposure associated with the recovered pods (Figure 27). Radiation levels ranged from 2 to 14 R/hr on the pods 8 hours after the shot. The pods would be transferred to the specially prepared M-boat for transport to Johnston Island. Figure 29 shows the transfer from tug to M-boat for a pod with the flotation gear still attached.

At Johnston Island the helicopters lowered the pods onto mattresses adjacent to the "hot" cell and a portable crane then swung the pods over the protective berm and placed them in the hot cell itself (Figures 30 and 20). Probably the M-boat was beached in the same area in reach of the crane so that the pods could be transferred to the hot cell. The hot-cell handling area had slave manipulators for remote handling of highly radioactive items.

An aircraft decontamination area was established at the far west end of the island (see Figure 10), consisting of a concertina wire-enclosed portion of the taxiway with a coral berm around it. A fresh-water reservoir tank with connecting hose was available to hose off the aircraft. This facility was not used because radioactivity on the sampler aircraft, which parked overnight at Johnston Island, had decayed sufficiently to permit their safe return to NAS Barbers Point, Hawaii, the next day.

JTG 8.4 was responsible for removing the radioactive cloud samples from the returning B-57s at Johnston Island and placing them aboard waiting C-118s for rapid return to LASL or LRL. The procedures used in removing these samples were as follows. First the B-57 was guided into an area restricted by barbed



Figure 29. Radioactive pod with flotation bag still attached is guided into sling in M-boat following DOMINIC shot.

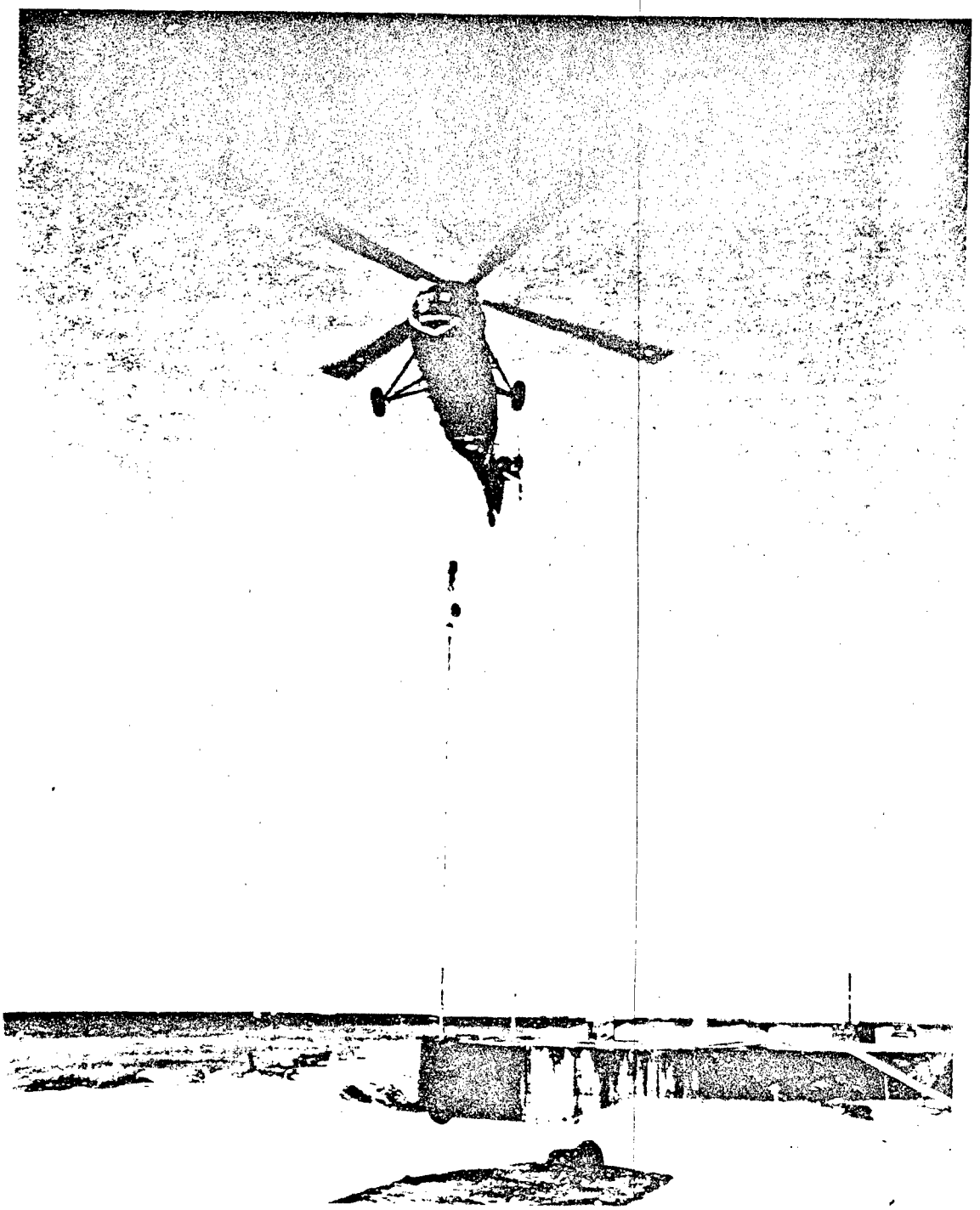


Figure 30. Pod is delivered to Johnston Island by helicopter during DOMINIC.

wire within which all personnel wore protective clothing (Figure 31). The pilot climbed out onto a platform supported by a forklift to prevent contact with the potentially contaminated skin of the aircraft (Figure 32). Filter samples were handled with long poles to limit exposure and were rolled like a cigar in a lead "cave" and packed in a "lead pig" (Figures 33 and 34). After being transported by C-118 from Johnston Island the lead cases were transferred to C-135 at Hickam AFB (Figure 35), where the courier officer and radsafe personnel checked the shipment for any radiation leakage. The procedures had been refined during prior tests to minimize exposures.

A personnel decontamination facility, which was established after the BLUEGILL Prime event in July 1962, was used for sampler aircraft crews as well as a routine radsafe support facility for Johnston Island.

A Disaster Control Team was established on Johnston Island for the missile shots. The team consisted of firefighting and medical personnel as well as five radsafe personnel equipped with twelve AN/PDR-39 gamma meters (four of which were modified for a higher range), four Gadora gamma meters, ten AN/PDR-27 beta-gamma meters, one MX-5 beta-gamma meter, and sufficient protective clothing for everyone on the Disaster Control Team. A second and independent Disaster Control Team was established afloat after the BLUEGILL Prime event caused extensive contamination requiring lengthy cleanup at Johnston Island.

Four of the missiles used at Johnston Island either did not launch or did not fly safely to the planned altitude. The latter required destruction of the missile and nuclear warhead prior to nuclear detonation. Two of these missiles were destroyed at extended ranges from Johnston Island and no contamination was deposited on any vessel or land mass. The other two caused radioactive contamination on or near Johnston Island. One burned on the launch pad causing extensive alpha contamination. A detailed description of these accidents and the radsafe measures taken may be found in Chapter 7, where the high-altitude rocket shots are discussed.

The clouds were plotted by the Radsafe Branch and cloud location and movement were used to direct aircraft safely through the danger area after the detonation.

Cloud Tracking

Tracking the radioactive cloud after detonation was done by the B-57 sampler pilots. They reported cloud location as they sampled. There were no aircraft specifically designated to track the cloud for extended periods in DOMINIC because all but one of the events were air bursts with negligible quantities of fallout. The B-57 samplers operating up to 3 hours after the detonation were sufficient to track the cloud. Although the underwater burst (SWORDFISH) created a plume over 2,000 feet (610 meters) high, no radioactive cloud was created. For the 24 shots at Christmas Island, one ship was designated as a fallout tracker and it steamed into the area of anticipated fallout. However, no significant amounts were ever detected (Reference C.1.B).



Figure 31. Sampler aircraft is guided into restricted area for sample removal, DOMINIC.

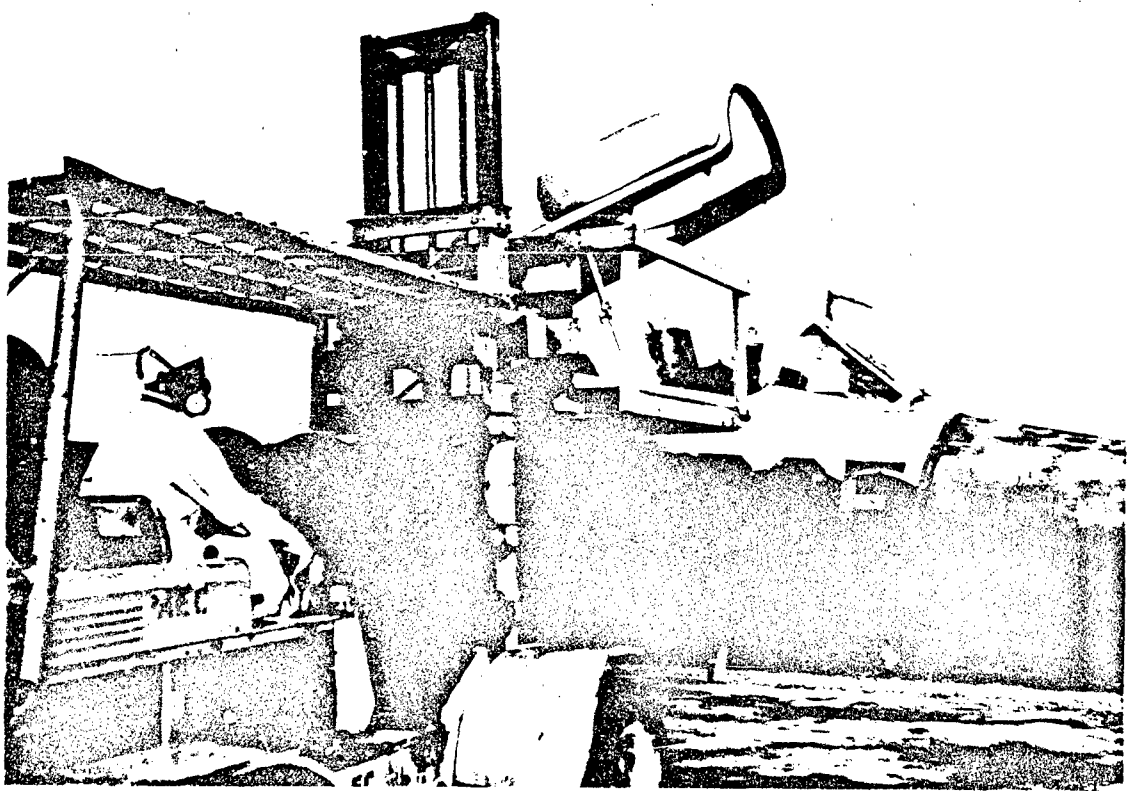


Figure 32. Pilot prepares to leave sampler B-57 via a platform on forklift, Johnston Island, DOMINIC.

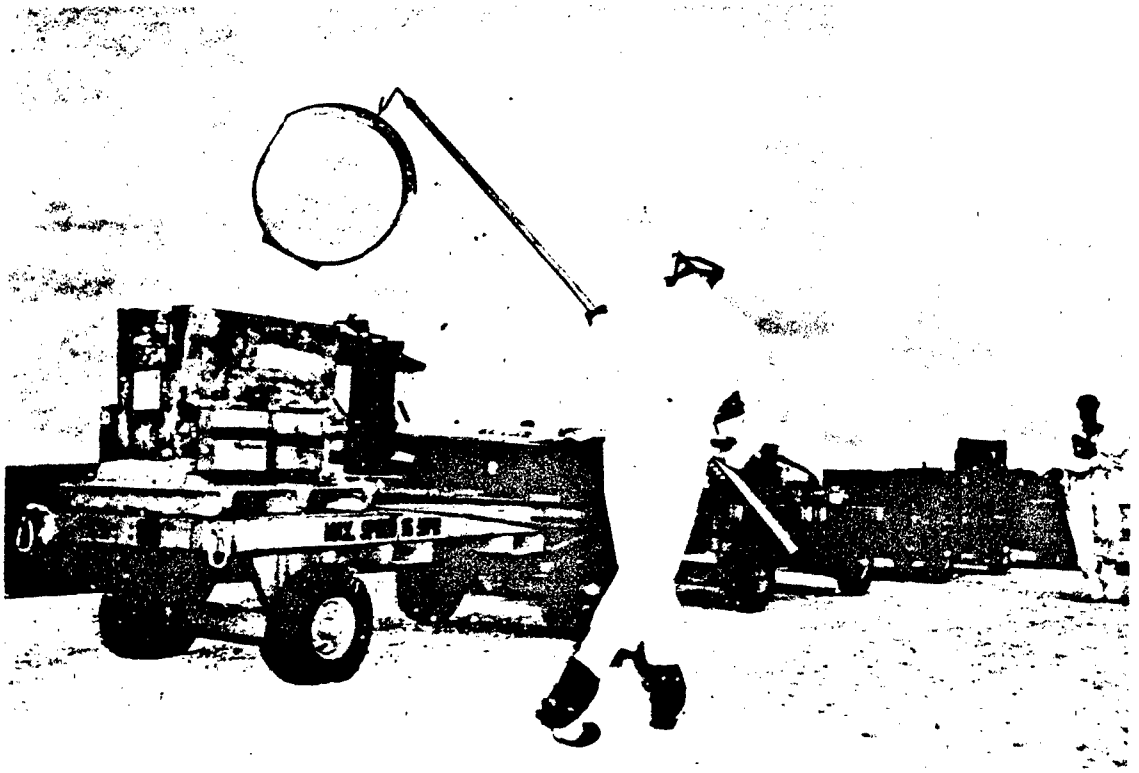


Figure 33. Filter with radioactive particulates from DOMINIC, BUMPING carried from B-57 sampler to lead cave.

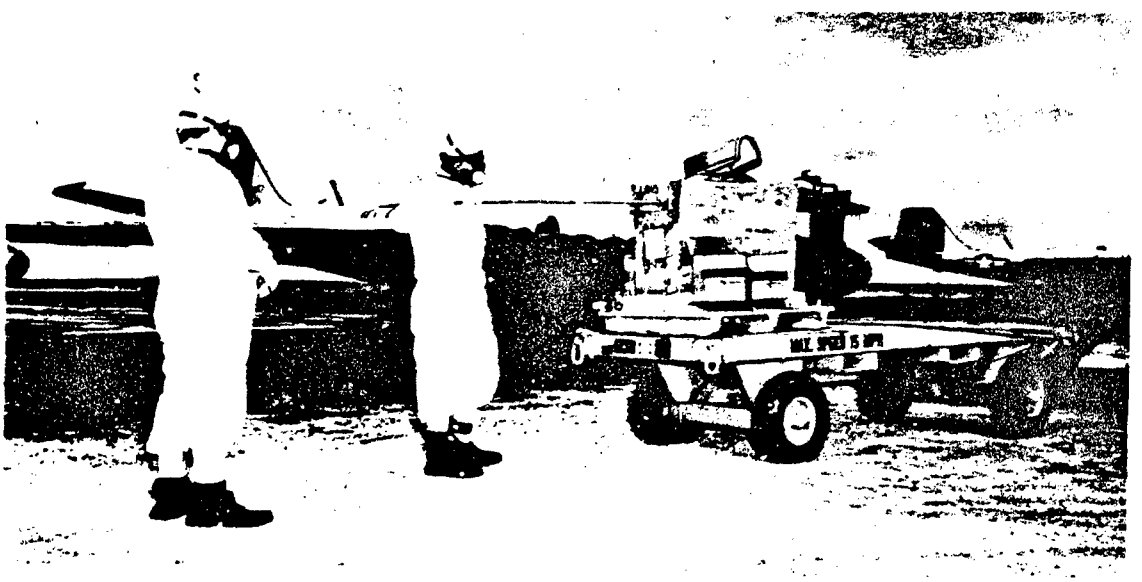


Figure 34. Radioactive filter in lead cave is rolled using long pole before being placed in lead pig, Johnston Island, DOMINIC.

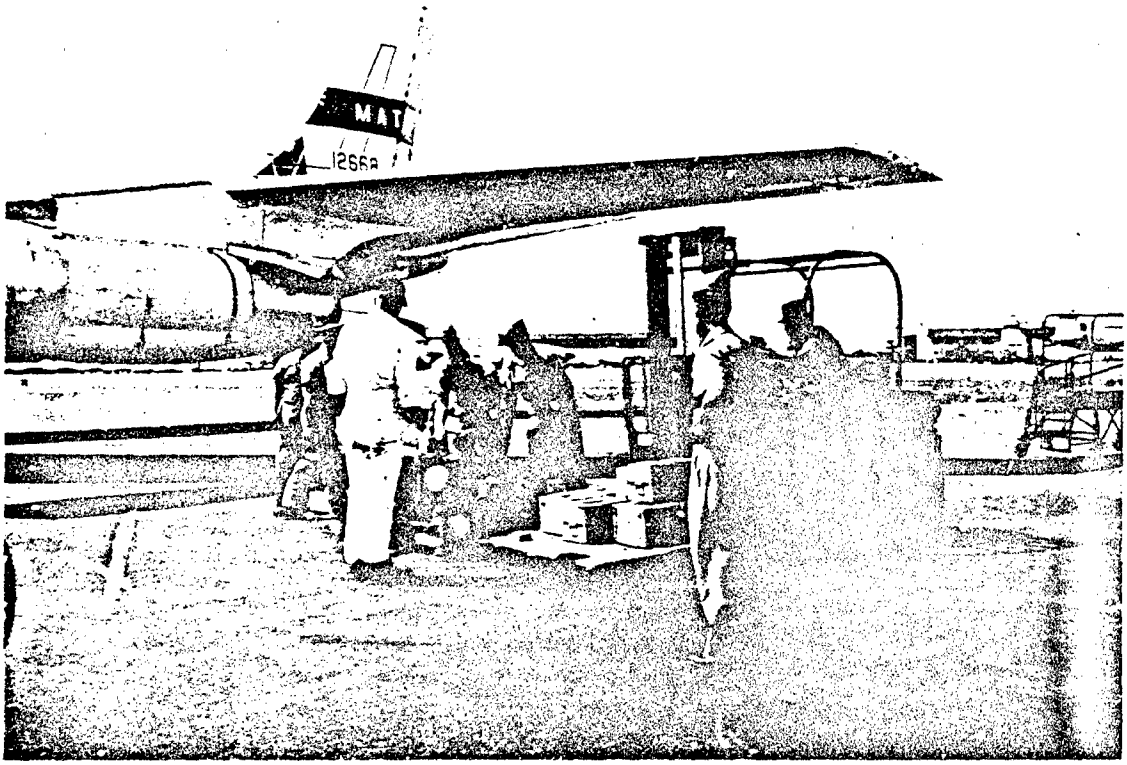


Figure 35. Weapon debris sample shipment in shielded containers being checked at Hickam AFB for radioactivity, DOMINIC.

Cloud Sampling

B-57s were used to obtain samples of the radioactive cloud after detonation. One B-57 was designated as sampler controller and a scientist from one of the two AEC weapon development laboratories rode in the rear seat of this B-57. He directed the sampler aircraft into the cloud at specific altitudes and locations. Based on the sampler pilot's report of radiation intensities and duration of cloud penetration, the controller determined if the aircraft needed to penetrate the cloud a second or third time to obtain a sufficient sample.

The samples were required for analysis by the Hq USAF experimental group and the weapon development laboratories, LASL and LRL. This analysis was used by Hq USAF to compare atmospheric radiochemical measurements for other tests. The laboratories used the samples primarily to determine the yield of the device.

Samples were collected in two ways by the B-57s. One way was to collect particulate matter on filter paper by passing ambient air through the filter while in the cloud. This could be controlled by the pilot or crew in the B-57. The crew also had a cockpit readout of the amount of radioactivity on the filter paper and could relay this to the airborne sampler controller for his use.

The second collection system was for gaseous material. This gaseous sampler was called a "double-squeegee." The probe was mounted on each wing of the B-57B and on each side of the fuselage on the B-57D. Compressors and bottles were inside the fuselage. Particulate matter from an in-line filter in the gaseous collector was also analyzed. The crew could control the operation of the system but could not determine the amount of radioactivity in the sample.

Sample Recovery and Return

B-57 sampler aircraft landed at Christmas or Johnston island, depending on shot location, and the cloud samples were immediately removed by trained JTG 8.4 personnel (Reference C.1.N). The B-57s flew from Christmas Island to perform sampling on the FRIGATE BIRD shot. No sampling was attempted on the SWORDFISH shot. It was desirable that the B-57s land as soon as possible after sampling to minimize pilot and crew exposure to the radiation that accumulated on the aircraft as it flew through the radioactive cloud. Sample-removal procedures are illustrated in Figures 33 and 34.

Experimental programs at Christmas and Johnston islands launched rockets through the nuclear cloud on some of the shots. The rocket nosecones were designed to collect samples of the cloud debris and later be recovered at sea. At Christmas Island the nosecones were recovered by Air Force helicopters. None of the five rocket nosecones launched from Johnston Island, however, was ever recovered.

The samples were not analyzed in the field, but were immediately loaded on C-135s at Christmas Island and C-118s at Johnston Island for rapid return to laboratories on the mainland. Courier officers selected from onsite personnel accompanied these shipments to their destination.

Personnel Decontamination

Personnel decontamination facilities were constructed on Christmas Island and were operated by JTG 8.4 radsafe personnel. The facility was of conventional design with designated entry area, shower area, and clean area for dressing. An adjacent laundry supported the facility with four washing machines, four hydroextractors* and one large dryer. Sampler crews, sample removal personnel, and other contaminated personnel used the facility on a regular basis (Reference C.1.N).

On Johnston Island, a facility for personnel decontamination was constructed and operated by H&N (JTG 8.5), the base support contractor. The "hot" tent had two shower compartments, each with two shower heads. The "clean" tent was for final monitoring and issue of clean clothing (Figure 36). Air sampling was conducted adjacent to the tents. Sampler crews, sample removal personnel, and the many personnel involved in the cleanup of the aborted STARFISH event and the BLUEGILL Prime missile, which was destroyed by fire, used this decontamination facility (Reference C.1.N).

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* A machine that uses a centrifuge principle to spin dry.

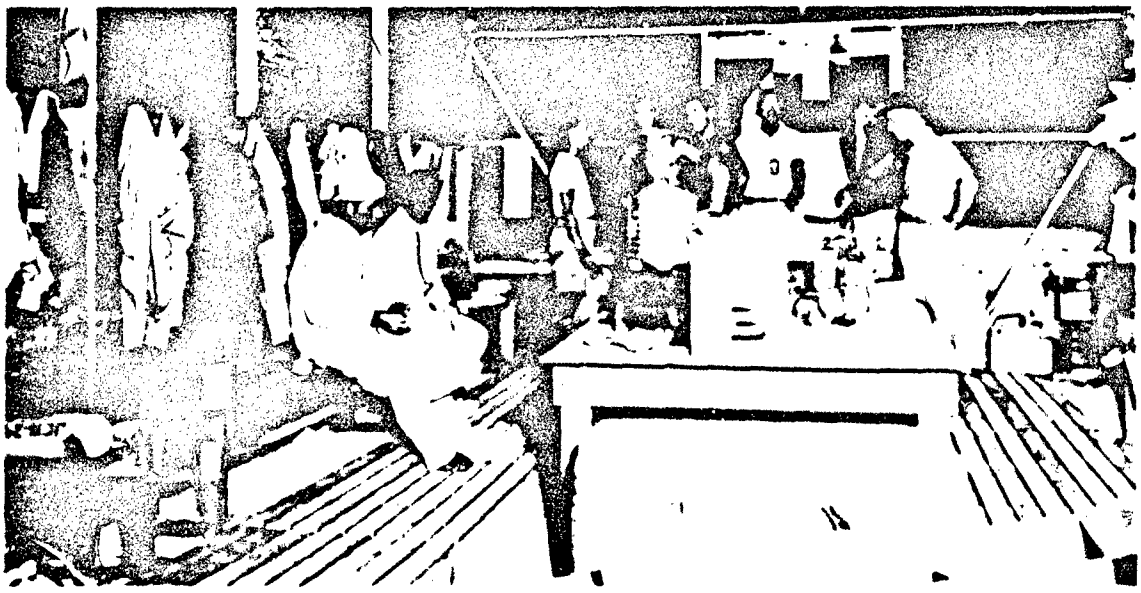


Figure 36. Interior of clean side of dressing decontamination tent at Johnston Island, Operation DOMINIC.

JTG 8.4 operated a personnel decontamination facility at NAS Barbers Point on Oahu for personnel involved in B-57 aircraft decontamination and maintenance.

Aircraft Decontamination

The B-57 cloud samplers were contaminated during their missions. After each mission at Christmas Island, these aircraft were taxied onto the decontamination pad one at a time and were washed down by jet sprays from a decontamination truck. After each airdrop mission near Johnston Island, the B-57 samplers were landed at Johnston Island and allowed to "cool down" overnight. The following day they were flown back to NAS Barbers Point where they were decontaminated in the same way as at Christmas Island. A primitive aircraft decontamination facility was constructed at Johnston Island but was not used (Reference C.I.N. pp. A-10 and A-18). Figure 37 shows the first survey of a sampler returned to NAS Barbers Point. Figures 38 and 39 show scrubdown underway and Figure 40 shows final inspection.

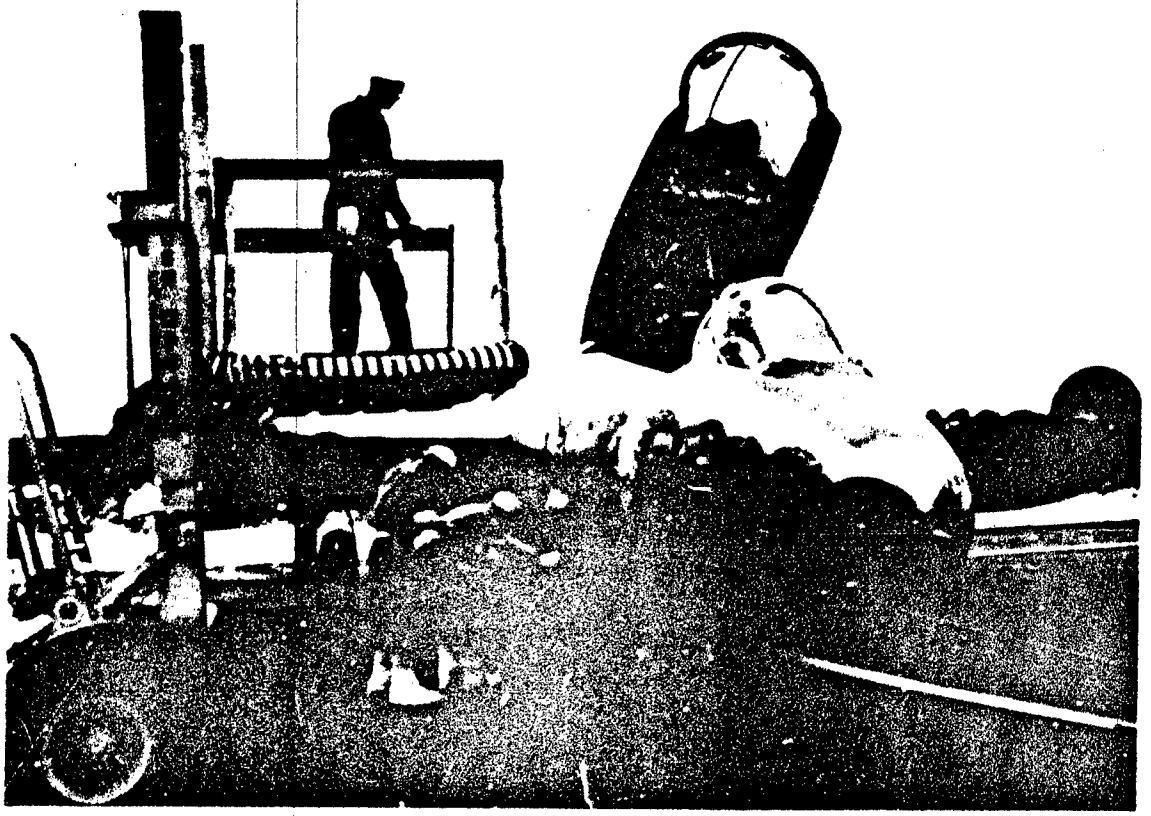


Figure 37. Crews prepare to decontaminate a B-57 sampler after crew and sample removal, Naval Air Station, Barbers Point, Operation DOMINIC.

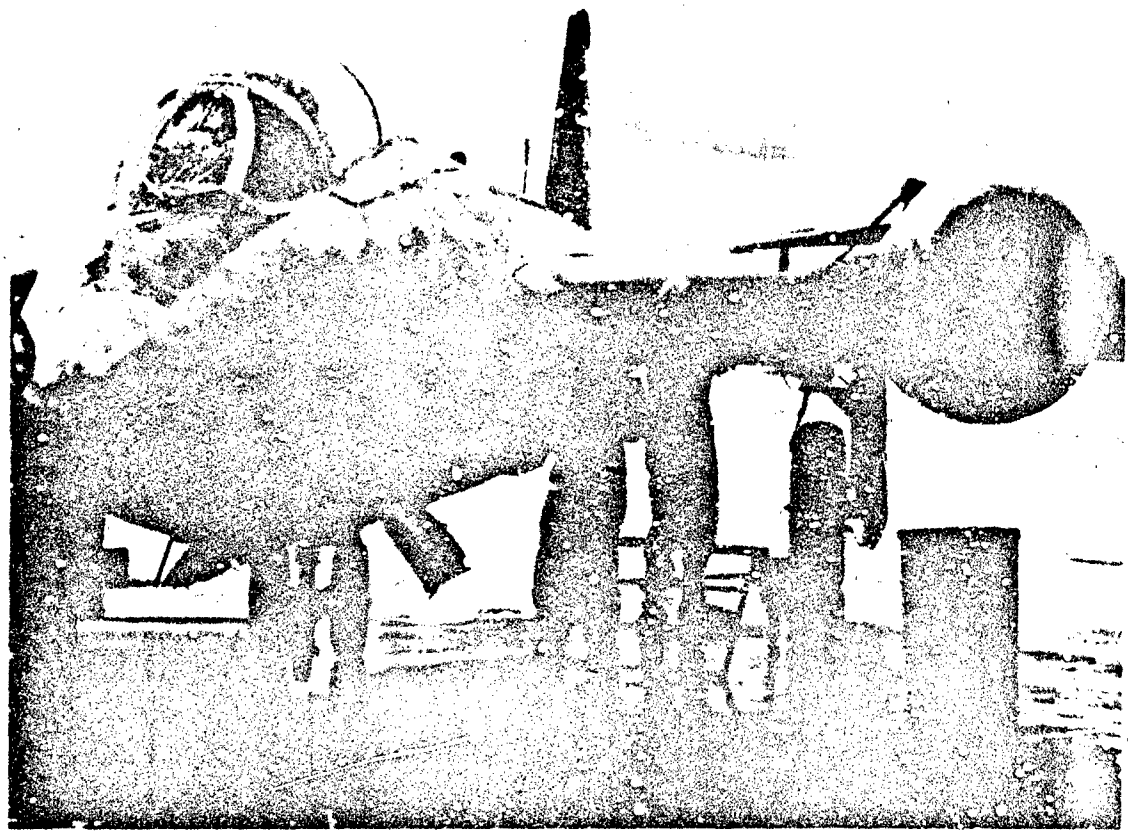


Figure 38. Scrubdown of B-57 sampler, Naval Air Station, Barbers Point, Operation DOMINIC.

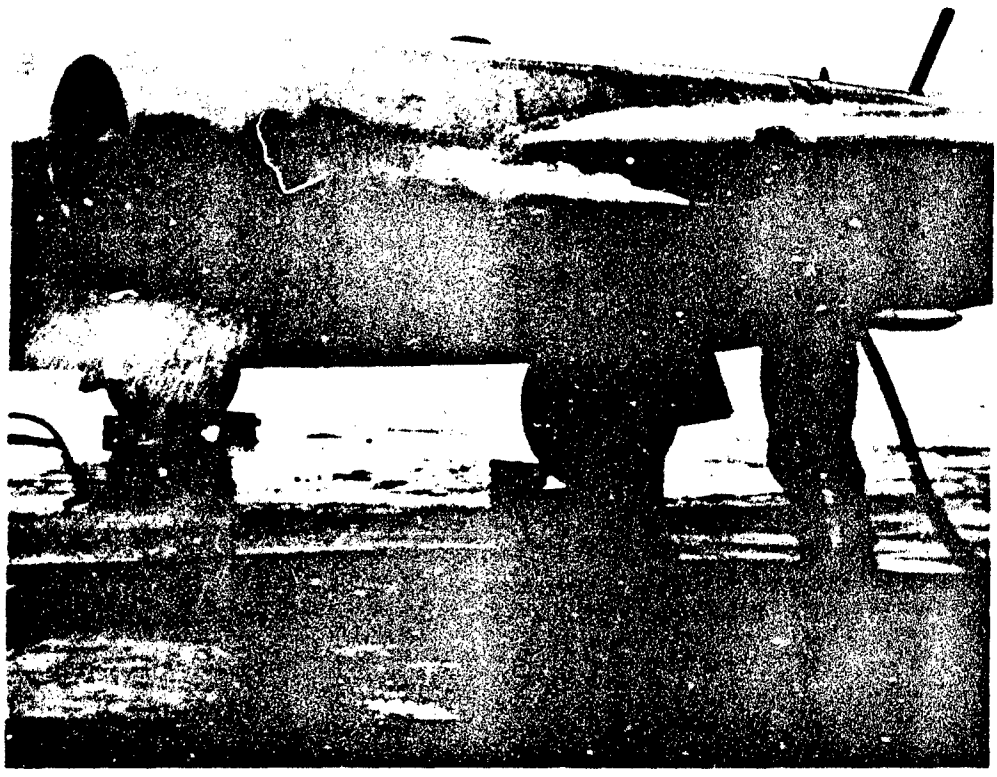


Figure 39. Washdown of B-57 sampler, Naval Air Station, Barbers Point, Operation DOMINIC.

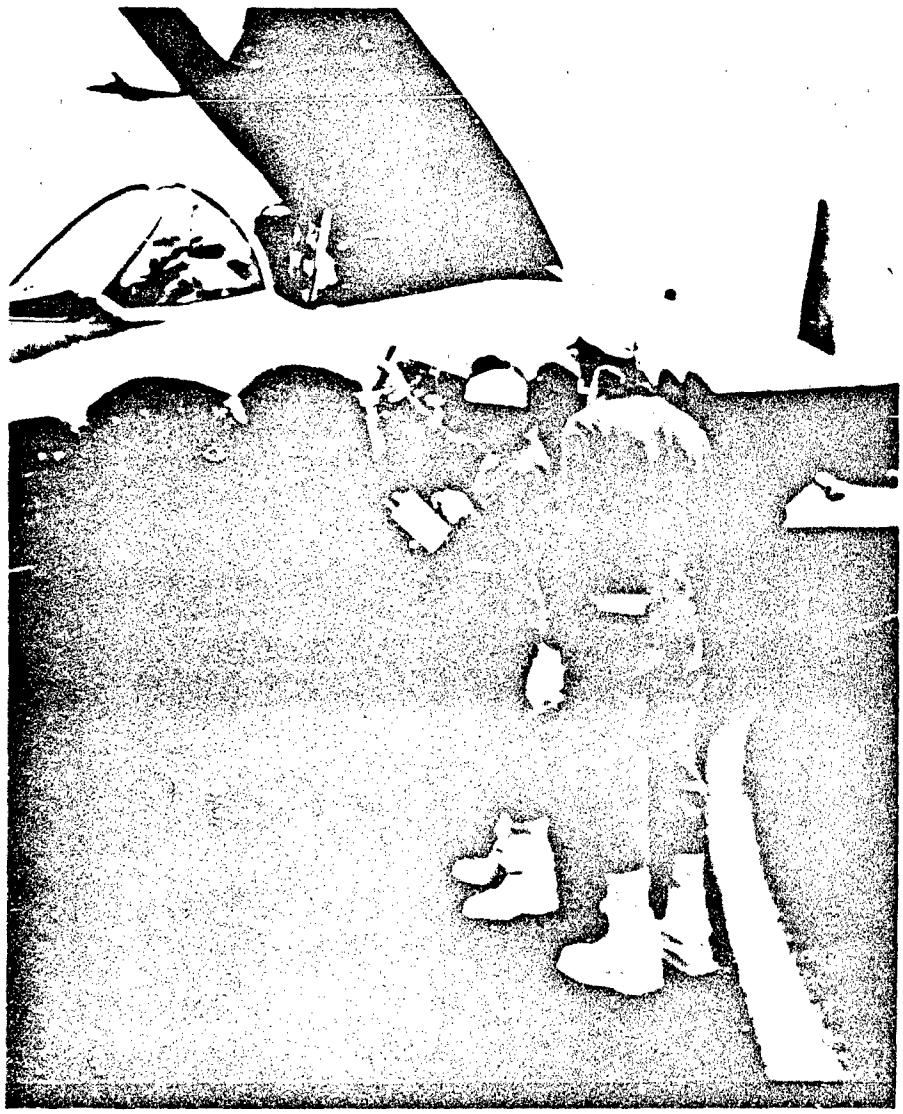


Figure 40. Final check after B-57 decontamination, Naval Air Station, Operation DOMINIC.

CHAPTER 3

DOD EXPERIMENTAL PARTICIPATION

The experimental program for Operation DOMINIC was divided into three phases, a weapon development phase, a weapon effects phase, and a weapon systems proof phase. The Department of Defense (DOD) participation in each of these programs was extensive. Even the experimental program for the weapon development shots at Christmas Island and later at Johnston Island, conducted by Atomic Energy Commission (AEC) laboratories, involved DOD personnel and units for device placement, cloud sampling, operation of airborne data recording stations, and general support. A few formal DOD experiments also were conducted at Christmas Island. The weapon effects phase was a DOD program involving many formal experimental projects. In addition, the weapon systems proof tests were also all DOD, although not many formal experiments were conducted along with these two Navy shots.

The central agency in the DOD experimental program was the Defense Atomic Support Agency (DASA). DASA was a joint service agency, formerly known as the Armed Forces Special Weapons Project and currently as the Defense Nuclear Agency.

On 21 October 1961, the Joint Chiefs of Staff (JCS) implemented the program for the proposed DOMINIC tests and assigned to DASA the responsibility for DOD effects experiments. Specifically, DASA's responsibilities were:

1. To plan and prepare experimental programs, to include delivery means for high-altitude effects tests at an overseas location
2. To plan experimental programs for nuclear weapon effects based on the possibility of continuing test programs
3. To prepare to provide necessary support to the AEC
4. To activate Joint Task Force 8 (JTF 8).

The Weapons Effects Test Group (WETG) at DASA Field Command (FCDASA), Sandia Base, New Mexico, was the specific organization within DASA charged with developing and executing the program. It was designated Task Unit (TU) 8.1.3 in the JTF 8 organizational structure. DOD effects experiments associated with the two Navy tests (SWORDFISH and FRIGATE BIRD) were the responsibility of the Navy, however, not TU 8.1.3. The DOMINIC experiments were given number designations, an organizational procedure that was commonly used in nuclear testing. However, there were two series of numbers given, one for the Christmas Island and Johnston Island phases of DOMINIC and a second for the SWORDFISH test. Therefore, some project numbers, such as 1.1, were used both at Johnston Island and in the SWORDFISH exercise. There were no numbered experiments on FRIGATE BIRD.

In preparation for executing DOMINIC DOD experiments, FCDASA requested that agencies responsible for projects forward the names and organizations of their participants. These listings formed Annex G of the FCDASA Engineering and Requirements Plan (E&R Plan). Some of the project lists have survived and are recapitulated in Table 14. Names on the lists were compared with the Consolidated List of Exposures, and this added information is shown in the last two columns of Table 14. It must be emphasized here that several project lists are not available. Those that are available appear to be complete. The relative radiation exposure potential involved for the different projects can be inferred from an examination of Table 14.

The following sections address the projects in their numerical sequence with the numbered Christmas and Johnston island experiments first, followed by the unnumbered Christmas and Johnston island experiments. Then the numbered SWORDFISH projects are discussed, followed by the unnumbered SWORDFISH projects.

CHRISTMAS AND JOHNSTON ISLAND NUMBERED PROJECTS INVOLVING THE DEPARTMENT OF DEFENSE

Project 1.1 — Blast Measurements at Various Distances from High-Altitude Nuclear Detonations

Agency: Army Ballistic Research Laboratories (BRL)

Operations: Missile pods were instrumented with pressure gauges, shock spectra gauges, and accelerometers. Microbarographs were placed on Johnston Island and aboard ships. Surface zero buoys were instrumented on the Johnston Island phase airdrop events. The missile pods and instrumentation aboard them became radioactive as a result of exposure to radiation at close ranges to the detonations.

Shots: STARFISH, BLUEGILL, KINGFISH, ANDROSCOGGIN, BUMPING, CALAMITY, CHAMA, HOUSATONIC.

Staffing: The project was managed and conducted by BRL personnel. Scripps Institution of Oceanography personnel already in the area were used to place instruments on surface zero buoys and on USS Forster (DER-334). The highest exposure recorded for BRL persons was less than 1 R.

Project Report: Reference C.2010.

Project 1.2 — Shock Photography

Agency: Naval Ordnance Laboratory (NOL)
Edgerton, Germeshausen & Grier (EG&G)

Operations: The blast and shock effects of selected Christmas Island airdrops were investigated and photographically documented. Films taken from aircraft platforms by EG&G were reviewed at NOL.

Shots: BIGHORN, HOUSATONIC, RINCONADA, SUNSET.

Table 14. Organizations scheduled to participate in experimental programs, DOMINIC.[a]

Project	Organization Code[b]	Number in E&R[c] Plans	Number Persons Badged[d]	Highest Exposure (R)
2.1	U.S. Army Chemical Center (8257)	16	7	1.325
4.1	School of Aerospace Medicine (4137, 4178)	36	3	0.000
6.1	White Sands Missile Range (8227)	32	21	0.340
	Aerojet General (8635)	14	12	0.063
	Sylvania (8613, 8641)	27	21	0.118
	Air Force Special Weapons Center (4108)	2	1	0.070
	Field Command, DASA (8008, 8130)	1	1	0.112
6.2/ 6.3[d]	Ballistics Research Lab (BRL) (8286)	20	17	0.950
	Geophysics Corp. of America (8638, 8647)	14	14	0.500
	Electro-Optical Systems (8634)	17	11	0.128
	Atlantic Research Corp. (3513, 8640)	17	12	0.083
	Aero Lab (8644)	9	5	0.112
	Schimmelman Engineering (8653)	1	1	0.040
6.4	Air Force Cambridge Research Lab (8642)	8	1	0.000
	University of Utah (8648)	2	2	0.023
	Comstock Wescott (8669)	1	1	0.000
	Adcole Corp. (8662)	3	1	0.000
	Wentworth Institution (8668)	1	1	0.000
	Unknown Contractor (4680)	1	1	0.000
	Matrix R & D, Nashau, MA (8665)	1	1	0.000
	Zimney Corp. (8654)	6	5	0.000
	American Science and Engineering (8636)	10	8	0.225
6.5a	Air Force Cambridge Research Lab (8642)	22	7	0.500
	Lowell Tech	1	0	N/A
	Nuclear Research Associates	8	0	N/A
	Lockheed	6	0	N/A
	Electro-Mechanics	4	0	N/A
	Barclay and Dexter	3	0	N/A
	Ft. Monmouth	6	0	N/A
6.5b	Illinois Institute of Technology	21	0	N/A
6.5c	Central Radio Propagation Lab, NBS (8652)	22	1	0.000
6.5d	U.S. Army Signal Radio Prop. Agency (8284)	13	6	0.483
6.5e	U.S. Army Signal Radio Prop. Agency (8284)	4	1	0.000
6.6	Geophysics Corp. of America (8638, 8647)	20	6	0.915
6.7	Air Force Special Weapons Center (4108, 8007)	15	11	0.500

(continued)

Table 14. Organizations scheduled to participate in experimental programs, DOMINIC[a] (continued).

Project	Organization Code[b]	Number in E&R[c] Plans	Number Persons Badged[d]	Highest Exposure (R)
6.8	Air Force Cambridge Research Lab (8642)	5	1	0.000
	Aerospace Research (8631)	14	4	0.000
	General Electric (8607)	2	1	0.000
	Field Command, DASA (8008, 8130)	2	1	0.000
6.9	Stanford Research Institute (8623)	40	12	0.615
	Field Command, DASA (8008)	1	1	0.380
6.10	Air Force Special Weapons Center (4108)	7	2	0.041
6.11	Stanford Research Institute (8623)	39	1	0.000
	Fort Monmouth	7	0	N/A
6.13	U.S. Army Missile Command (8256)	7	2	0.048
	USAS American Mariner Crew (8344)	60	55	0.310
	RCA (8608)	125	76	0.440
	Barnes Engineering (8680)	17	10	0.040
	Picatinny Arsenal (8262	4	3	0.065
	New Mexico State University (8637)	10	7	0.072
	Western Electric (8674)	2	1	0.000
	Aero Lab Development Company (8644)	2	2	0.112
7.1	Kaman Nuclear (8658)	6	0	N/A
7.2	Lincoln Labs, MIT (8632)	12	12	0.760
7.3	White Sands Missile Range (8227)	14	13	0.340
	Weapons Effects Test, FC DASA (8008, 8130)	8	4	0.245
	Columbia University (8666)	2	2	0.093
	EDL, Sylvania (8641)	1	1	0.129
	New Mexico State University (8637)	1	1	0.072
	Sylvania (8613)	2	2	0.118
	Hughes Aircraft (8643)	11	11	0.109
	Pueblo Army Depot (8289)	3	2	0.218
7.4	ASD, Wright-Patterson AFB (41 3)	9	0	N/A
	Stanford Research Institute (8623)	57	1	0.000
	Electronic Communications, Inc. (8661)		4	0.352
8A.1	American Science and Engineering (8636)	9	2	0.325
	Weather Central, Hanscom Field (4657)	16	1	0.000
	Technical Operations	8	0	N/A
	Geophysics Corp. of America	1	0	N/A
	Lowell Tech	1	0	N/A
	Wentworth Institution	1	0	N/A
	ASD, Wright Patterson AFB	3	0	N/A

(continued)

Table 14. Organizations scheduled to participate in experimental programs, DOMINIC[a] (continued).

Project	Organization Code[b]	Number in E&R[c] Plans	Number Persons Badged[d]	Highest Exposure (R)
8A.2	EG&G (8160)	20	3	0.380
8A.3	ASD, Wright-Patterson AFB (4123)	9	9	0.500
	American Science and Engineering (8636)	15	12	0.325
8B	Air Force Special Weapons Center (8007)	5	5	0.500
	Allied Research Associates (8657)	7	4	0.349
8C	Air Force Special Weapons Center (8007)	5	5	0.500
	AVCO Corporation (8649)	12	12	0.034
9.1a	Air Force Cambridge Research Lab (8642)	2	2	0.970
	University of Utah (8648)	5	5	0.023
	Oklahoma State University (8675)	1	1	0.000
9.1b	Geophysics Corporation of America (8638, 8647)	13	7	0.500
9.4b	Air Force Special Weapons Center (8007, 8130)	5	4	0.180
	General Dynamics (8660)	9	3	0.380
	Northrop Ventura (8651)	3	2	0.036
9.6	Cubic Corporation (8603)	47	21	1.270

Notes:

[a] Some projects are not listed because there were no data in the historical files available for review.

[b] Some agencies in this column have more than one organizational code listed because the agency was given two or more codes during DOMINIC.

[c] Engineering and Requirements Plans.

[d] This column shows the number of persons from the E&R Plan who were issued a badge during DOMINIC (obtained from the Consolidated List). The number does not normally indicate the total number of persons badged from the agency.

[d] BRL submitted a combined list of personnel for Projects 6.2 and 6.3; thus these projects are grouped together. This list indicated that AFCRL personnel for Project 6.3 were also involved in Project 6.4 and would be listed under that project

Source: FC DASA Engineering and Requirements Plans for DOMINIC, Annex G.

Staffing: The project report acknowledges four EG&G persons, of whom three were badged. The highest exposure recorded for the three was 0.380 R. NOL project personnel may have remained off site and simply reviewed the films. Some NOL personnel were badged for DOMINIC and they could have been associated with this project, although NOL also had other projects.

Project Report: Reference C.2011.

Project 2.1 -- External Neutron Flux Measurements

Agency: Army Nuclear Defense Laboratory (NDL)

Operations: NDL instrumentation was mounted on the pods of the three Thor missile shots. The instruments were then analyzed in the mobile laboratory on Johnston Island after recovery from the pods. Recovery of the pods was done by JTF 8. Instrumentation was returned to the project 9 hours following STARFISH, 8 hours following BLUEGILL, and 6 hours following KINGFISH. Exposure potential existed in recovering, removing, and analyzing the instruments from the pods.

Shots: STARFISH, BLUEGILL, KINGFISH.

Staffing: NDL personnel conducted Projects 2.1, 2.2, and 2.3. A pre-event personnel list for Projects 2.1 and 2.2 from NDL (see Table 14) shows that seven of sixteen people on this list were badged during DOMINIC. The highest exposure recorded was 1.325 R. No such list is available for Project 2.3; however, it is probable that the same personnel took part in all three projects.

Project Report: Reference C.2012.

Project 2.2 -- Gamma Radiation Measurements

Agency: Army Nuclear Defense Laboratory

Operations: Gamma-detector packages were placed in each of the three pods for each of the Thor shots. The packages were then analyzed in the laboratory after the pods were recovered in the same manner as Project 2.1, above.

Shots: STARFISH, BLUEGILL, KINGFISH.

Staffing: See Project 2.1 above.

Project Report: Reference C.2013.

Project 2.3 -- Alpha Contamination Monitoring

Agencies: Army Nuclear Defense Laboratory (NDL)
Army Chemical Corps School

Operations: Alpha monitoring stations were set up downwind of the Johnston Island missile launch pads. These stations were to determine possible alpha contamination if a missile with warhead were destroyed on or very near the launch pads. This project was initiated after the second attempt to launch BLUEGILL ended with the missile and warhead burning on the launch pad. No data were obtained by this project since no repeats of the BLUEGILL accident occurred.

Monitoring stations were located in and around the T[illegible]or pad, which was heavily alpha-contaminated when the second BLUEGILL attempt burned on the pad. Although the pad had been cleaned up, some low-level alpha contamination still existed in the area.

Shots: CHECKMATE, BLUEGILL, KINGFISH, TIGHTROPE.

Staffing: The project was staffed by an officer from NDL and one from the Chemical Corps School, but personnel from other projects were also used. The agencies the officers represented did have personnel on the Consolidated List, but the identified officers were not among them. This suggests that these officers' work on this project was offsite only.

Project Report: Reference C.2052.

Project 4.1 -- Production of Chorioretinal Burns by Nuclear Detonations and Tests of Protective Devices and Photographic Materials

Agencies: Air Force School of Aerospace Medicine (AFSAM)
6570th Aerospace Medical Research Laboratories
Naval Material Laboratory (NML)

Operations: Rabbits and monkeys were carried in aircraft at various distances from the bursts to determine the effect of detonations on the eyes of the animals. As many as ten aircraft were used on several shots. Thermal measurements were made from the same aircraft stations as part of this project.

Shots: ENCINO, SWANEE, TANANA, NAMBE, YESO, HARLEM, STARFISH, CHAMA, CHECKMATE, BLUEGILL, CALAMITY, HOUSATONIC, KINGFISH, TIGHTROPE.

Staffing: AFSAM managed this project with the other agencies noted. NML took the thermal measurements. Only three men out of thirty-six identified were badged and no one recorded any radiation.

Project Report: Refer[illegible]nce C.2014.

Project 4.2 -- Photoelectric and Psychophysical Measures of Nuclear Weapons Flashes

Agency: Aviation Medical Acceleration Laboratory, Naval Air Development Center (NADC)

Operations: Brightness of the bomb flashes was measured from a station near A-site at Christmas Island using photoelectric instrumentation. Three observers were used on four shots to measure reaction to flashblindness. The observer entered a light-tight enclosure 20 minutes before the shot. At shot time the observer was looking at the shot through a viewer with his right eye. After the flash, the time to correctly resolve a test pattern was recorded. In all cases, the flashes were not bright enough to produce an after-image in any of the observers' eyes.

Shots: RINCONADA, DULCE, PETIT, OTOWI, BIGHORN, BLUESTONE, SUNSET, PAMLICO.

Staffing: NADC managed this project using Omnitech, Inc., as a contractor. Only one NADC person was badged, and Omnitech does not appear in the Consolidated List. It is assumed that NADC must have had assistance from others on Christmas Island to execute this project. The source organization of two of the volunteer flashblindness subjects is not established in the project report. One observer was the single NADC man badged and his exposure was zero.

Project Report: Reference C.2016.

Project 6.1 -- Fireball Attenuation

Agencies: Army Electronics Research and Development Activity (ERDA)
Electronic Defense Laboratories, Sylvania
Aerojet General Corporation
Air Force Special Weapons Center (AFSWC)

Operations: Using rocket-borne radio transmitters and receivers on Johnston Island and four ships (USS Oak Hill [LSD-7], USS Fort Marion [LSD-22], USS Polk County [LST-1084], and USNS Point Barrow [T-AKD-1]), the radar performance near a high-altitude nuclear detonation was measured.

There was a potential for exposure for personnel on Johnston Island due to the return of the missile pods there. However, unless a man's duties involved handling these objects the potential was very low, even considering the generally tight quarters on the island. The destruction of the Thor missile and its warhead on Johnston Island on 25 July added the possibility of internal exposure to alpha contamination. However, unless duties involved the cleanup of this launch pad the potential was low.

Shots: BLUEGILL, KINGFISH, TIGHTROPE.

Staffing: ERDA personnel were on Johnston Island and may have been on board the ships listed above. AFSWC personnel were on Johnston Island. Sylvania's Electronics Defense Laboratory and Aerojet General Corporation had 21 and 12 personnel, respectively, badged for this project. The Consolidated List shows 21 individuals badged for this project from White Sands Missile Range (WSMR), where ERDA was located. The highest recorded exposure for WSMR personnel was 0.340 R. The highest exposure recorded for Sylvania and Aerojet personnel was 0.118 R.

Project Report: Reference C.2015.

Project 6.2 -- Gamma Ray Scanning of Debris Cloud

Agencies: Army Ballistic Research Laboratories (BRL)
Electro-Optical Systems Inc. (EOS)
Aero Lab, Inc.
Atlantic Research Corporation

Operations: Both direct and indirect attenuation measurements were made by launching rockets from Johnston Island. Receivers were located at Johnston Island and at Aberdeen Proving Ground, Maryland. The rockets did not need to be recovered as the data were telemetered to the data recorders. The rockets were the same ones used by Project 6.3.

Shots: Rockets were launched for STARFISH, BLUEGILL, and KINGFISH. Indirect attenuation measurements were made on all five high-altitude shots.

Staffing: BRL manned this project with assistance from Aero Lab and Atlantic Research Corporation for the instrumented rockets, and from EOS with data-recording and experiment design. One person from BRL received 0.950 R (see Table 14). Everyone associated with this project was also associated with Project 6.3. For both projects, badges were issued to 17 from BRL, 12 from Atlantic Research, 5 from Aero Lab, and 11 from EOS.

Project Report: Reference C.2017.

Project 6.3 -- D-Region Physical Chemistry

Agencies: Army Ballistic Research Laboratories
Geophysics Corporation of America (GCA)
Electro-Optical Systems Inc.
Air Force Cambridge Research Laboratories (AFCRL)

Operations: Attenuation of signals transmitted through the radioactive cloud were measured using rocket-borne transmitters and receivers located on Johnston Island. Honest John-Nike and Nike-Cajun rockets were launched from Johnston Island and were instrumented by Projects 6.2 and 6.3. No rocket recovery was required.

Shots: STARFISH, BLUEGILL, KINGFISH.

Staffing: Staff was shared with Project 6.2 with the addition of 14 men from GCA and an unknown number from AFCRL.

Project Report: Reference C.2018.

Project 6.4 -- E- and F-Region Physical Chemistry

Agencies: Air Force Cambridge Research Laboratory (AFCRL)
American Science and Engineering

Operations: Direct attenuation of signals transmitted through the radioactive cloud was measured using rocket-borne transmitters and receivers located on Johnston Island. Javelin rockets were launched from Johnston Island and no recovery of them was required as their data were telemetered.

Shots: STARFISH and KINGFISH.

Staffing: AFCRL used a variety of contractors (see Table 14). Exposures recorded by badged personnel working on this project were very low or zero.

Project Report: Reference C.2019.

Project 6.5a -- Ionospheric Soundings and Magnetic Measurements

Agencies: Air Force Cambridge Research Laboratory (AFCRL)
Lockheed Missiles and Space Division
Nuclear Research Associates
Electro-Mechanics Co.
Space Sciences Inc.

Operations: Radiofrequency propagation, geomagnetic field, and ionospheric experiments were conducted at a number of offsite locations including Midway, Palmyra, Tongatabu, Kauai, California, Canton, Samoa, Wake, Trinidad, Okinawa, Johnston Island, and on USS Takelma (ATF-113). There was some project activity at Johnston Island. There was no radiation exposure potential except on Johnston Island and Palmyra. There were measurable air concentrations on Palmyra on three occasions resulting from Christmas Island airdrops, but these were extremely low. The slight possibility of exposure at Johnston Island is discussed under Project 6.1.

Shots: All events after 17 June 1962 (DULCE) to the end of the series.

Staffing: AFCRL used several contractors (seen Table 14). Although the E&R List (Table 14) does not show Polytechnic Engineering Corporation, they also assisted AFCRL on this project. The Consolidated List shows that one person from Polytechnic Engineering was badged and received no exposure. The other contractors did not send personnel to areas in the Pacific where badging was required.

Project Report: Reference C.2020.

Project 6.5b -- Ionospheric Measurements in the Southern Conjugate Area

Agency: Illinois Institute of Technology Research Institute (IITRI)
(formerly Armour Research Foundation)

Operations: Radio propagation, magnetic, and ionospheric experiments were conducted on Tutuila, Samoa and Tongatabu.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: The project was staffed by personnel from IITRI. None of the 21 people scheduled to participate in this project were badged. Most of the personnel were sent to locations other than Christmas or Johnston Island.

Project Report: Reference C.2021.

Project 6.5c -- Vertical Ionospheric Sounding Measurements

Agency: Central Radio Propagation Lab, National Bureau of Standards (NBS)

Operations: High-frequency soundings of the ionosphere were taken at Maui, French Frigate Shoals, Tutuila, Wake, Canton, Midway, and Tongatabu.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: Twenty-two from NBS were identified in the E&R plan as likely participants with zero exposures.

Project Report: Reference C.2022.

Project 6.5d -- Effects of Thermonuclear Radiation on the Ionosphere

Agency: Army Signal Radio Propagation Agency (SRPA)

Operations: HF propagation experiments were conducted with the transmitter at Kauai, Hawaii, and receivers at Okinawa, Adak, Alaska, and Palo Alto, California. Ionospheric soundings were taken using HF sounders on Johnston Island and Kwajalein. The possibility of low-level exposures of personnel on Johnston Island is discussed under Project 6.1.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: Table 14 shows that SRPA had six personnel badged of the thirteen scheduled to participate. These six were probably on Johnston Island at some point in the test series. The other seven were probably at islands where badging was not necessary. The highest exposure of SRPA personnel was 0.48 R.

Project Report: Reference C.2023.

Project 6.5e -- Magnetic Measurements

Agency: Army Signal Research and Development Laboratory (SRDL)

Operations: Extremely-low-frequency impulses were measured using magnetometers located on the islands of Hawaii and Tutuila.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: Although SRDL conducted this experiment and wrote the project report, the only person scheduled to participate who was badged (see Table 14) was from SRPA. Since both agencies were located at Ft. Monmouth, New Jersey, this is not unusual. Persons on the islands of Tutuila and Hawaii were not badged.

Project Report: Reference C.2024.

Project 6.6 -- Long-Term Debris History

Agency: Geophysics Corporation of America (GCA)

Operations: Bomb debris was tracked for a long period and over a wide geographical area after detonation. Observations were made using optical techniques from Johnston Island, French Frigate Shoals, Tutuila, Tongatabu, USS Summit County (LST-1146), USS Henry County (LST-824), and Point Barrow.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: This project was managed by GCA. Table 14 shows that 6 of the 20 personnel from GCA were badged; the highest recorded exposure was 0.915 R.

Project 6.7 -- Debris Expansion Experiment

Agency: Air Force Special Weapons Center (AFSWC)

Operations: Five instrumented rockets were launched from Johnston Island for measurements on STARFISH and two for CHECKMATE. Data were telemetered from the rockets to Johnston Island, Canton, French Frigate Shoals, Oahu, and Hawaii so that rocket recovery was not necessary.

Shots: STARFISH, CHECKMATE.

Staffing: This project was managed by AFSWC. Table 14 shows that 11 of the 15 AFSWC personnel were badged. None recorded more than 0.50 R.

Project Report: Reference C.2026.

Project 6.8 -- Riometer Measurements

Agencies: Air Force Cambridge Research Laboratories (AFCRL)
Aerospace Research Corporation
Stanford Research Institute (SRI)

Operations: Measurements of cosmic noise attenuation were made at Johnston Island, French Frigate Shoals, Canton, Tutuila, Tongatabu, Palmyra, Midway, Wake, Fiji, Oahu, Samoa, Rarotonga, Viti Levu, Christmas, MV Acania, Summit County, Henry County, USNS Harris County (T-LST-822), Point Barrow, Takelma, USS Hassayampa (AO-145), USS Hitchiti (ATF-103), USNS Pvt. Frank S. Petrarca (T-AK-250), and USAS American Mariner. Small amounts of air contamination were measured on three occasions at Palmyra.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: AFCRL managed this project but had several contractors. Aerospace Research Corporation installed and operated riometers on Midway, French Frigate Shoals, Oahu, Palmyra, and the ships. Table 14 shows that 4 of 14 Aerospace Research Corporation personnel were badged; all readings were zero. GCA helped man some of these riometers wherever they had Project 6.6 personnel. One person from SRI working with Project 6.9 took the riometer readings on Canton. Other SRI personnel operated the riometers at all Project 6.11 sites and aboard Acania. At Christmas Island personnel from Hq USAF operated the riometers. There are three separate listings for Hq USAF on the Consolidated List, totaling 13 persons; all badges read zero except one, which read 0.079 R. IITRI personnel operated the riometers on Tonga, Samoa, and the civilian ship, Hifofua. A person from General Electric-TEMPO operated the riometer on Johnston Island; his exposure was zero.

Project Report: Reference C.2027.

Project 6.9 -- Radar Clutter Measurements

Agency: Stanford Research Institute (SRI)

Operations: Measurements of burst location clutter ionization using various types of cameras and radars were conducted at Johnston Island, Canton, Acania, the Downrange Anti-Missile Measurement Program (DAMP) ship (American Mariner), and on board the RC-121 aircraft.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: The equipment was operated by SRI personnel at all sites except American Mariner and on board the RC-121 aircraft. Barnes Engineering Company personnel from Project 6.13 operated the cameras on board American Mariner. There is no explanation for the fact that five of the twelve badged SRI men received exposures ranging up to 0.615 R, unless they assisted informally on other projects at Johnston Island.

Project Report: Reference C.2028.

Project 6.10 -- Large Scale Ionization Effects from High-Altitude Nuclear Detonations

Agency: Air Force Cambridge Research Laboratories (AFCRL)

Operations: Effects of nuclear detonations on the ionosphere were measured from aboard a KC-135 based in the Fiji Islands, and on Maui, Hawaii, Midway, and French Frigate Shoals. An ionosonde trailer van and all-sky camera were located at the Nendi airfield in the Fijis. The islands involved never recorded radiation and the KC-135 stayed south of the Equator, over a thousand miles from the detonations.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: The KC-135 aircraft was No. 53131. The all-sky camera at Nandi was operated by members of the Dominion Physical Laboratory, New Zealand.

Project Report: Reference C.2029.

Project 6.11 -- HF Communications Experiment

Agencies: Army Signal Research and Development Laboratory
Stanford Research Institute (SRI)

Operations: The effects of high-altitude nuclear explosions on high-frequency communications were studied. Twelve sites -- Okinawa, Kwajalein, Canton, Kauai, Wake, Midway, Hawaii, Tutuila, Viti Levu, Rarotonga, Fairbanks, Alaska, and Palo Alto, California -- were used to make measurements. None of these locations received any radiation exposure from DOMINIC tests.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: SRI personnel manned the 12 sites. Only one person was badged and he recorded no exposure (see Table 14).

Project Report: Reference C.2030.

Project 6.12 -- Piggyback Satellite Packages

Agency: Air Force Cambridge Research Laboratories

Operations: Four satellites were instrumented for Project 6.12, but they were not operational at the times of the high-altitude bursts.

Project Report: Reference C.2031.

Project 6.13 -- RF and Optical Measurements

Agencies: Army Missile Command (AMC)
Radio Corporation of America (RCA)
Barnes Engineering Company

Operations: Radiofrequency (RF) measurements to determine radar performance in a nuclear burst were made. Measurements were made from American Mariner. Rocket probes were launched from Johnston Island. Optical measurements were also made from American Mariner by Barnes Engineering personnel.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: RCA personnel operated the RF equipment on American Mariner; Barnes Engineering personnel operated the optical equipment on the DAMP ship. Other contractors assisted AMC, including Atlantic Research who launched the rockets from Johnston Island. Everyone on American Mariner appears to have been badged, and the highest reading was less than 0.5 R.

Project Report: Reference C.2032.

Project 7.1 -- Electromagnetic Signal, Underwater Measurements

Agency: Kaman Nuclear

Operations: Measurements were conducted from two ships, USS Inflict (MSO-456) and USS Loyalty (MSO-457), stationed off Oahu, Hawaii.

Shots: This project participated in all 24 shots at Christmas Island, plus SWORDFISH, FRIGATE BIRD, and STARFISH.

Staffing: This project was staffed by 3 men from Kaman Nuclear. Two men from Kaman Nuclear were badged, but they were visitors to the test site and not Project 7.1 participants.

Project Report: Reference C.2033.

Project 7.2 -- Radiofrequency Radiometry

Agency: Lincoln Laboratory, Massachusetts Institute of Technology

Operations: Ground-based measurements were made at Johnston and Palmyra islands.

Shots: All FISHBOWL shots.

Staffing: The project was staffed by Lincoln Laboratory personnel. Five of the twelve persons shown in Table 14 had exposures greater than zero, the highest being 0.760 R. Very low-level air contamination was measured on Palmyra Island on three occasions.

Project Report: Reference C.2034.

Project 7.3 -- Microwave Attenuation Due to Nuclear Burst

Agencies: Electronics Research Laboratories, Columbia University
Hughes Aircraft Company
Army Signal Missile Support Agency (SMSA)

Operations: Radar signal attenuation during low-altitude nuclear tests was measured. Beacons and reflectors were dropped from a B-57 aircraft and monitored from Christmas Island.

Shots: YUKON, MUSKEGON, SWANEE, CHETCO, TANANA, NAMBE, ALMA, TRUCKEE, HARLEM, RINCONADA, DULCE, PETIT, BIGHORN, BLUESTONE, SUNSET.

Staffing: SMSA provided the radars and three crews for the experiment with assistance from Columbia University. Hughes Aircraft serviced and flew the B-57 and the G.T. Schjeldahl Company and Pueblo Army Depot assisted the project. The highest badge reading of any person identified with the project was 0.340 R.

Project Report: Reference C.2043.

Project 7.4 -- Communication Propagation Investigation Equipment

Agency: Air Force Aeronautical Systems Division (ASD)

Operations: Radiofrequency communications between aircraft and stations at Johnston Island, Hickam AFB, and six other Pacific island sites were monitored.

Shots: STARFISH, CHECKMATE, BLUEGILL.

Staffing: ASD was in charge of this project. SRI managed the project for ASD, assisted by Boeing Corporation and the Collins Radio Company (who had personnel at Hickam AFB) and the Mitre Corporation. Although 66 persons were scheduled to participate in this project, only 5 were badged and readings were very low or zero. Duty at most of the islands involved did not require badging.

Project Report: Reference D.9.

Project 7.5 -- Thermal Radiation from Air Burst Nuclear Weapons Incident on Low-Altitude Aircraft

Agency: Air Force Aeronautical Systems Division (ASD)

Operations: Two B-57B aircraft were positioned at selected ranges from the detonations to determine the thermal energy reflected from clouds and terrain incident on the aircraft surfaces. Three B-57s were attached to the project, but only two were used on each shot. The aircraft were also used by Project 7.3 as radar targets on several shots when they were not taking thermal measurements.

There was little or no exposure to persons involved with this project at Christmas Island. Aircraft were between 14,400 and 56,000 feet (4.4 and 17.1 km) from the bursts, depending on the predicted yields, and flight crew exposures were all below 0.350 R. When operating with Project 7.3, the ranges from the burst were much greater.

Shots: ADOBE, AZTEC, QUESTA, MESILLA, ENCINO, NAMBE, ALMA, YESO, RINCONADA, BIGHORN.

Staffing: ASD managed the project, but the Project Officer was from the Air Force Flight Test Center at Edwards AFB, California. The three flight crews were made up of men from units at Edwards AFB, Patrick AFB, Florida, Holloman AFB, New Mexico, and ASD. Ground support was similarly mixed. The radar controllers were from Nellis AFB, Nevada, Eglin AFB, Florida, and Cannon AFB, New Mexico.

Project Report: Reference D.10.

Projects 7.6 through 7.11

Agency: Office of Chief of Naval Operations

Operations: Under these project designations the performance of communications and navigation systems on operational naval units was monitored. The units were operating throughout the Pacific region.

Shots: All FISHBOWL shots.

Staffing: Regular Navy crews.

Project 8A.1 -- High-Altitude Nuclear Detonation Optical-Infrared Effects

Agencies: Air Force Cambridge Research Laboratories
Technical Operations, Inc.
American Science and Engineering

Operations: Optical-infrared radiation from the high-altitude shots was measured. Two KC-135 aircraft platforms were used in addition to ground stations at Johnston Island and Maui, Hawaii. KC-135s were those also used by Project 8A.2.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: Only three people out of forty-seven personnel identified as probable participants were badged. Readings on these three badges were zero or very low. Personnel at Maui were not badged.

Project Report: Reference C.2035.

Project 8A.2 -- Optical Phenomenology of High-Altitude Nuclear Detonations

Agency: Edgerton, Germeshausen & Grier (EG&G)

Operations: This project obtained optical coverage of the five high-altitude events from land-based and airborne platforms. Aircraft used were KC-135s, Nos. 53120, 53144, 60376. Three project members flew aboard each aircraft for all shots except the first, when two members were aboard each aircraft. Land-based sites were Johnston Island, Samoa, Fiji, and Tonga. Personnel were stationed at Hickam, Johnston Island, Samoa, Fiji, Tonga, and the island of Hawaii. Only at Johnston Island was there a potential for exposure and this was low.

Shots: STARFISH, BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: At Johnston Island personnel strength varied from five to ten. At Samoa the peak strength was eight. Two people were at Fiji and two at Tonga. There were four personnel from the Army Pictorial Center, one from the University of Rochester, one from Holmes & Narver, and one from Photo-Sonics, Inc. working for EG&G on this project, none of whom were badged. Only three of twenty identified probable participants were badged (see Table 14).

Project Report: Reference C.2036.

Project 8A.3 -- Structural Response to Thermal Radiation from High-Altitude Fireball

Agencies: Air Force Flight Dynamics Laboratory (AFFDL)
American Science and Engineering (ASE)

Operations: Instrument-carrying pods were exposed to high-altitude detonations. Returned pods were placed in "hot" cells on Johnston Island once they were recovered by Marine Corps helicopters or Navy fleet tugs. The instruments were then removed. Project personnel working near the pods or instruments removed from the pods could have been exposed to beta and gamma radiation. No alpha activity was detected on the pods.

Shots: BLUEGILL, KINGFISH.

Staffing: AFFDL had nine persons badged for this project. ASE, who was their contractor, had 12 persons badged. However, all readings were less than 0.5 R.

Project Report: Reference C.2037.

Project 8B -- Nuclear Weapon X-Ray Effects as Measured by Passive Instruments

Agencies: Air Force Special Weapons Center (AFSWC)
Allied Research Associates (ARA)

Operations: Instruments carried to high-altitudes in pods attached to the Thor missiles were used. Pods were recovered by Marine Corps helicopters or Navy fleet tugs and returned to Johnston Island for analysis. Project personnel working near the pods, or instruments from the pods, could have been exposed to beta and gamma radiation. No alpha radiation was detected on the pods.

Shots: STARFISH, KINGFISH.

Staffing: Five military personnel from AFSWC were associated with this project, and ARA had between four and seven. All readings were less than 0.50 R.

Project Report: Reference C.2038.

Project 8C -- Reentry Vehicle Tests

Agencies: Air Force Special Weapons Center (AFSWC)
AVCO Research and and Advanced Development Corporation

Operations: Two reentry vehicles (RVs) were to be carried aloft by the Thor missile and exposed to the effects of a high-altitude nuclear detonation. The Thor missile blew up after 1 minute of flight. The RVs that were attached to the missile when it blew up could have been contaminated and

their recovery and inspection would have resulted in a potential exposure source for project personnel.

Shots: First STARFISH attempt.

Staffing: Five military officers from AFSWC and 12 persons from AVCO Research and Advanced Development Corporation participated in this project. All readings were less than 0.5 R.

Project Report: Reference C.2039.

Project 9.1a -- Atmospheric Properties

Agencies: Air Force Cambridge Research Laboratories (AFCRL)
University of Utah
Oklahoma State University Research Foundation
Wentworth Institute

Operations: Measurement of atmospheric properties were made at varying altitudes using rockets launched from Johnston Island. Rocket payloads were not recovered.

Shots: BLUEGILL, KINGFISH, CHECKMATE, TIGHTROPE.

Staffing: AFCRL had two persons badged who were assigned to this project, the University of Utah had five badged, and the Oklahoma State University and the Wentworth Institute each had one person badged. The Weapons Effects Test Group (WETG) from Field Command, Defense Atomic Support Agency (FCDASA) had one person assigned to this project. Of the nine personnel badged for this project, one had a relatively high reading (0.97 R).

Project Report: Reference C.2040.

Project 9.1b -- Ionospheric Wind Measurements

Agencies: Air Force Cambridge Research Laboratories (AFCRL)
Geophysics Corporation of America (GCA)

Operations: Measurement of wind velocities at high altitudes was made by ejecting a sodium vapor trail from a Nike-Cajun rocket at dusk or dawn. The trail was photographed by cameras on Johnston Island and by three ships stationed in the ship array around Johnston Island. The ships were Summit County, Henry County, and Point Barrow.

Shots: FISHBOWL shots.

Staffing: AFCRL had one person badged who was badged under organization code 8130 (WETG, FCDASA). GCA had seven badged who worked on this project. The highest exposure was 0.5 R.

Project Report: Reference C.2051.

Project 9.4b -- Pod and Recovery Unit Fabrication

Agency: Air Force Special Weapons Center (AFSWC)

Operations: Provided instrument pods that were attached to Thor missiles. Recovery of pods and analysis of pod damage could have exposed persons to beta and gamma radiation on Johnston Island.

Shots: STARFISH, BLUEGILL, KINGFISH.

Staffing: AFSWC had four personnel badged for this project. General Dynamics and Northrop Ventura had three and two persons, respectively, badged. All persons badged for this project recorded less than 0.50 R.

Project Report: Reference C.2041.

Project 9.6 -- Tracking and Positioning

Agency: Cubic Corporation

Operations: Cubic Corporation provided tracking and positioning data for the small rockets and Thor missile pods employed at Johnston Island for FISHBOWL events. All tracking equipment was located on Johnston Island.

Shots: FISHBOWL shots.

Staffing: A total of 40 persons from Cubic Corporation was badged. One had a reading of 1.27 R, but all other exposures were below 0.50 R, including 21 identified as probably Project 9.6 participants. How this individual received this exposure is not recorded in available records.

Project Report: Reference C.2082.

Project 32 -- High-Altitude Measurements

Agency: Sandia Corporation

Operations: Measurements of safety, fuzing, and weapon performance were made at Johnston Island and at various offsite locations. An attempt was made to sample weapon debris by using rockets but none were recovered.

Staffing: All the Project 32 areas were managed and executed by Sandia personnel. There were 318 men badged; only one reading exceeded 0.50 R (0.59 R).

Project Report: WT-2046.

UNNUMBERED CHRISTMAS ISLAND AND FISHBOWL EXPERIMENTS
THAT INVOLVED THE DEPARTMENT OF DEFENSE

Project Stemwinder

Agency: U.S. Weather Bureau

Operations: B-57 sampler aircraft took radiation intensity readings in the cloud stem to determine the amount of radioactive debris in that portion of the cloud. It appears that a single B-57 took the readings on each of the shots. The stem penetrations usually took place from 1/2 to 1 hour after the bursts, except for BIGHORN and BLUESTONE when they were 3 to 4 hours after burst. The B-57 did this on a noninterference basis with its regular sampling missions. It is not clear in the project report whether the B-57 proceeded to sample in the main cloud for the AEC weapon laboratories after its Stemwinder activities or was not scheduled to sample that day. B-57 crews were exposed to significant levels of radiation in the nuclear cloud stems, although the levels were lower than in the main cloud. Peak exposure rates were 2 R/hr, but the time of exposure was less than 1 minute at this high rate.

Shots: ARKANSAS, QUESTA, YUKON, ENCINO, ALMA, TRUCKEE, DULCE, BIGHORN, BLUESTONE.

Staffing: Four persons from the U.S. Weather Bureau in Washington, D.C., fielded this project. Two had zero exposures, one had 0.02 R and one had 0.073 R. Many other personnel assisted, including the sampler aircraft crews from the 9th Weather Reconnaissance Wing and 1211th Test Squadron, and sampler controllers from LASL AND LRL. The exposures of these personnel from the Stemwinder project activities were probably small compared to the exposures from their sampling activities.

Project Report: Reference C.2060.

477L NUDETS Proof Test

Agencies: Air Force Aeronautical Systems Division
Mitre Corporation

Operations: Experiments using a nuclear-detonation-detection system on Palmyra Island were conducted. Very low-level airborne contamination was detected on three occasions at Palmyra Island.

Shots: All CHRISTMAS shots.

Staffing: This project was managed and executed by personnel from Mitre Corporation. Four were badged and all had zero readings.

Project Report: No Project Officer's Report (POR) issued.

Seismic Project (VELA T/074)

Agency: Geotechnical Corporation (for Hq USAF)

Operations: Four seismological observatories were installed at selected Pacific islands and recorded nuclear burst signals. The islands selected were Oahu, Penrhyn, Johnston, and Palmyra.

Shots: All shots.

Staffing: All four sites were supposedly manned by Geotechnical Corporation. However, if they were on Johnston Island, they would have been badged and should appear in the Consolidated List, but they do not.

Project Report: No POR issued.

Long-Range Infrasonic Project

Agencies: Hq USAF
Army Signal Radio Propagation Agency (SRPA)
Air Force Cambridge Research Laboratory (AFCRL)
National Bureau of Standards (NBS)
Navy Electronics Laboratory (NEL)

Operations: Infrasonic receivers were set up at nine locations to record signals from the shots. Locations were Oahu, Johnston, Palmyra, Kwajalein, Adak or Shemya, American Samoa, Wake, Midway, and San Diego, California.

Shots: All shots.

Staffing: Four sites were manned by SRPA, four by AFCRL, and one by NEL. The Johnston Island site was manned by SRPA.

Project Report: No POR issued.

Airborne Diagnostic Project

Agencies: Hq USAF
Edgerton, Germeshausen & Grier (EG&G)

Operations: Optical and electromagnetic equipment was operated on board a KC-135 to test and calibrate the equipment using the DOMINIC detonations. The aircraft was generally about 250 nmi (463 km) from the detonations. Air Force crews flew the aircraft and EG&G assisted Hq USAF in operating the equipment and processing the data.

Shots: All shots.

Staffing: Strategic Air Command, EG&G, and Hq, USAF personnel were aboard the aircraft. Specific numbers of personnel associated with this project cannot be established.

Project Report: No POR issued.

Analysis of Debris

Agencies: Hq USAF
Los Alamos Scientific Laboratory (LASL)
Lawrence Radiation Laboratory (LRL)
1211th Test Squadron, Kirtland AFB, New Mexico

Operations: Particulate and gaseous samples were collected from the radioactive cloud using B-57 sampling aircraft. This was the primary cloud sampling program and was jointly sponsored by LASL, LRL, and Hq USAF. The 1211th Test Squadron flew the B-57s. A scientific observer from LASL or LRL controlled the cloud penetrations of the B-57s from an airborne platform. The radiation exposure potential was negligible for most Hq USAF, LASL, and LRL personnel. It was higher for sampler aircraft crews because they had to penetrate the radioactive cloud. Sample removal personnel and B-57 decontamination and maintenance personnel were exposed to radiation from radioactive samples and aircraft.

Rockets were fired through the clouds with cloud sampler nosecones on several of the LRL Christmas Island airdrop shots. The rockets were fired from Christmas and recovered by Air Force helicopters by fishing them with nets from the water. They were carried back to Christmas Island slung from long cables from the helicopters to minimize the exposures.

Shots: All airdrop shots, plus FRIGATE BIRD.

Project Report: No POR issued.

Electromagnetic Pulse Project

Agencies: Denver Research Institute (DRI)

Central Radio Propagation Laboratory, National Bureau of Standards (NBS)

Operations: Electromagnetic pulse (EMP) measurements were made at Fanning, Palmyra, Penhryn, Fairbanks, Alaska, Philippines, Kauai, Maui, and Denver, Colorado.

Shots: Planning was for all shots.

Staffing: All sites except Maui were manned by DRI personnel. The Maui site was manned by NBS personnel. One person from DRI was badged; his badge showed no exposure.

Project Report: No POR issued.

Direct Visible Light and Atmospheric Fluorescence

Agency: Hq USAF

Operations: Visible light and atmospheric fluorescence from high-altitude nuclear detonations were recorded at Canton Island and at Mauna Loa on the island of Hawaii.

Shots: STARFISH, KINGFISH, BLUEGILL, TIGHTROPE, and CHECKMATE.

Staffing: Hq USAF and EG&G personnel were at both locations.

Project Report: No POR issued.

NUMBERED SWORDFISH PROJECTS THAT INVOLVED THE DEPARTMENT OF DEFENSE

SWORDFISH Project 1.1 -- Underwater Pressures

Agency: Naval Ordnance Laboratory (NOL)

Operations: Pressure gauges were suspended from the two platforms in the towed array and from USS Bausell (DD-845), USS Molala (ATF-106), USS Agerholm (DD-826), and USS Monticello (LSD-35). Project personnel also aided Project 1.2 by operating cameras at shot time. Recovery of the gauge strings and recorders from the platforms was required. Exposure was possible as the platforms were within the base surge. The platforms from which the NOL gauges were suspended measured at about 1 R/hr 90 minutes after the shot and required washdown, which was done at H+2.5. After this project personnel were aboard the platforms for 2 hours.

Staffing: Operating as Task Element 8.9.2.1, personnel from NOL had charge of this project.

Project Report: Reference C.2000.

SWORDFISH Project 1.2 -- Surface Phenomena Measurements by Photography

Agency: Naval Ordnance Laboratory (NOL)

Operations: The formation, growth, and dissipation of visible surface phenomena, including slicks, spray domes, plumes, fallout, base surge, and foam patch, were recorded and measured using airborne and surface ship cameras.

Staffing: Operating as Task Element 8.9.2.2, NOL personnel also had responsibility for this project. Four NOL personnel can be positively identified. Seventeen Navy photographers "from various units" under the supervision of two NOL employees operated the cameras on Molala, USS Hopewell (DD-681), and Monticello. Detachment 35, Heavy Photographic Squadron Sixty-Two (VAP-62) supplied the two A3D aircraft used. Marine Corps Aircraft Repair Squadron 37 (MARS-37), Third Marine Corps Aircraft Wing supplied the two R5D aircraft. No personnel other than those from these units appear to have been aboard the planes for the photographic runs. The photo runs continued for at least 17 minutes after the blast.

Project Report: Reference C.2001.

SWORDFISH Project 1.3a -- Effects of Underwater Nuclear Explosions on Sonar Systems at Close Ranges

Agency: Naval Electronics Laboratory (NEL)

Operations: The effects of an antisubmarine rocket (ASROC) detonation on active and passive sonar systems within 10 nmi (18.5 km) were determined. The sonars used for the project were on Agerholm, USS Anderson (DD-786), Hopewell, and USS Razorback (SS-394). Sonar targets were launched from Razorback's torpedo tubes. A helicopter from Medium Helicopter Squadron 363 (HMM-363), stationed on the Monticello, also dropped two sonar targets. Data were recorded by ships' crews for analysis at NEL.

Staffing: NEL managed this project, but there is no record of NEL employees on the Consolidated List; therefore they probably were involved only in analysis.

Project Report: Reference C.2002.

SWORDFISH Project 1.3b -- Effects of an Underwater Nuclear Explosion on Hydroacoustic Systems

Agency: Naval Electronics Laboratory (NEL)

Operations: The effect of an underwater explosion on long-range hydroacoustical systems was determined.

Staffing: NEL directed this project, but was apparently involved only in analysis.

Project Report: Reference C.2003.

SWORDFISH Project 1.4 -- Nuclear Burst Detection

The information this project collected was combined with Project 1.3b.

SWORDFISH Project 1.5 -- Hydroacoustic Measurements

Agency: General Atronics

Operations: A remotely sited experiment based on USS Cree (ATF-84) as part of the Vela (nuclear test detection) effort of the United States.

SWORDFISH Project 2.1 -- Radiological Effects From an Underwater Explosion

Agency: Naval Radiological Defense Laboratory

Operations: Gamma intensity recording equipment and instrumentation to measure the physical characteristics of the base surge were placed on the towed array of eight coracles, rafts, and Bausell. This instrumentation

required recovery. The towed array was set out and retrieved by Molala and by four LCMs from Monticello. After the shot, they retrieved the array and took the remaining parts (except Bausell) to Monticello for transportation back to San Diego. There was a high radiation exposure potential for personnel on recovery operations and especially for those on USS Sioux (ATF-75). Sioux entered the contaminated pool three times to collect samples. Chapter 5 describes the approximate location of Bausell, the coracles, and Sioux at shot time.

Staffing: The project was supervised by NRDL as Task Element 8.9.2.4. NRDL had 17 personnel badged during DOMINIC. Four of those can be identified as maintaining, installing, and recovering the instruments for this project. The project leader and the two other authors of the project leader's report are on the Consolidated List; hence they probably were at the SWORDFISH site. Sioux was to enter the pool of radioactive water shortly after the detonation to collect water samples. To reduce the number of personnel exposed to potentially high radiation, only 15 of the ship's crew were aboard. Thirteen ran the ship, and two assisted the three NRDL personnel aboard. The highest exposures of these men exceeded the Maximum Permissible Exposure (MPE) of 3.00 R. Other than the water sampling equipment on Sioux, the equipment used to collect data for this project was part of the towed array, mounted at 13 locations above and below decks on Bausell and on the eight coracles.

Project Report: Reference C.2004.

SWORDFISH Project 2.2 -- Airborne Monitoring of the Radioactive Pool

Agencies: Naval Radiological Defense Laboratory (NRDL)
Patrol Squadron 46 (VP-46)

Operations: Two P2V planes were fitted with two types of radiation detectors. Beginning about 3 hours after the detonation and each day for 6 days thereafter, the plane located and then flew over the contaminated patch of water a number of times taking measurements. The altitude of the P2V surveys was 500 feet (153 meters). VP-46 operated out of Naval Air Station North Island, San Diego, California. Exposures were experienced as the aircraft passed over the radioactive pool. Intensity of the radiation at the aircraft were 0.097 R/hr peak at H+3, 0.014 R/hr on D+1, and declining to 0.00025 R/hr on D+6.

Staffing: The project was sponsored by the Advanced Research Projects Agency (ARPA) as part of the Vela Program and directed by NRDL. The data-gathering aircraft were P2V-7s from VP-46. Flight Crews 3 and 8 alternated on the daily flights. Apparently four NRDL personnel were aboard each flight to handle the radiation detectors and help guide the plane's passes over the radioactive pool. Exposures of the NRDL personnel cannot be identified on the Consolidated List, but the exposures of the aircraft crews are probably identical to the 14 reported for VP-46 in the Consolidated List (Code 8322). The highest exposure recorded for this group was only 0.041 R.

Project Report: Reference D.1.

SWORDFISH Project 3.1 -- Shock Motions of Ships and Equipment

Agency: Navy David Taylor Model Basin (DTMB)

Operations: The motion the SWORDFISH blast produced was determined for ships and platforms in the vicinity of the blast as well as the damage this motion caused. The surface waves produced by the blast were photographed. Bausell, Agerholm, Anderson, Hopewell, and Razorback were fitted with gauges to record their motion in response to the shock waves from SWORDFISH. Bausell had three high-speed cameras to record the motion of selected pieces of equipment and two cameras to record the surface effects from the detonation. The two platforms in the towed array also had gauges attached. Agerholm and Anderson each had two cameras to record Bausell's motion in the waves caused by SWORDFISH. The position of the ships and platforms at shot time are further discussed in Chapter 5.

Potential for radiation exposure to project personnel was low to nil. The base surge apparently did not reach and contaminate any of the test ships.

Staffing: Organized as Task Element 8.9.2.5, personnel from DTMB had charge of this project. The project officer was from DTMB, and ten other DTMB personnel are listed as having made "important contributions during the operation." DTMB was not assigned an organizational code on the Consolidated List, however, so it appears DTMB personnel were not on site. Bausell, Agerholm, Anderson, Hopewell, and Razorback were the ships taking part. Motion pictures of Bausell were taken from Agerholm and Anderson, but no record has been located of the photographers or their organization.

Project Report: Reference C.2005.

SWORDFISH Project 7.1 -- Effects on the Operation of Anti-Submarine Warfare Sonar Equipment

Agency: Navy Bureau of Weapons (BuWeps)

Operations: To observe the effect of the ASROC explosion on the performance of certain sonar systems, sonobuoys were placed near the detonation point and at long ranges. The sonobuoys transmitted data to P2V aircraft, where they were recorded for later analysis.

Staffing: Information on participants is very limited. The project was an in-house Navy project managed by BuWeps. A P2V aircraft participated. The unit to which the aircraft belonged cannot be identified, but it may have been from VP-46, which supplied a P2V for Project 2.2. No participants can be identified by name. BuWeps was assigned an organization code number, but apparently no BuWeps personnel actually were badged.

Project Report: No POR issued.

SWORDFISH Project 9.1 — Ship Damage Assessment and Technical Support of Test Elements

Agencies: Navy Bureau of Weapons (BuWeps)
Navy Bureau of Ships (BuShips)

Operations: The degree to which the weapon-delivery capability of an ASROC-equipped destroyer would be impaired by the detonation of an ASROC weapon at fairly close range was determined by a series of pre- and post-test inspections. Inspection teams reboarded Bausell after 1440, the time of radsafe clearance. Bausell was not contaminated by the base surge.

Staffing: The project leader and his deputy were from BuShips. A list of project personnel shows five personnnel from the Naval Ordnance Test Station, four from BuShips, two from DTMB, and one each from Mobile Ordnance Service Unit Four, RCA, Minneapolis-Honeywell, Librascope, Sangamo Electric Company, and Western Electric. None of these were badged, however, and it appears that the inspections may have taken place after the ships returned to San Diego. The ships participating were Bausell, Agerholm, Anderson, Hopewell, and Razorback.

Project Report: Reference C.2006.

SWORDFISH Project 9.2 — Time Command Signals

Agencies: Edgerton Germeshausen & Grier (EG&G)

Operations: To provide timing signals and voice countdown for the SWORDFISH shot, a control center was established on Agerholm and manned by three EG&G personnel. On Anderson, two EG&G personnel manned a remote signal station. Two EG&G personnel were stationed on Monticello to replace batteries and maintain EG&G equipment in the towed array and other ships not manned by EG&G personnel.

Staffing: Organized as Task Element 8.9.2.7, personnel from EG&G carried out this project under DASA sponsorship. The EG&G crew probably numbered seven, although only the apparent project leader can be identified by name.

Project Report: Reference D.3.

SWORDFISH Project 9.3 -- Technical Photography

Agency: Navy Bureau of Weapons

Operations: Aircraft and ship-based cameras were used. The project apparently included the 17 Navy cameramen and 21 cameras taking pictures for Project 1.2 from Molala, Hopewell, and Monticello.

Staffing: VAP-62 and the Third Marine Air Wing provided aircraft and crews. The source of the photographers on the ships is not known.

Project Report: None identified.

UNNUMBERED SWORDFISH EXPERIMENTS INVOLVING THE DEPARTMENT OF DEFENSE

Shipboard Radioactive Pool Monitoring

Agency: Naval Radiological Defense Laboratory (NRDL)

Operations: In order to determine the extent, radiation level, and drift of the contaminated water between 6 and 24 hours after the detonation, Sioux made a number of passes through the radioactive pool, taking readings with two underwater radiation detectors. The ship then stood by for about 2 hours, while USC&GSS Pioneer made ready to track the pool for a related AEC program, described immediately below.

During the period from H+6 to H+24 Sioux crossed the radioactive pool nine times and each crossing lasted from 30 minutes to 2 hours. At H+7 the peak reading 3 feet (1 meter) above the surface of the pool was 0.5 R/hr, dropping to 0.10 R/hr at H+19. While Sioux was returning to San Diego measurements were made of the radiation intensity at the intake of the saltwater systems, which was found to be 0.005 R/hr. This had declined to background by the time of its arrival at the Naval Repair Facility in San Diego.

Staffing: About 1800 on shot day, Sioux obtained water samples for Project 2.1. The Project 2.1 NRDL personnel and the skeleton crew of fifteen then left the ship and were replaced by the rest of the crew and the AEC and NRDL personnel working on the pool monitoring project described above.

Project Report: Reference D.2.

Tracking the Contaminated Water and Investigating the Water's Effects on Marine Life

Agency: Naval Ordnance Laboratory (NOL)

Operations: About 27 hours after the shot, Pioneer started its survey and continued that work until 28 May when the ship returned to San Diego. On 1 June the ship left San Diego to resume the program, and it continued to track and study the pool until 25 June. Pool intensity had decayed by the time the survey resumed in June.

Staffing: The measurements were made from Pioneer, a ship belonging to the U.S. Coast and Geodetic Survey. The radiation measurements were made by an NOL employee. Woods Hole Oceanographic Institute (WHOI), NRDL, and Texas A&M took part in this effort and probably had employees aboard. WHOI's focus was marine life, the roles of NRDL and Texas A&M are not known.

Project Report: Reference D.4.

FRIGATE BIRD EXPERIMENTS INVOLVING THE DEPARTMENT OF DEFENSE

Collection of Samples for Radiochemical Analysis

Agencies: Lawrence Radiation Laboratory (LRL)
1211th Flight Test Squadron, Kirtland AFB, New Mexico

Operations: Cloud samples were collected by five B-57 aircraft under the control of the TU 8.1.2 controller in a KC-135. The operations began 70 minutes after explosion and concluded 130 minutes later. Two C-130s and a C-135, under the control of one or more of the RC-121s took airborne diagnostic measurements. The B57s were based at Christmas Island.

This mission required a longer flight in contaminated aircraft and therefore the exposure potential was somewhat higher than the Christmas missions being flown.

Project Report: Reference D.6.

Bhangmeter Measurements of Weapon Yield

Agency: Edgerton, Germeshausen & Grier (EG&G)

Objective: Weapon yield was measured using bhangmeters.

Operations: USS Carbonero (SS-337) and USS Medregal (SS-480) each carried two optical-yield-measuring devices, one sighted through the periscope and the other mounted on an extension mast held above the surface by the submerged submarine. EG&G supplied the instruments and the personnel to operate them; however, the number of EG&G men on each submarine is not available. At shot time Carbonero and Medregal were about 30 and 29 nmi (55.60 and 53.74 km), respectively, from surface zero.

Project Report: Reference D.3.

CHAPTER 4

WEAPON DEVELOPMENT TEST OPERATIONS

Twenty-four devices developed by the Atomic Energy Commission (AEC) weapon laboratories were tested at Christmas Island from late April through early July 1962, opening Operation DOMINIC. The extension of DOMINIC into the fall of the year allowed time for five additional devices to be made ready; these were tested within the Johnston Island danger area using test techniques that were in many ways identical to those used at Christmas Island. This extension was the result of the destruction of a missile and warhead on Johnston Island in late July, which required a 2-month pause in operations there in order to clean up and rebuild the missile launch site.

Weapon development tests had been conducted in conjunction with effects tests in previous test series; or more properly, the effects tests had been conducted as noninterfering experiments during weapon development shots. However, as the Department of Defense (DOD) effects experiments became more complex, they began to interfere. Therefore, beginning in 1955 the DOD sponsored test shots expressly for the purpose of studying effects. It also sponsored shots in 1956 and 1958. DOD interest in conducting experiments on weapon development shots did not cease, however, and the restraints and complications resulting from the DOD effects experiments apparently continued. Finally, the commander of the scientific task group in the 1958 test series recommended in his final report that the effects tests and the weapon development tests be conducted separately in both time and place (Reference D.11). The circumstances of DOMINIC generally allowed this to take place.

The weapon development shots were all airdrop devices. Weapon performance measurements were taken from aircraft and surface stations and were therefore primarily photo-optical and radiofrequency measurements. These measurements, in combination with debris-cloud samples, were apparently enough for the weapon designers to judge the effectiveness of their designs. The sampling was primarily from manned B-57 aircraft, but rockets with recoverable nosecone collectors were also used for several shots at Christmas Island.

CHRISTMAS ISLAND AIRDROPS

The targets for these airdrops were rafts equipped with radar reflectors and lights. These were moored at one of seven mooring points 10 to 20 nmi (18.5 to 37 km) south of Christmas Island. Figure 41 is a photograph of one of the rafts with personnel aboard.

The devices were detonated as airbursts; that is, they were exploded at such an altitude that the fireball formed did not touch the ocean surface, and thus no local fallout was formed. As the normal trade winds were from east-northeast, device debris at lower altitudes (up to about 15,000 feet [4.6 km]) was carried in a west-southwest direction. The nearest land in this direction is Jarvis Island, about 230 nmi (about 425 km) distant. Device debris at

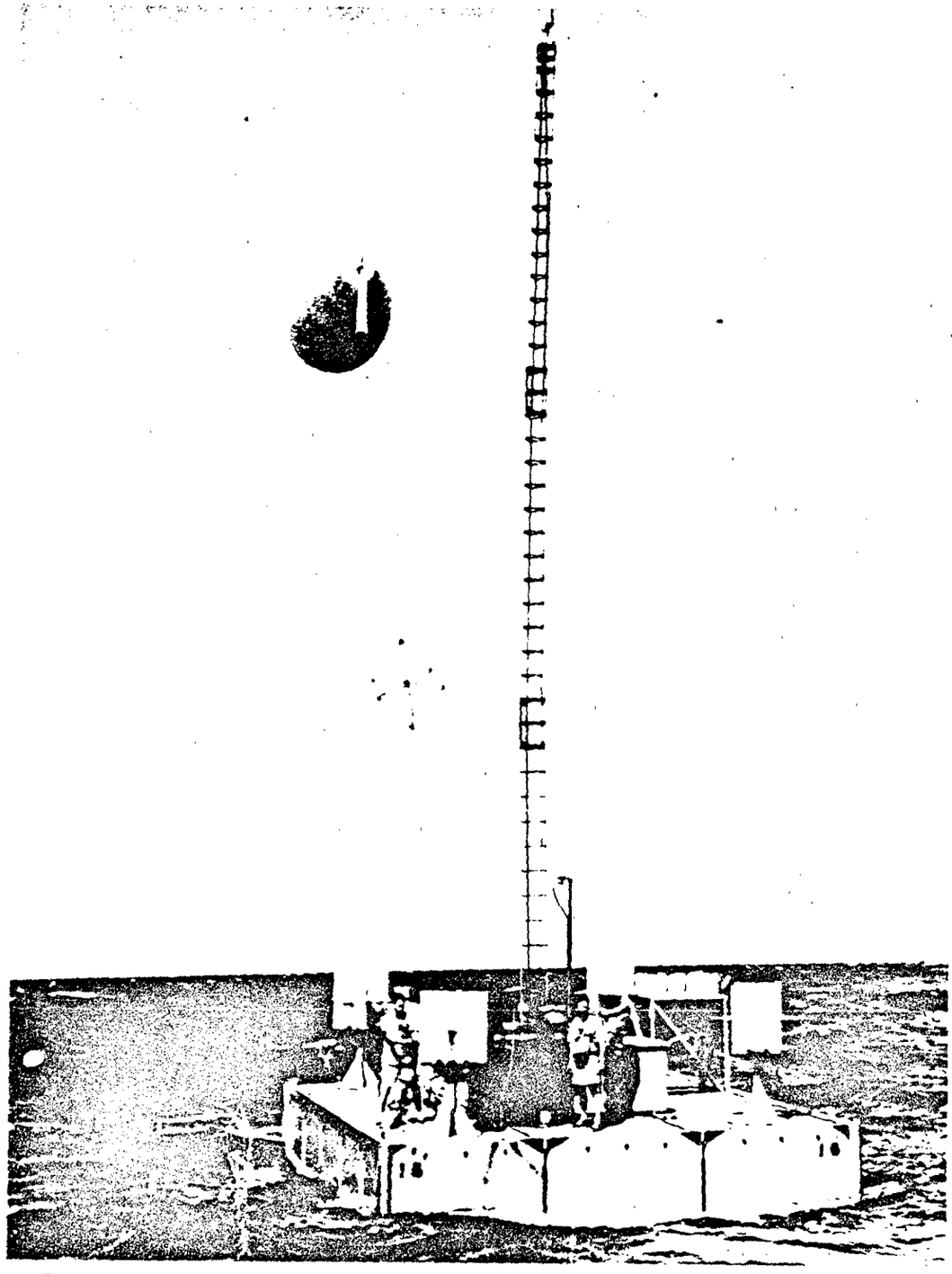


Figure 41. Airdrop target raft with service personnel aboard, DOMINIC.

altitudes above 15,000 feet (4.6 km) was carried east to southeast, the nearest land in this direction being Malden Island, about 360 nmi (about 670 km) distant.

Figure 42 is a photograph of the cloud formed by shot YUKON as viewed from one of the scientific sites on Christmas Island.

The burst heights were raised more than was necessary to avoid seawater contamination and to improve the probability of a cloudless line of sight



Figure 42. Cloud from DOMINIC, YUKON as viewed from Christmas Island.

between the burst point and instrumented aircraft. The limiting factor in raising the height of burst was potential damage to the B-52 aircraft that dropped the weapon. The particular moored raft used as an aimpoint depended on the predicted size of the burst. It was desired to have the bursts as close as possible to the surface stations on Christmas Island without damaging the sites with the blast pressures. The predicted effects at A-site (see map, Figure 2, and photograph, Figure 4) were used to determine the surface-zero raft location. D-site, closer to the burst point, was not manned during the tests. Other than D-site there were no evacuations. Most of Joint Task Force 8 (JTF 8) and all of the U.K. personnel and native residents on Christmas Island were normally on the northern and western ends of the island. The average number of persons on Christmas Island was 4,000 or less during this period: about 460 U.K. personnel and 450 natives, the rest being JTF 8 personnel (Reference C.3.1, p. I-5). The natives who wished to be evacuated were moved to USS Cabildo (LSD-16), which remained in the harbor area during the shot, apparently ready to move out if required. About 175 of the natives were aboard for each of the shots.

The test devices were prepared and placed in standard ballistic or drop cases (their exterior metal shell) in the United States and were flown to Naval Air Station (NAS) Barbers Point in Hawaii. At Barbers Point the devices were checked by AEC laboratory personnel and when ready were loaded into one of two Air Force B-52s used as drop planes. Although the devices were to be detonated at an altitude that would produce no local fallout, the winds had to be acceptable as well so that even if the device were somehow detonated on the ocean surface the fallout would be deposited in the open sea rather than on populated islands. For the success of the diagnostic measurements, clear weather was also required.

With acceptable weather predicted about 4 hours before each test, the B-52 left Barbers Point and flew 1,200 nmi (2,224 km) to the Christmas Island area. Also flying from Barbers Point were two Air Force Tactical Air Command C-130 turboprop aircraft that had been prepared as diagnostic instrument platforms. The B-52 drop aircraft similarly had diagnostic instrumentation aboard and these three planes served as the primary airborne stations for receiving and recording weapon development diagnostic information. Ground stations on Christmas Island also had sites with weapon diagnostic instruments. At appropriate times on shot days, other aircraft involved as experimental stations and in various support roles left Hickam AFB for the Christmas Island area.

Sampling of the debris cloud was done by Air Force B-57s based on Christmas Island. There were 15 in this sampling fleet and 4 to 6 were usually sampling on each shot with an additional plane used as a sampler controller, observing the cloud and directing the samplers. The sampling was usually done on the northern (Christmas Island) side of the cloud with the sampling runs being made approximately perpendicular to the prevailing trade winds. The samplers also took measurements for the U.S. Weather Bureau (USWB) experiment, Project Stemwinder. Their flight paths during these experiments were in the cloud stem and typical flight paths for these are shown in Figure 43. Cloud sampling with rocket-borne samplers was also tried, requiring the use of Air Force H-21 helicopters from Christmas Island in the recovery of the collectors in the rocket nosecones (Figure 28).

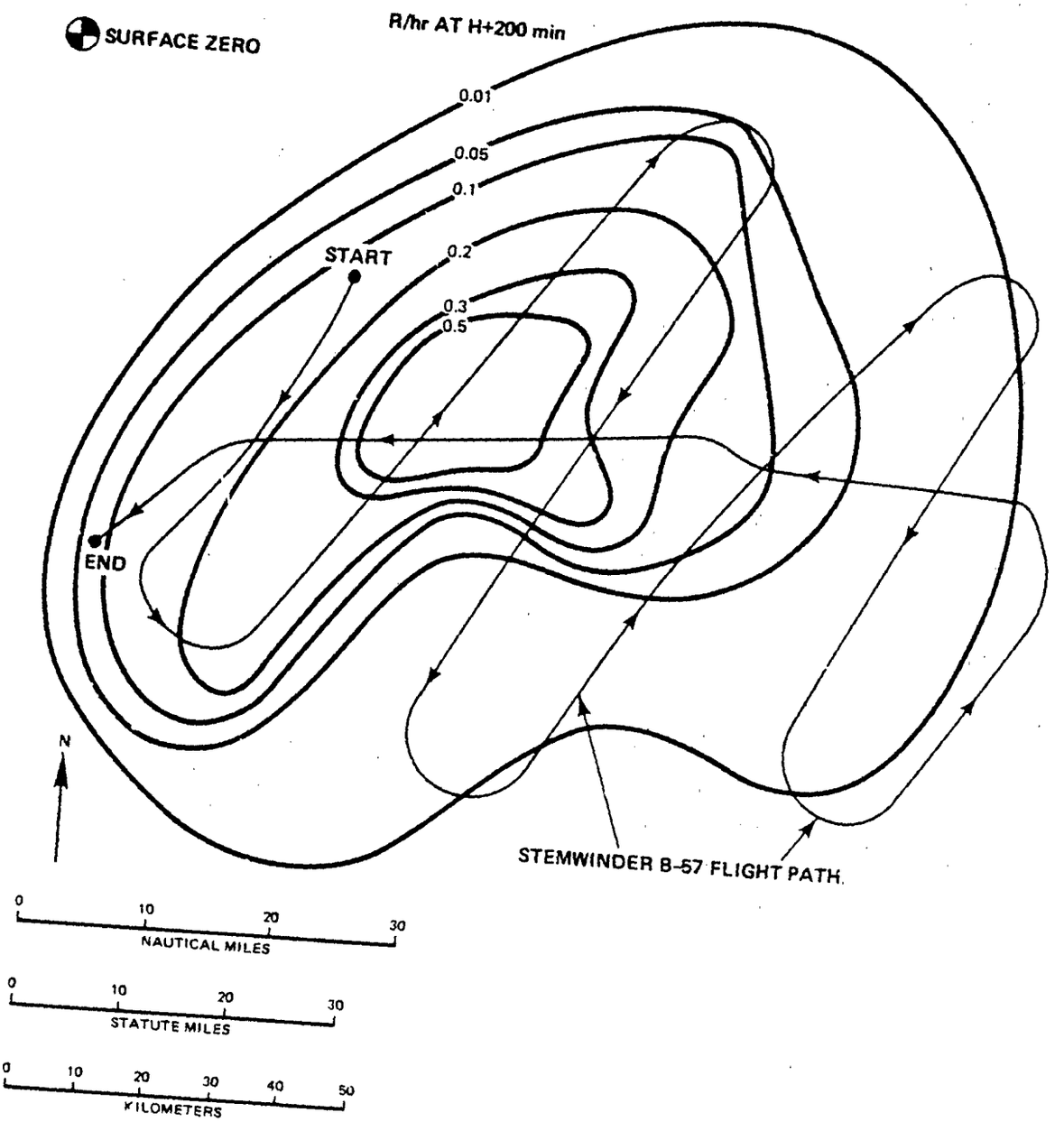


Figure 43. Sampling track and radiation pattern in the DOMINIC, BLUESTONE cloud at 45,000 feet (13.7 km) (source: Reference C.2060).

Other aircraft in the area providing support for the operations included an RC-121 acting as an Airborne Aircraft Operations Center (AAOC) and several C-54s in various configurations used as photo stations and search and rescue (SAR) planes. WB-50s were used to fly upwind of the burst area some 50 nmi (93 km) to check the clouds approaching the burst point. If enough clouds were approaching to interfere with the lines of sight between the diagnostic aircraft and the burst or between the Christmas Island stations and the burst, the drop could be delayed. Navy P2V aircraft also patrolled the danger area before the shot and were in a position to act as SAR aircraft if required.

In spite of the attempt to completely separate weapon-development and weapon-effects operations, there were a few DOD effects experiments conducted at Christmas Island. Most of these used aircraft either as the object being studied or as an aerial platform. Two B-57s were used in an Air Force thermal effects experiment (Project 7.5) and one B-57 was used as radar target in an experiment with a ground-based radar (Project 7.3). C-54s and C-118s carried rabbits and monkeys for experiments on the effects of the bursts on the eye (Project 4.1). The B-57 aircraft experiments were based on Christmas Island and required not only surface support for aircraft maintenance but also special ground-based radar controllers as exact positioning of the aircraft was important in the conduct of the experiments. Project 4.1 aircraft were based at Hickam AFB.

Aircraft used in the Christmas Island operations are summarized in Table 15.

Surface DOD experiments included a test of personnel reaction to the flash of a nuclear burst (Project 4.2) and the measurement of possible water waves generated by the explosions. Mooring and servicing the moored skiffs south of Christmas Island for the water-wave project was done by USS Conserver (ARS-39).

The target rafts (Figure 41) also required servicing. These had generators aboard to power lights and these had to be started. The rafts also had balloons, called kytoons, for some shots and these had to be deployed. After the shots, the rafts were reboarded and towed in for refurbishing as some were damaged. In addition, the saltwater spray led to deterioration. The rafts were sunk if they were radiologically hot, although they were generally only slightly above the background of 0.00003 R/hr (Reference C.3.1, p. J-7).

The Navy also provided surface patrols in addition to the P2V aircraft based on the Christmas Island airfield. The surface patrols were conducted by five Navy destroyers, with two in the Christmas Island area at sea and one in port at Christmas Island. Another two were at Pearl Harbor for upkeep. Cabildo supported Christmas Island operations, especially target raft support, along with a fleet of small boats including four LCUs, eight LCMs, and a variety of barges, lighters, and wherries.

A Navy ship (identity not reported) was also used as a fallout detection ship. This ship was sent in the direction of the debris cloud on at least nine of the Christmas Island shots to detect fallout. The ship avoided rainshowers that could bring down the suspended debris particles, but it was otherwise prepared to find fallout. None was found except on one unidentified event when

Table 15. Aircraft participation[a] in DOMINIC, Christmas Island tests.

Event	C-130 Diagnostic	B-57 Sampler[b]	B-57 Project 7.3	B-57 Project 7.5	C-54 Project 4.1	C-118 Project 4.1	KC-135 Hq USAF	H-21 SAR[c] and Nosecone Recovery	RC-121 AAOC[d]	WB-50 Weather
ADOBE	2	5	1	2			1	1	1	2
AZTEC	2	7		2			1	1	1	1
ARKANSAS	2	9					1	1	1	1
QUESTA	2	8		2				1	1	1
YUKON	2	8	1					1	1	1
MESILLA	2	5	1	2				1	1	1
MUSKEGON	2	8	2					1	1	1
ENCINO	2	6	1	2	5	5	1	5	1	1
SWANEE	2	7	1		4	5	1	1	1	1
CHETCO	1	8	2				1	4	1	1
TANANA	2	7	3		5	4	2	1	1	1
NAMBE	2	5	1	2	5		1	1	1	1
ALMA	2	8	1	2			2	1	1	1
TRUCKEE	2	6	1				2	1		1
YESO	2	9		2	3	5	3	5		1
HARLEM	2	6	1		3	5	1	4		1
RINCONADA	2	5	1	2			1	4		1
DULCE	2	5	1				2	1		1
PETIT	2	7	1				2	4		1
OTOWI	2	4	3				2	1		1
BIGHORN	2	9		2			3	4		1
BLUESTONE	2	8		1			2	3		1
SUNSET	2	6	1				2	1		1
PAMLICO	2	7					2	1		1

Notes:

[a] Does not include the B-52 drop aircraft (1 per shot), which also made diagnostic measurements, the RC-54 photo planes (1 per shot), the SC-54 SAR planes (1 per shot), or the Navy P2V flying patrols from Christmas Island. Shot day patrol pattern is not documented; however, Patrol Squadron 28, one of the two squadrons involved, averaged three to four 8-hour patrols per day for the 81 days ending 7 July 1962.

[b] Also participated in Project Stemwinder.

[c] SAR -- Search and Rescue.

[d] AAOC -- Airborne Air Operations Center.

Source: Reference C.4 (modified).

a reading of 0.00006 R/hr (about twice background) was made. No ships with positive readings are specified in the source (Reference C.3.1, p. K-5).

The weapon development operations as evolved at Christmas Island, and later at Johnston Island, were quite efficient. There were no last-minute cancellations, and the airbursts did not raise the radiological background at Christmas Island perceptibly. The pace of the tests was rapid and was not set by the operational limitations but by the availability of the devices to be tested (Reference D.12).

For each of the shots, the DOD experiments are listed below and special DOD support activities are summarized. Not included are the general support aircraft, nor are the Strategic Air Command (SAC) B-52s (Nos. 013 and 620) and the two C-130s (Nos. 298 and 199) that participated in each shot except as noted.

For all of the shots one or two KC-135 aircraft (Nos. 53121 and 91514), based at Hickam AFB, participated at several hundred kilometers range from the burst. These aircraft were instrumented for Hq USAF by Edgerton, Germeshausen & Grier, Inc. and took optical and test detection measurements. From RINCONADA until the last shot, both KC-135s were used.

ADOBE -- 25 April 1962, 0646 (1546 GMT)

The line of sight between shot ADOBE and ground-based instruments was obscured by clouds. On succeeding shots the support WB-50 was moved to observe incoming clouds, and the shot hour was moved to daylight so that clouds could be seen and the shot held until the line of sight was clear.

- Los Alamos Scientific Laboratory (LASL) device: intermediate range yield
- DOD Project: 7.5
- Special DOD Support: Five B-57s sampled the cloud at from 30,000 to 60,000 feet (9.1 to 18.3 km) altitude. Conserver supported the Joint Task Group (JTG) 8.5.2 water-wave experiment. Ship positions are shown in Figure 44.

AZTEC -- 27 April 1962, 0702 (1602 GMT)

- LASL device: intermediate range yield
- DOD Project: 7.5
- Special DOD Support: Seven B-57s sampled the cloud at from 37,000 to 65,000 feet (11.3 to 19.8 km). Conserver supported the JTG 8.5.2 water-wave experiment. Ship positions are shown in Figure 45.

ARKANSAS -- 2 May 1962, 0902 (1802 GMT)

This shot was postponed from 29 April because of weather.

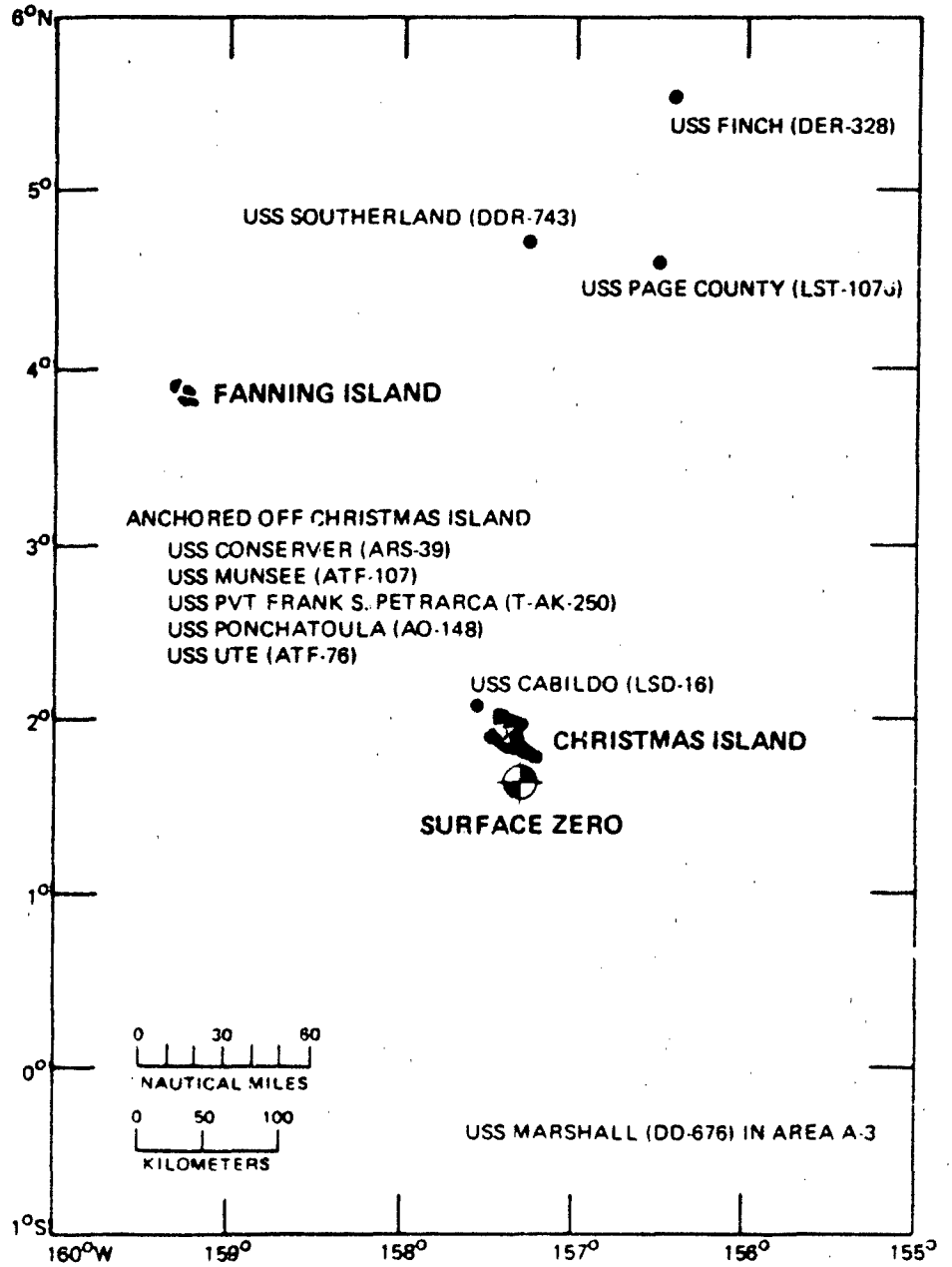


Figure 44. Ship positions, shot ADOBE, DOMINIC.

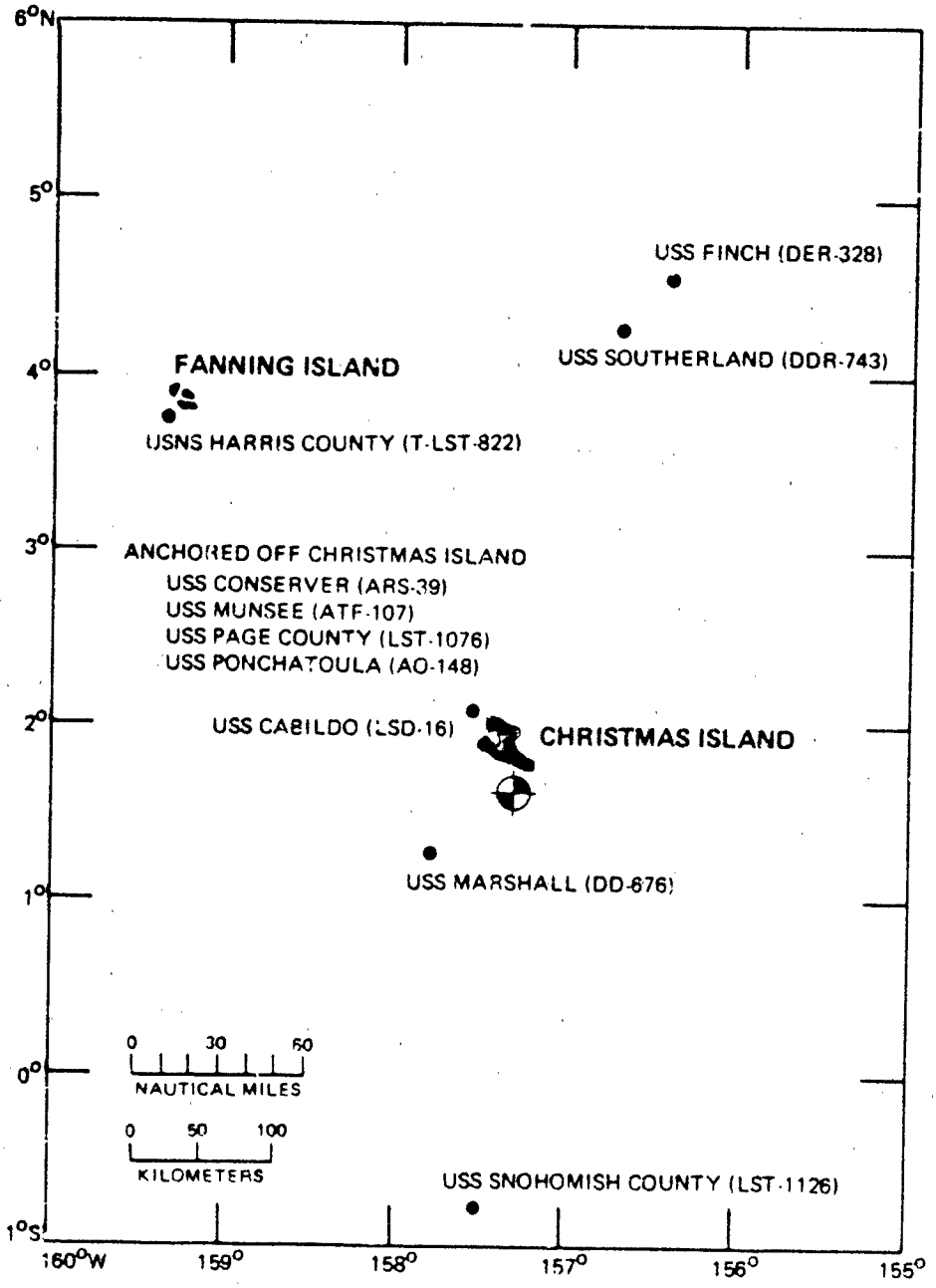


Figure 45. Ship positions, shot AZTEC, DOMINIC.

- Lawrence Radiation Laboratory (LRL) device; low megaton range yield
- DOD Projects: None
- Special DOD Support: Nine B-57s sampled the cloud at from 40,000 to 62,000 feet (12.2 to 18.9 km) altitude between H+85 minutes and H+190 minutes. Some of these also took gamma intensity readings for the Stemwinder experiment. Conserver supported the JTG 8.5.2 water-wave experiment. Ship positions are shown in Figure 46.

QUESTA -- 4 May 1962, 1005 (1905 GMT)

- LASL device; intermediate range yield
- DOD Project: 7.5
- Special DOD Support: Eight B-57s sampled the cloud at 43,000 to 62,000 feet (13.1 to 18.9 km) altitude. Some of these also took measurements for the USWB Project Stemwinder. This was the last Christmas Island shot on which JTG 8.5.2 used ships to measure water waves south of Christmas Island; thus Conserver was no longer required to service the project skiffs. The Hq USAF KC-135 did not participate. Ship positions are shown in Figure 47.

YUKON -- 8 May 1962, 0901 (1801 GMT)

- LRL device; intermediate range yield
- DOD Project: 7.3
- Special DOD Support: Eight B-57s sampled the cloud. Some of these also took measurements for the USWB Project Stemwinder. Project 7.5 aircraft were used by Project 7.3. The Hq USAF KC-135 did not participate. Ship positions are shown in Figure 48.

MESILLA -- 9 May 1962, 0801 (1701 GMT)

- LASL device; intermediate range yield
- DOD Project: 7.5
- Special DOD Support: Five B-57s sampled between 40,000 and 49,000 feet (12.2 to 14.9 km) altitude. The Hq USAF KC-135 did not participate. Ship positions are shown in Figure 49.

MUSKEGON -- 11 May 1962, 0637 (1537 GMT)

- LRL device; intermediate range yield
- DOD Project: 7.3
- Special DOD Support: Eight B-57s sampled the cloud at altitudes from 35,000 to 56,000 feet (10.7 to 17.1 km)

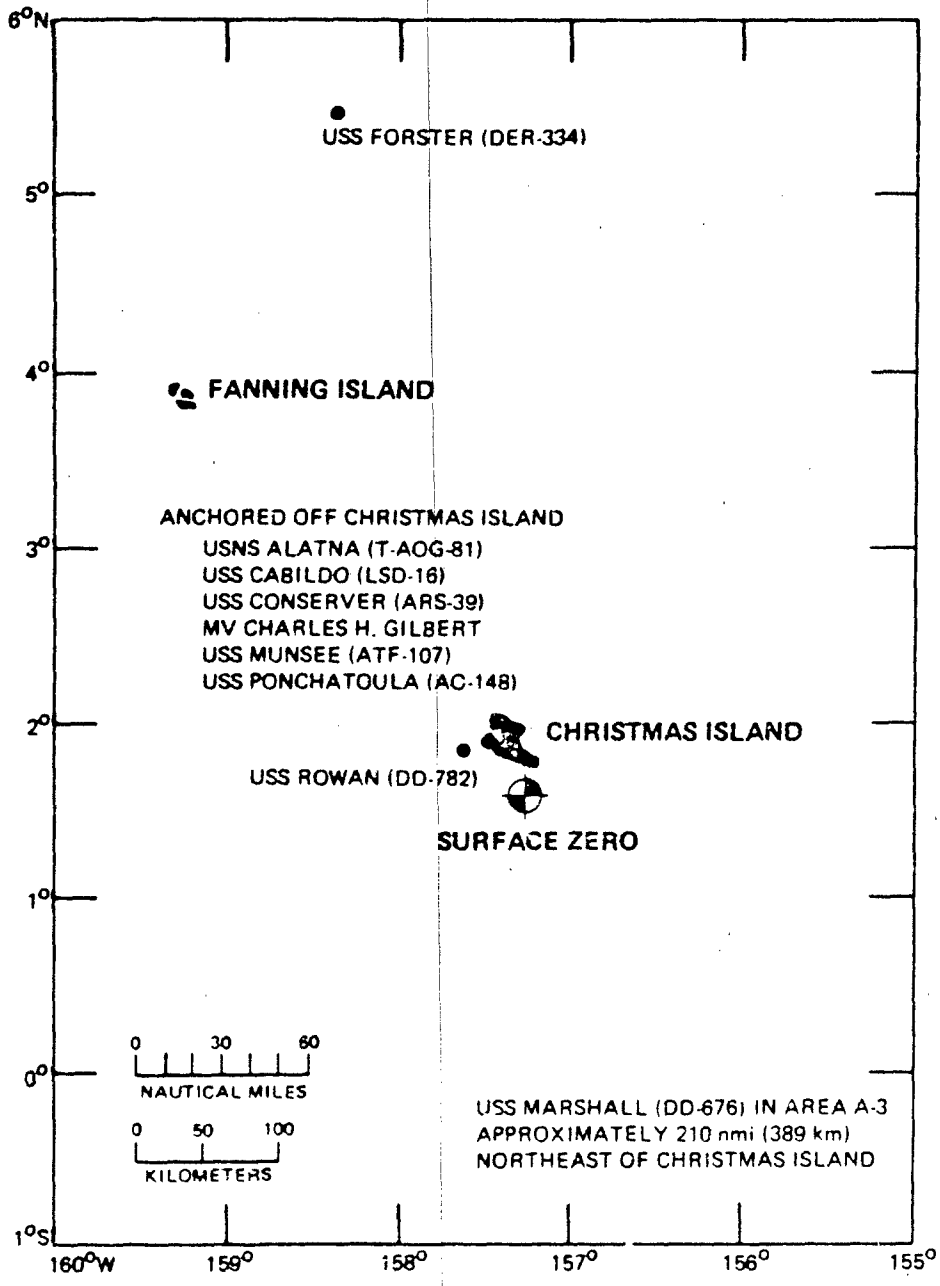


Figure 46. Ship positions, shot ARKANSAS, DOMINIC.

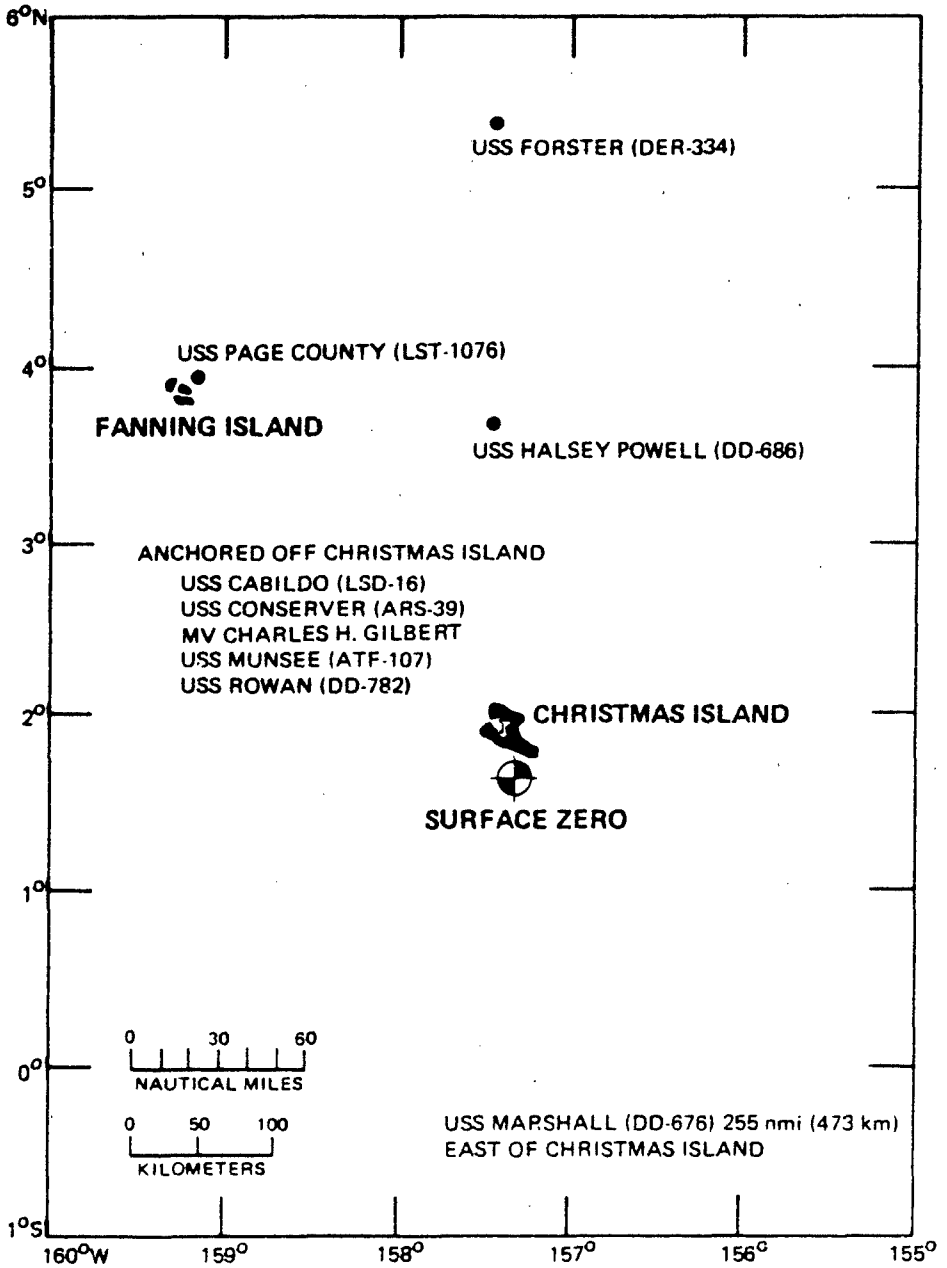


Figure 47. Ship positions, shot QUESTA, DOMINIC.

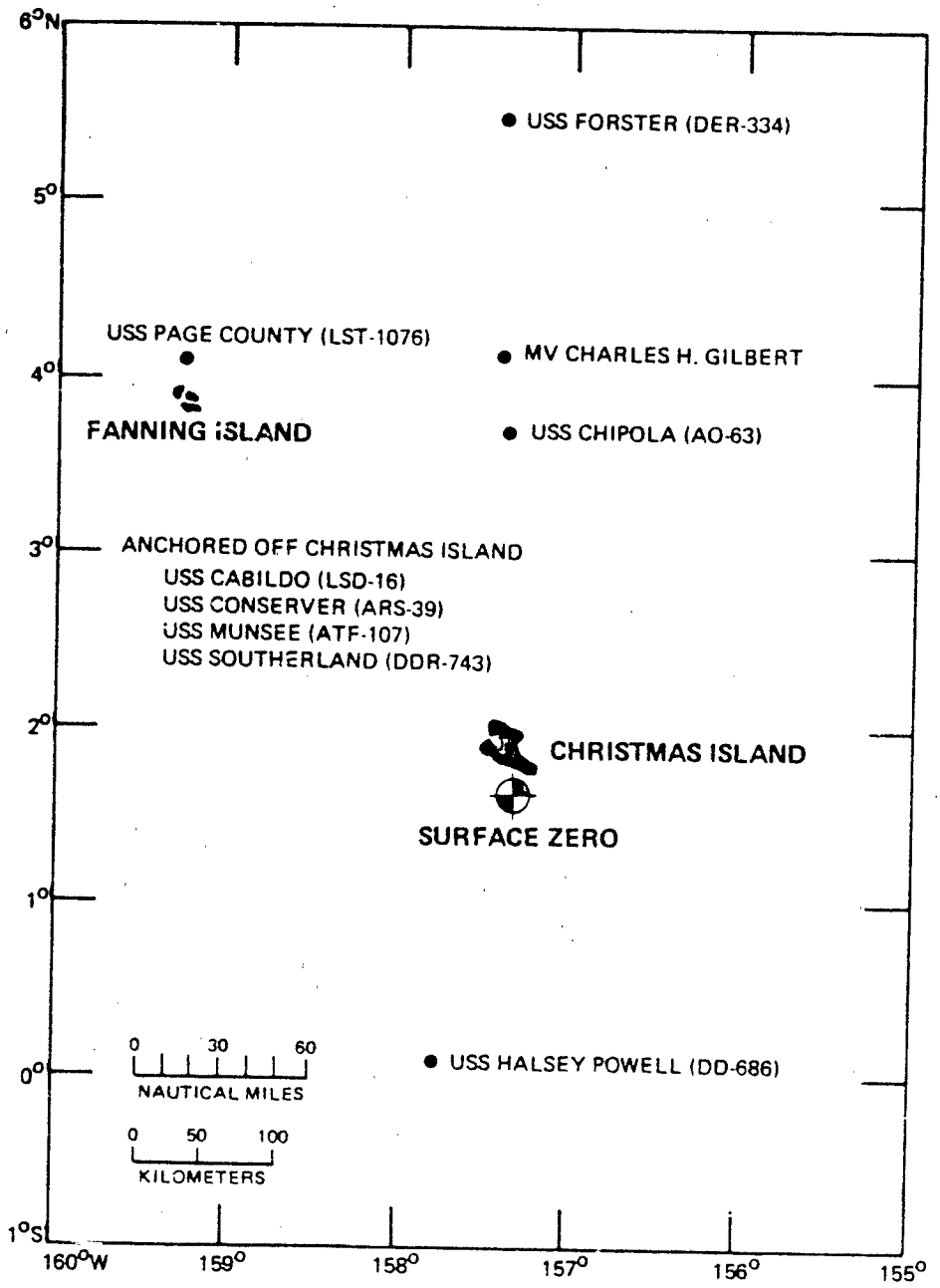


Figure 48. Ship positions, shot YUKON, DOMINIC.

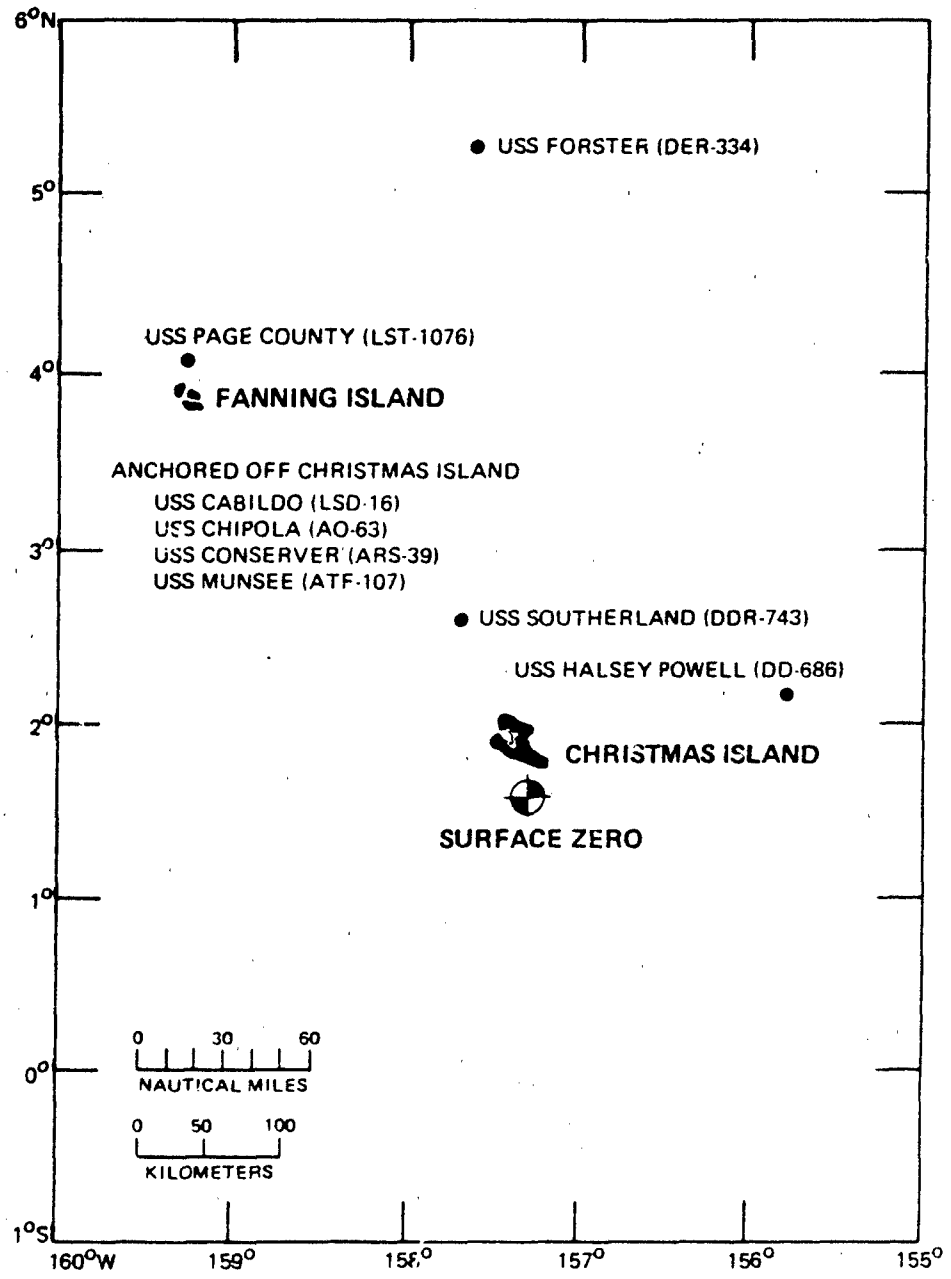


Figure 49. Ship positions, shot MESILLA, DOMINIC.

from H+51 minutes to H+144 minutes. The Project 7.5 B-57 acted as a radar target from Project 7.3, and the Hq USAF KC-135 did not participate. Ship positions are shown in Figure 50.

ENCINO -- 12 May 1962, 0803 (1703 GMT)

- LASL device; intermediate range yield
- DOD Projects: 4.1 and 7.5
- Special DOD Support: Six B-57s sampled the cloud at altitudes from 47,000 to 59,000 feet (14.3 to 18.0 km). This was the first time that the array of C-54s and C-118s from Project 4.1 participated. The samplers also took measurements for the USWB Project Stormwinder. Ship positions are shown in Figure 51.

SWANEE -- 14 May 1962, 0622 (1522 GMT)

- LRL device; intermediate range yield
- DOD Projects: 4.1 and 7.5
- Special DOD Support: Seven B-57s sampled the cloud from 38,000 to 57,000 feet (11.6 to 17.4 km) between H+42 and H+160 minutes. The Hq USAF KC-135 did not participate. Ship positions are shown in Figure 52.

CHETCO -- 19 May 1962, 0637 (1537 GMT)

- LRL device; intermediate range yield
- DOD Projects: 7.5
- Special DOD Support: Eight B-57s sampled the cloud at altitudes from 38,000 to 57,000 feet (11.6 to 17.4 km) between H+54 and H+123 minutes. C-130 No. 298 aborted because of a fire in an engine. The target raft was measured at 0.75 R/hr 4 to 6 hours after burst, the highest by a factor of 10 over any other test. Ship positions are shown in Figure 53.

TANANA -- 25 May 1962, 0709 (1609 GMT)

This shot had been postponed several days because of weather.

- LRL device; low range yield
- DOD Projects: 4.1 and 7.3
- Special DOD Support: Seven B-57s sampled the cloud and a second KC-135 joined the Hq USAF KC-135 in making remote measurements. Ship positions are shown in Figure 54.

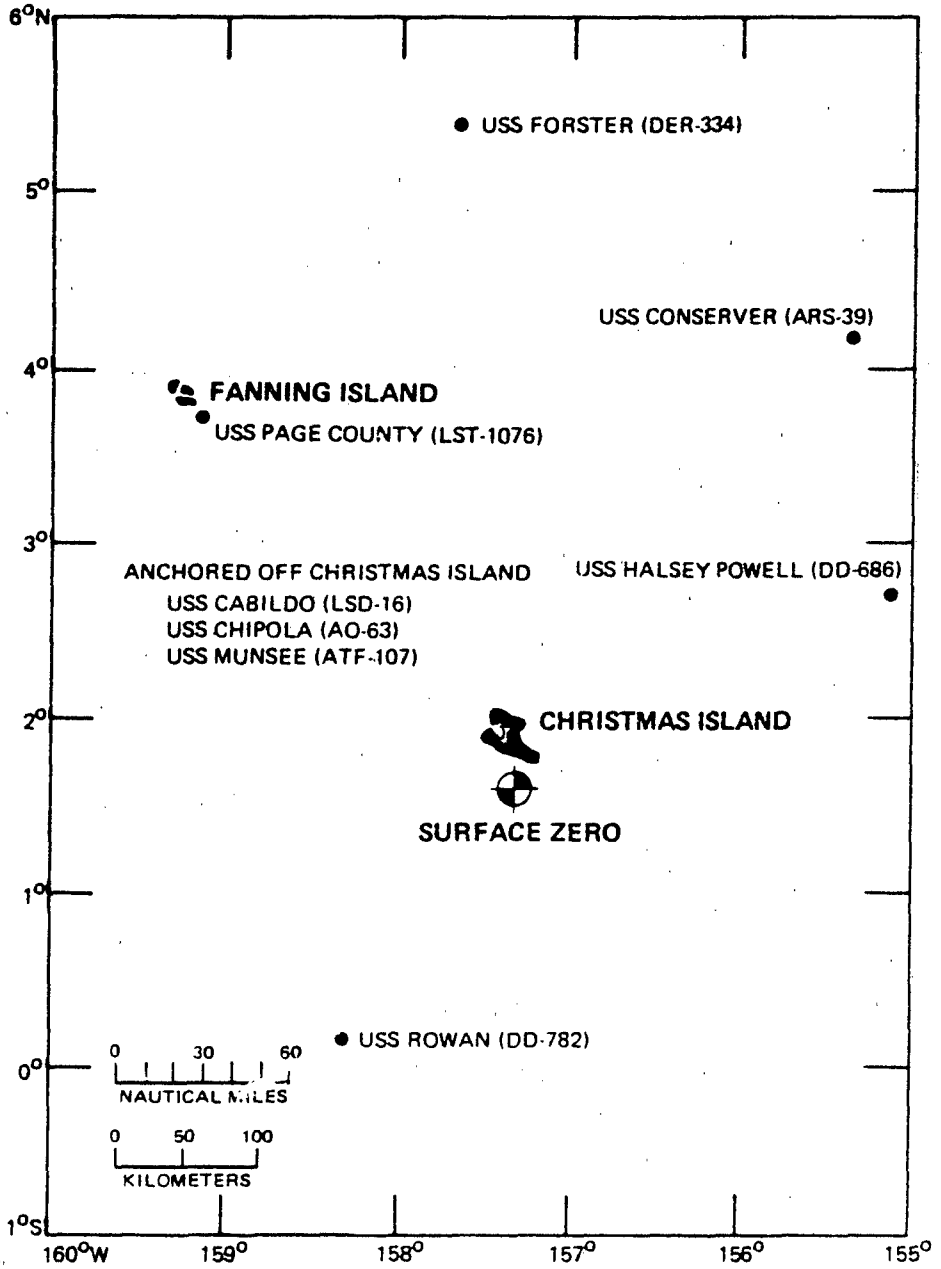


Figure 50. Ship positions, shot MUSKEGON, DOMINIC.

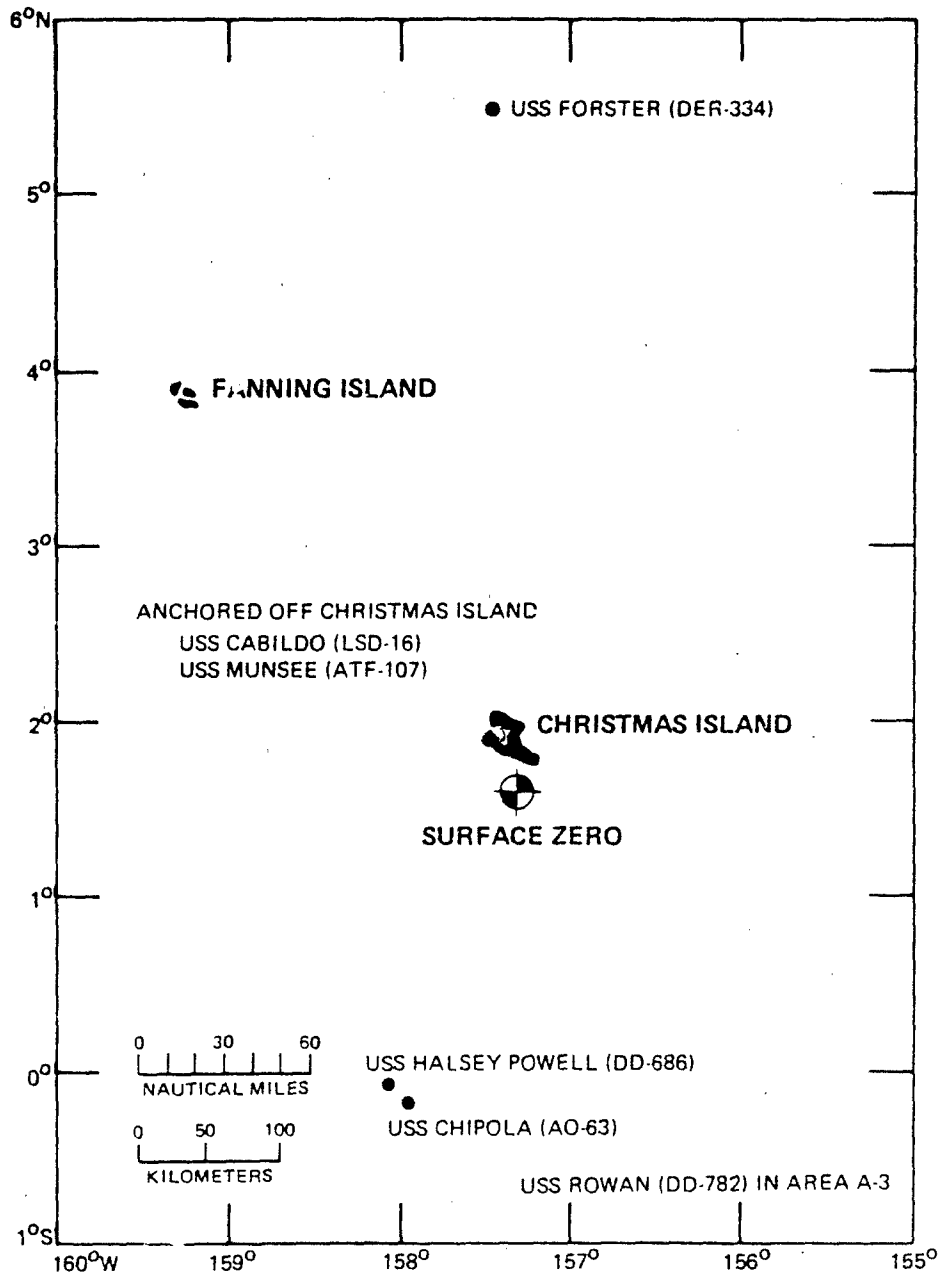


Figure 51. Ship positions, shot ENCINO, DOMINIC.

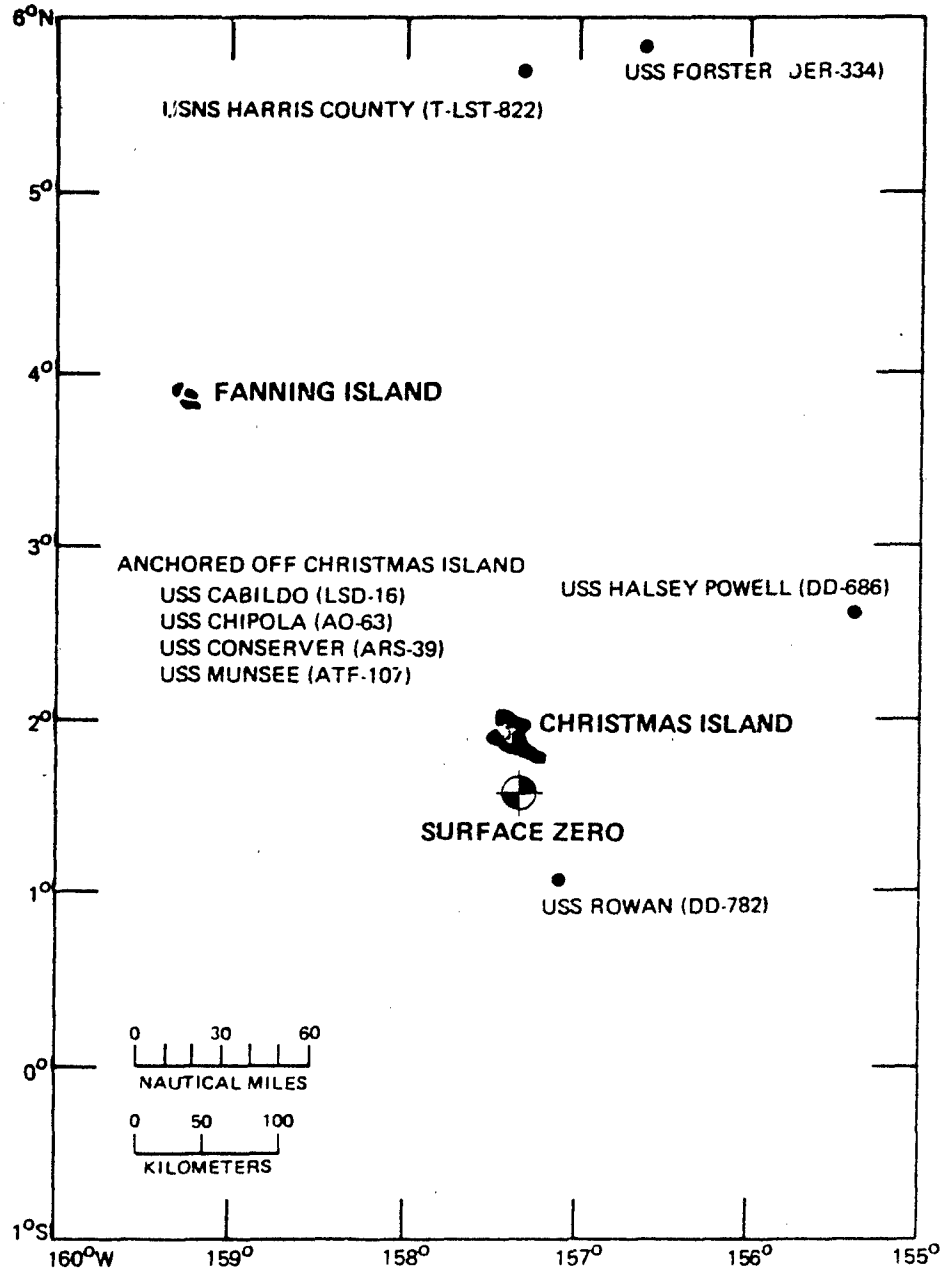


Figure 52. Ship positions, shot SWANEE, DOMINIC.

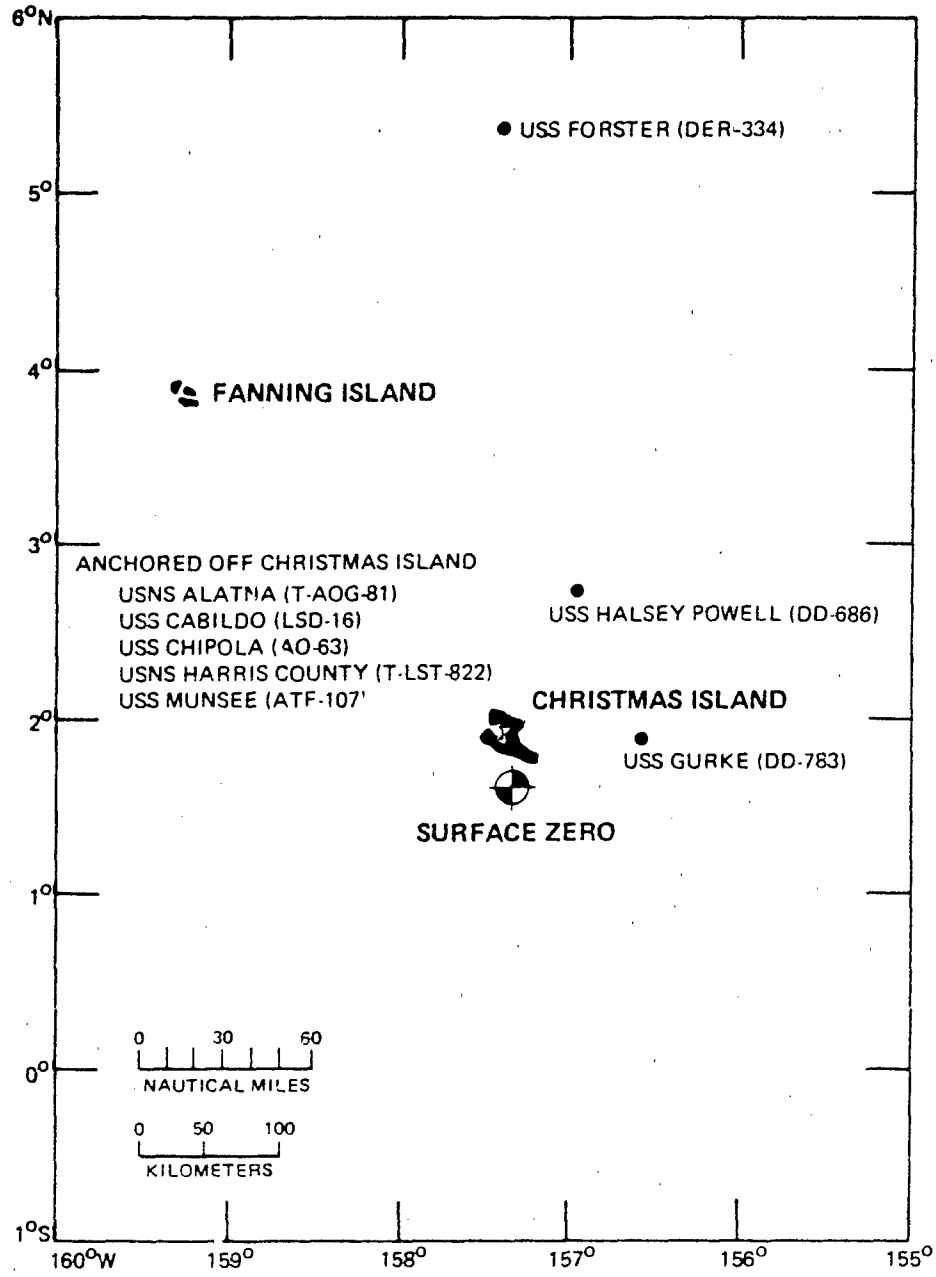


Figure 53. Ship positions, shot CHETCO, DOMINIC.

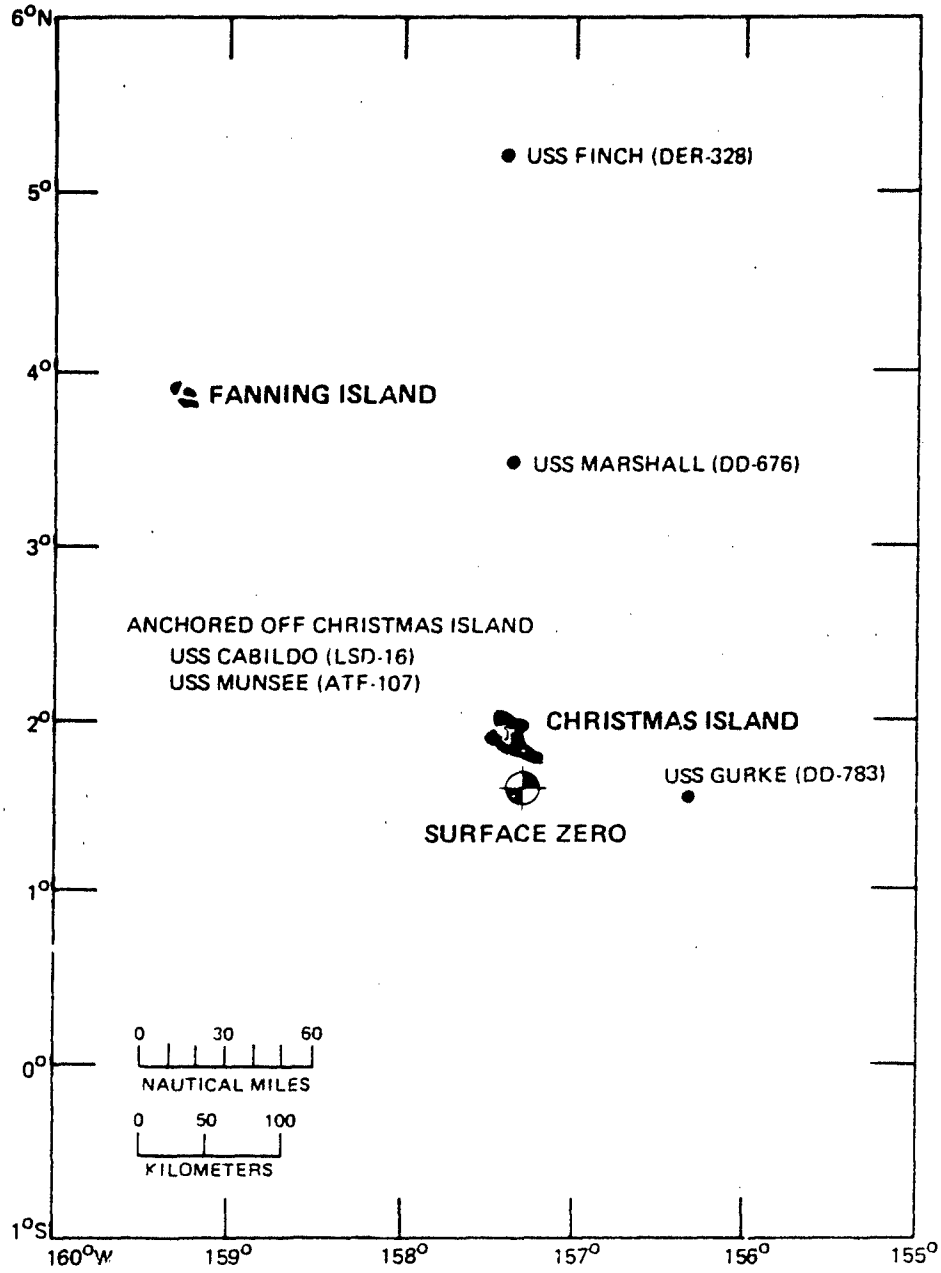


Figure 54. Ship positions, shot TANANA, DOMINIC.

NAMBE -- 27 May 1962, 0803 (1703)

- LASL device; intermediate range yield
- DOD Projects: 4.1, 7.3, and 7.5
- Special DOD Support: Five B-57 samplers took samples at from 40,000 to 54,000 feet (12.2 to 16.5 km). This was the last Christmas Island shot to use an RC-121 as an Airborne Air Operations Center (AAOC) to assist the ground-based AOC. Ship positions are shown in Figure 55.

ALMA -- 8 June 1962, 0803 (1703 GMT)

ALMA had been postponed for several days due to unfavorable winds. This shot caused light damage at A-site and demolished the light structures that constituted D-site. Glass and lights were broken at the main camp.

- LASL device; intermediate range yield
- DOD Projects: 7.3 and 7.5
- Special DOD Support: Eight B-57s took samples at from 47,000 to 61,000 feet (14.3 to 18.6 km). The C-130 diagnostic aircraft were based on Christmas Island instead of NAS Barbers Point for this shot. Ship positions are shown in Figure 56.

TRUCKEE -- 9 June 1962, 0637 (1537 GMT)

- LRL device; intermediate range yield
- DOD Projects: 7.3
- Special DOD Support: Six B-57s sampled the cloud at altitudes from 40,000 to 59,000 feet (12.2 to 18.0 km) at times from H+60 to H+135 minutes. A second KC-135 participated at long range. Ship positions are shown in Figure 57.

YESO -- 10 June 1962, 0601 (0701 GMT)

- LASL device; low megaton range yield
- DOD Projects: 4.1 and 7.5
- Special DOD Support: Eight B-57 samplers and one B-57 controller sampled the cloud from 42,000 to 62,000 feet (12.8 to 18.9 km) from H+57 to H+134 minutes. Ship positions are shown in Figure 58.

HARLEM -- 17 June 1962, 0637 (1537 GMT)

- LRL device; intermediate range yield
- DOD Project: 7.3
- Special DOD Support: Six B-57s sampled the cloud. Four rockets launched from A-site flew through the cloud collecting samples. All were recovered by Air Force H-21

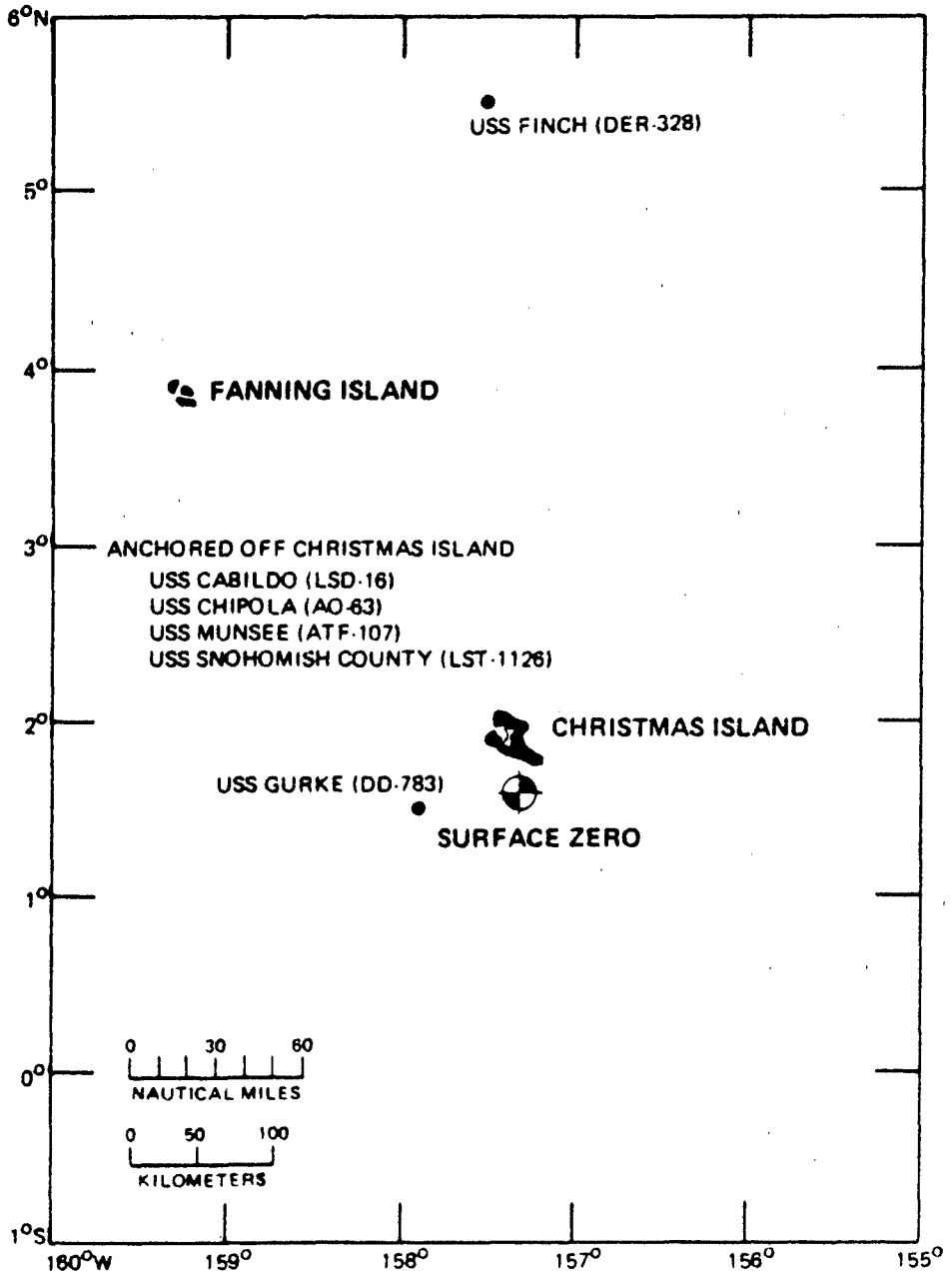


Figure 55. Ship positions, shot NAMBE, DOMINIC.

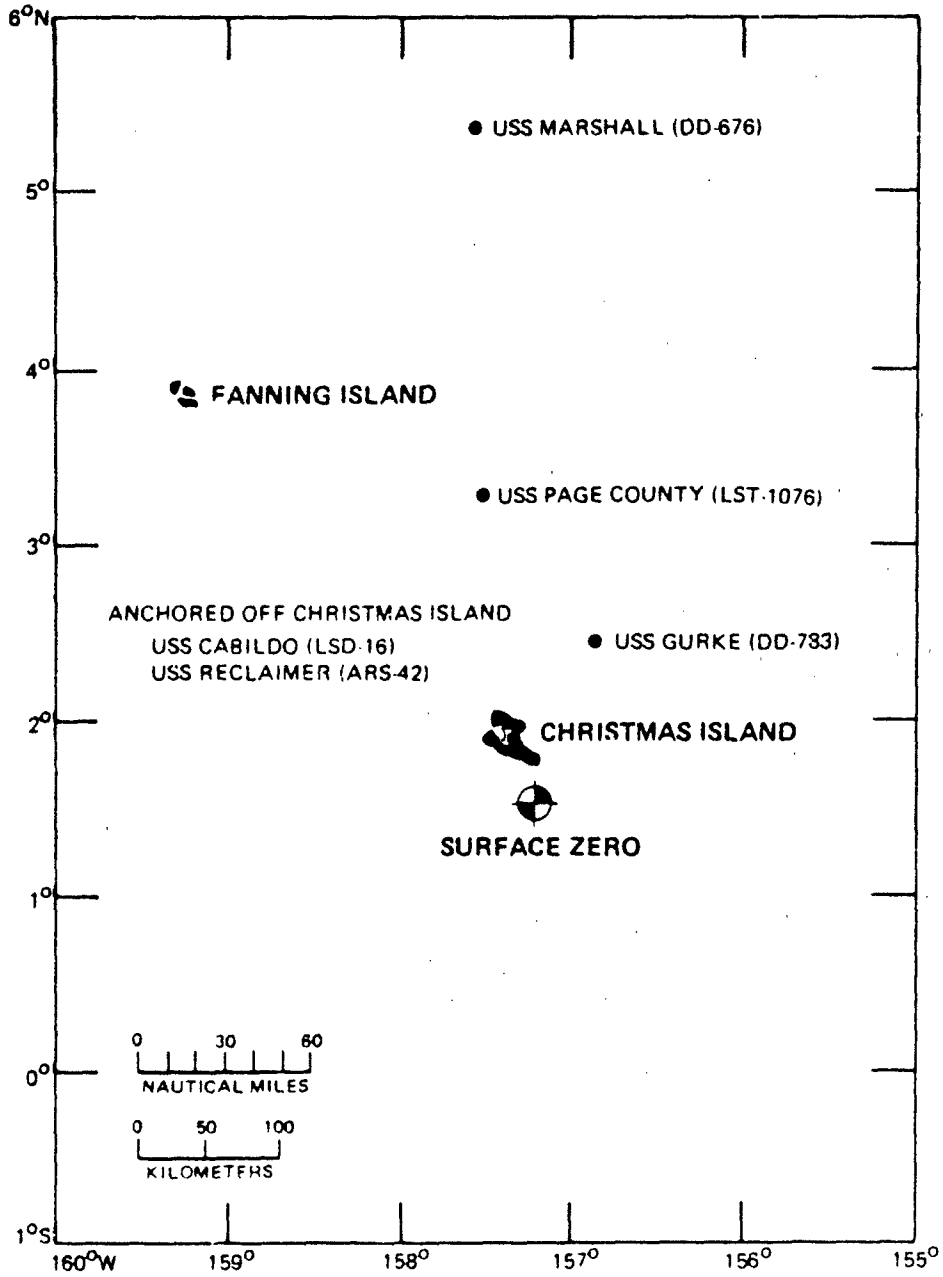


Figure 56. Ship positions, shot ALMA, DOMINIC.

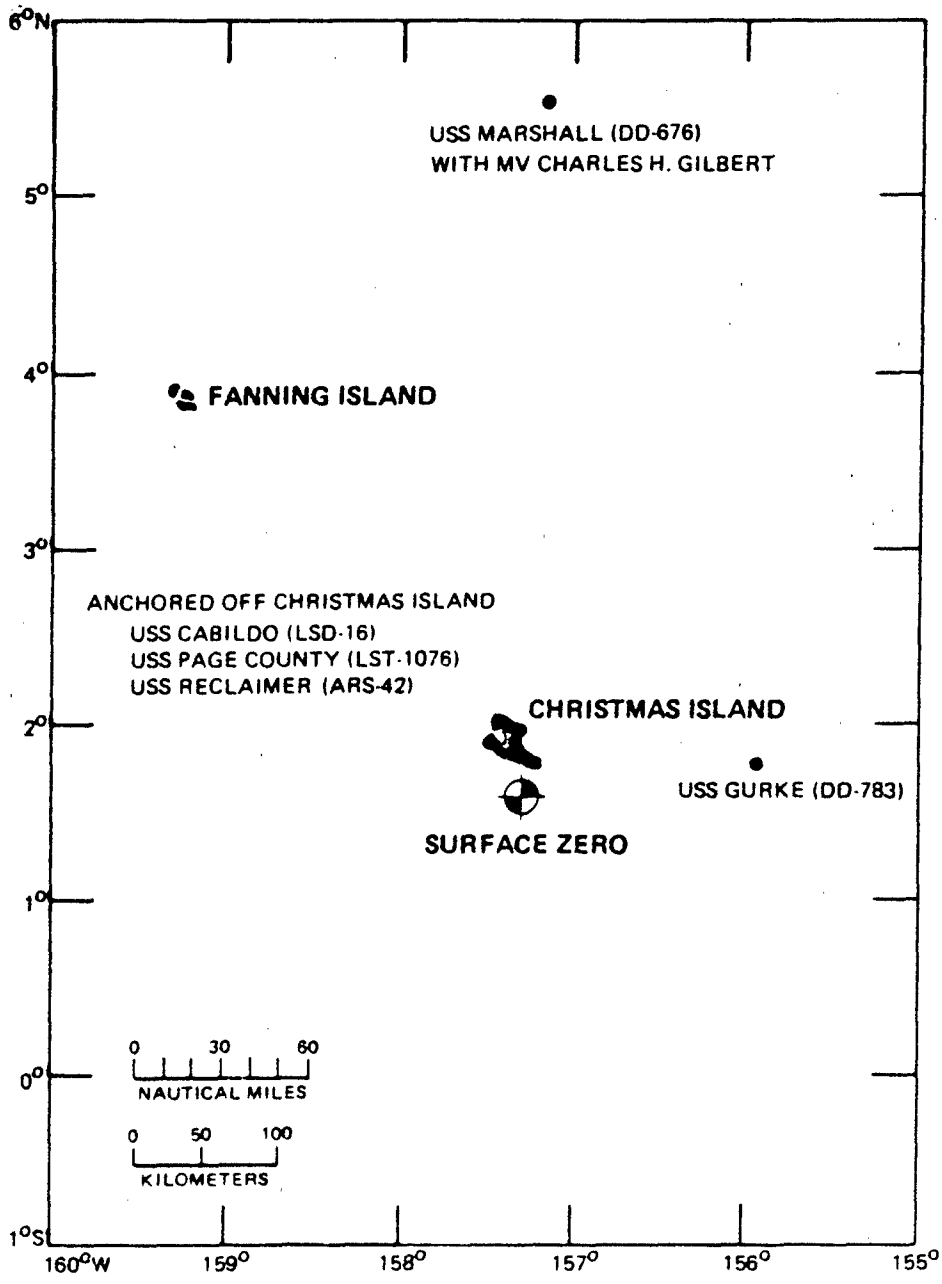


Figure 57. Ship positions, shot TRUCKEE, DOMINIC.

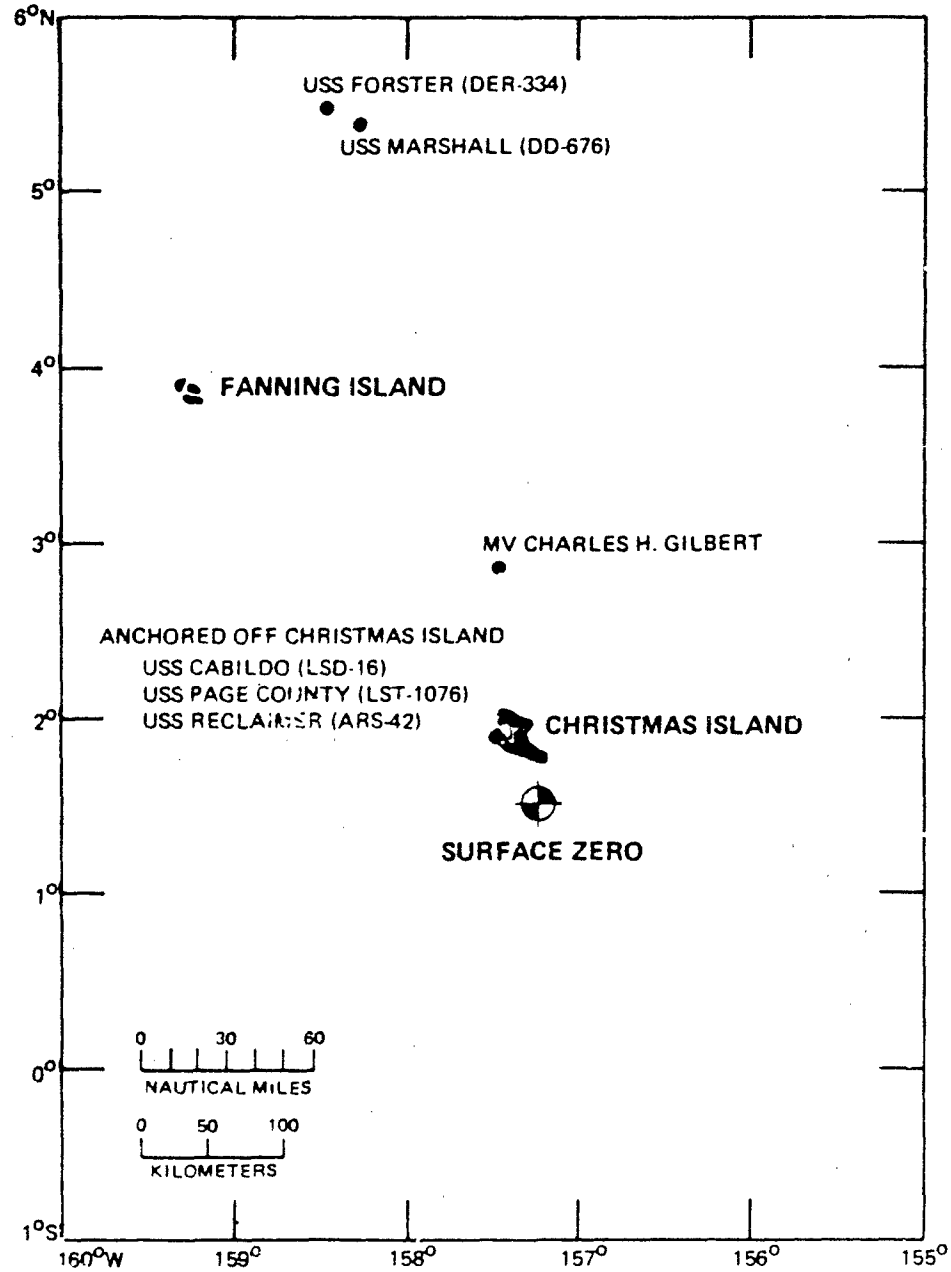


Figure 58. Ship positions, shot YESO, DOMINIC.

helicopters stationed at Christmas Island. Times of rocket launch were H+10 and H+11 minutes. Recovery time is not known. Ship positions are shown in Figure 59.

RINCONADA -- 15 June 1962, 0701 (1601 GMT)

RINCONADA had been postponed for 2 days due to unsatisfactory winds.

- LASL device; intermediate range yield
- DOD Projects: 1.2, 4.2, 7.3, and 7.5
- Special DOD Support: Five B-57s sampled the cloud at altitudes from 45,000 to 65,000 feet (13.7 to 19.8 km). A second KC-135 was used for long-range measurements. Ship positions are shown in Figure 60.

DULCE -- 17 June 1962, 0701 (1601 GMT)

- LASL device; yield range 20 to 200 KT
- DOD Projects: 4.2 and 7.3
- Special DOD Support: Five B-57s sampled the cloud at altitudes from 42,000 to 56,000 feet (12.8 to 17.1 km). These samplers also collected data for the USW [illegible]ect Stemwinder. Ship positions are shown in Figure

PETIT -- 19 June 1962, 0601 (1501 GMT)

- LRL device; low range yield
- DOD Projects: 4.2 and 7.3
- Special DOD Support: Seven B-57s were involved in the cloud sampling. Ship positions are shown in Figure 62.

OTOWI -- 22 June 1962, 0701 (1601 GMT)

- LASL device; intermediate range yield
- DOD Projects: None
- Special DOD Support: Four B-57s collected samples at altitudes from 41,000 to 56,000 feet (12.5 to 17.1 km). Ship positions are shown in Figure 63.

BIGHORN -- 27 June 1962, 0619 (1519 GMT)

This shot had been postponed three times between 24 and 26 June because of unsatisfactory winds.

- LRL device; megaton range yield
- DOD Projects: 1.2, 4.2, and 7.5

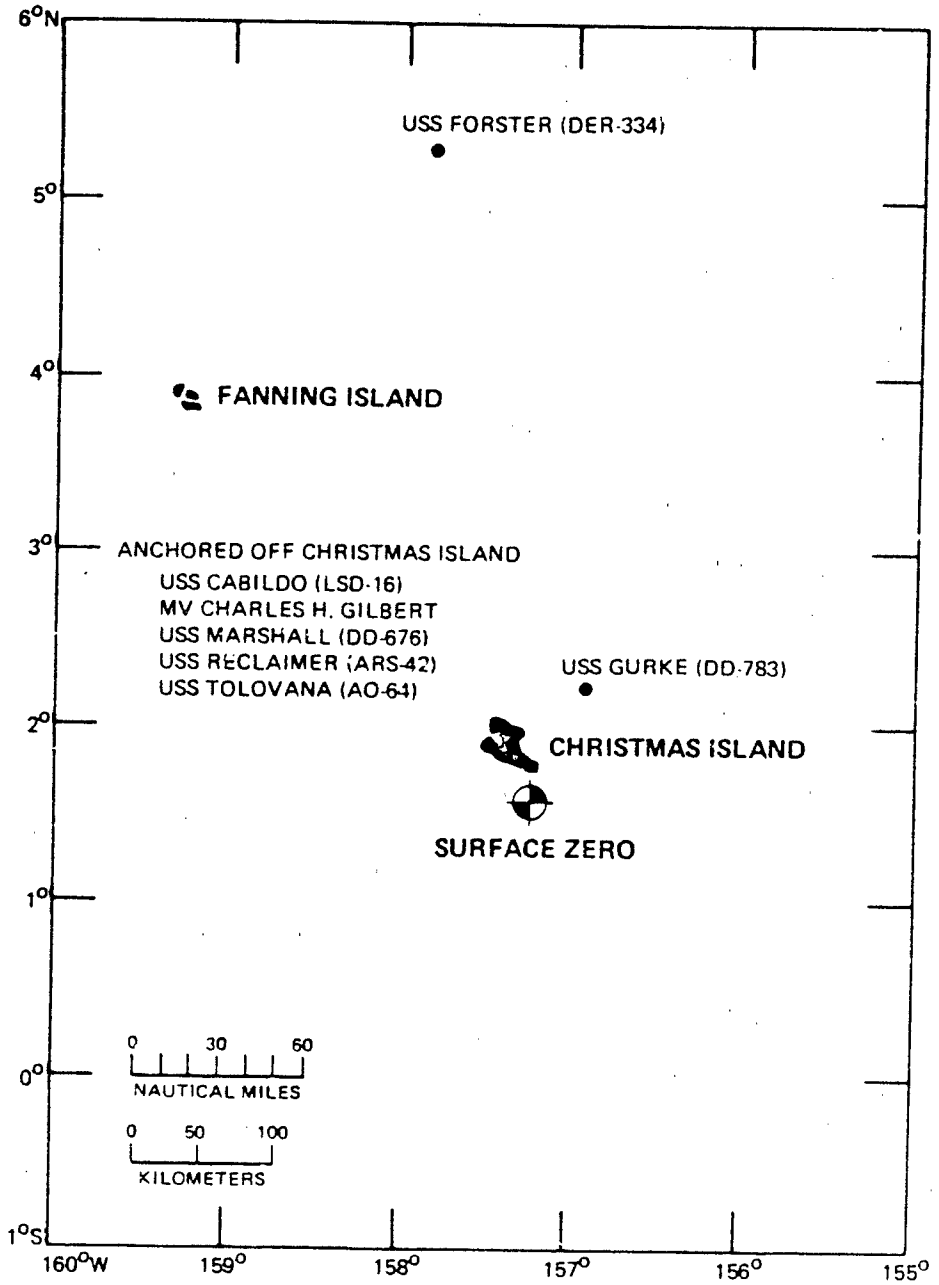


Figure 59. Ship positions, shot HARLEM, DOMINIC.

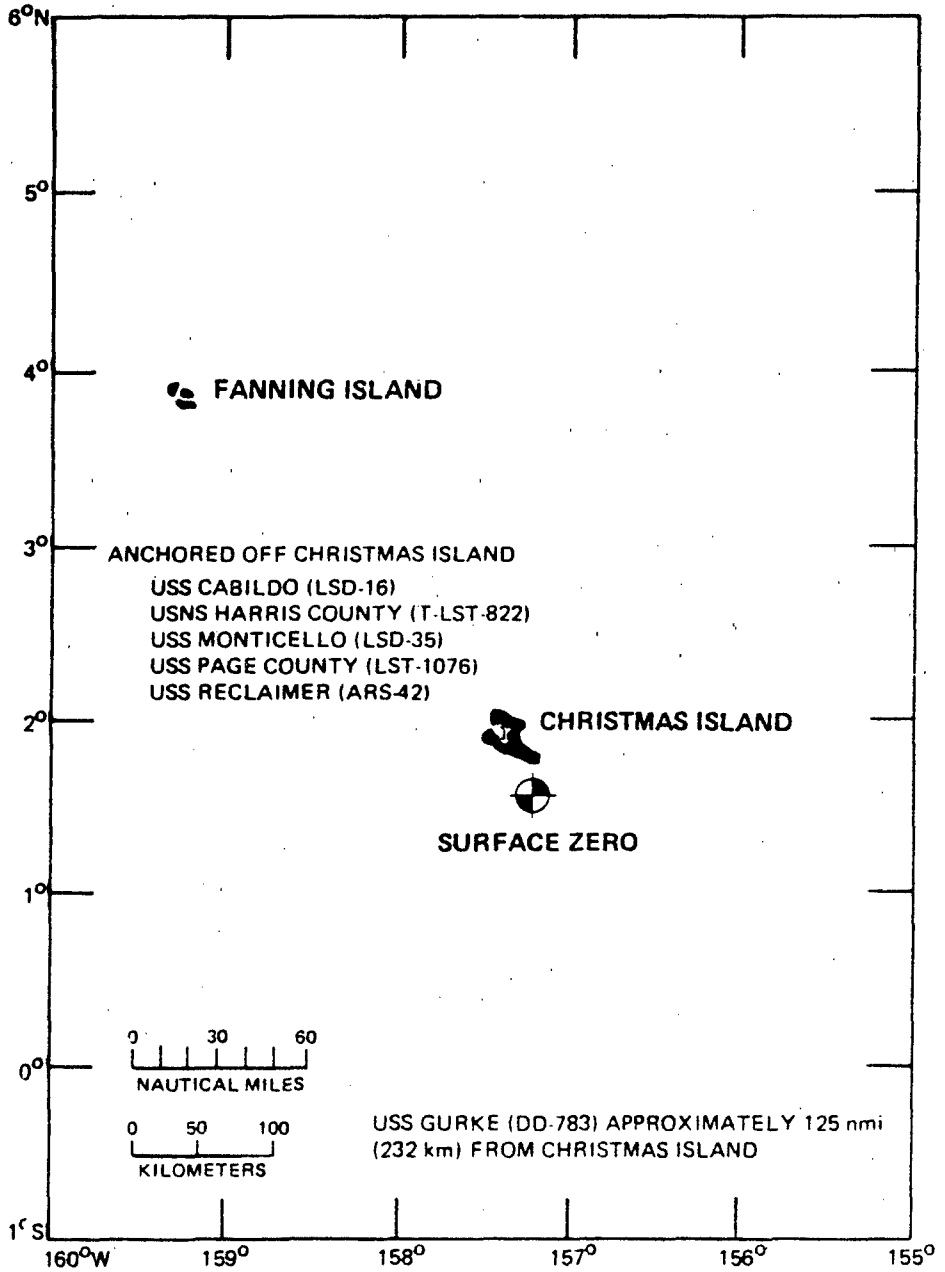


Figure 60. Ship positions, shot RINCONADA, DOMINIC.

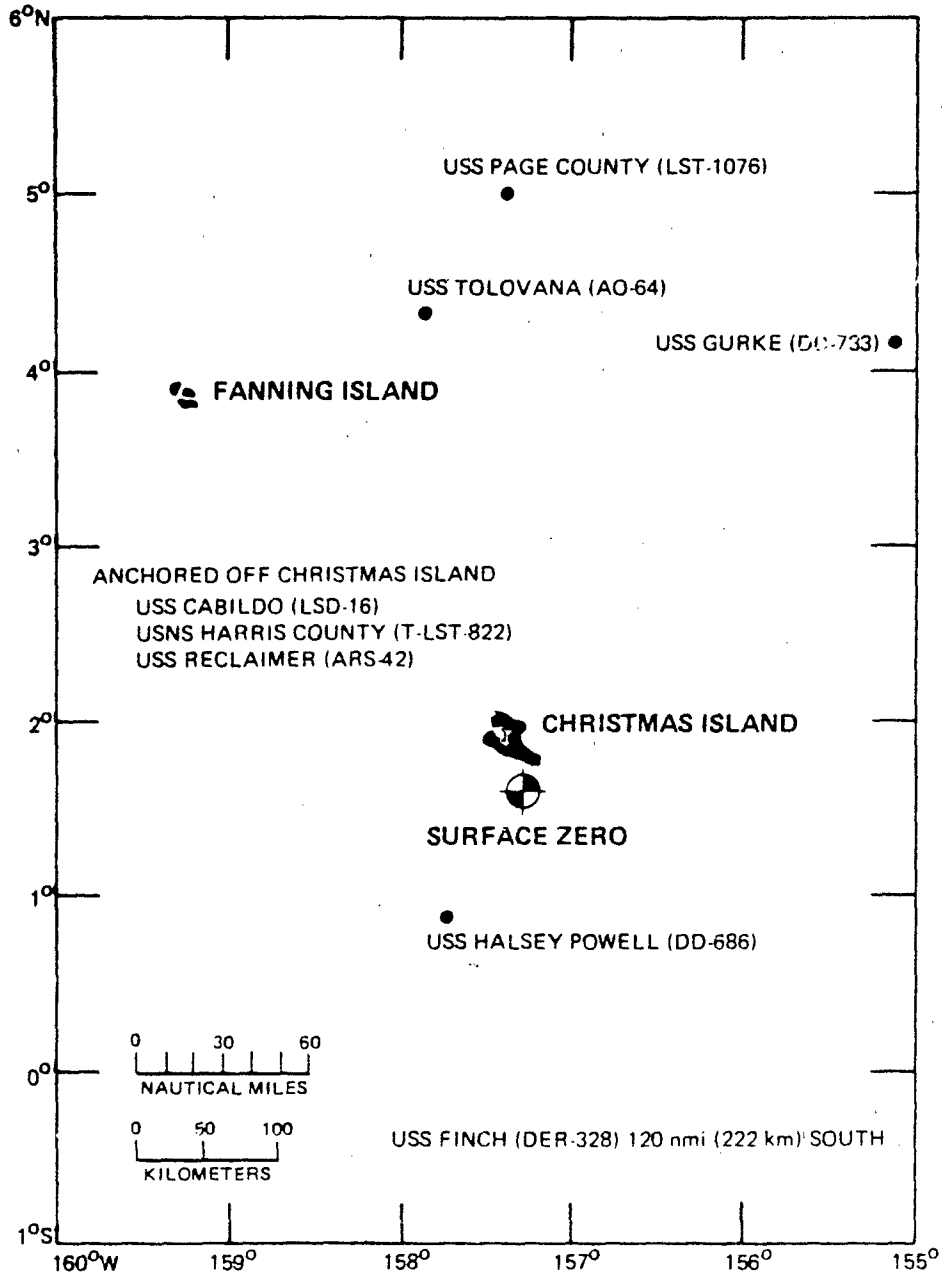


Figure 61. Ship positions, shot DULCE, DOMINIC.

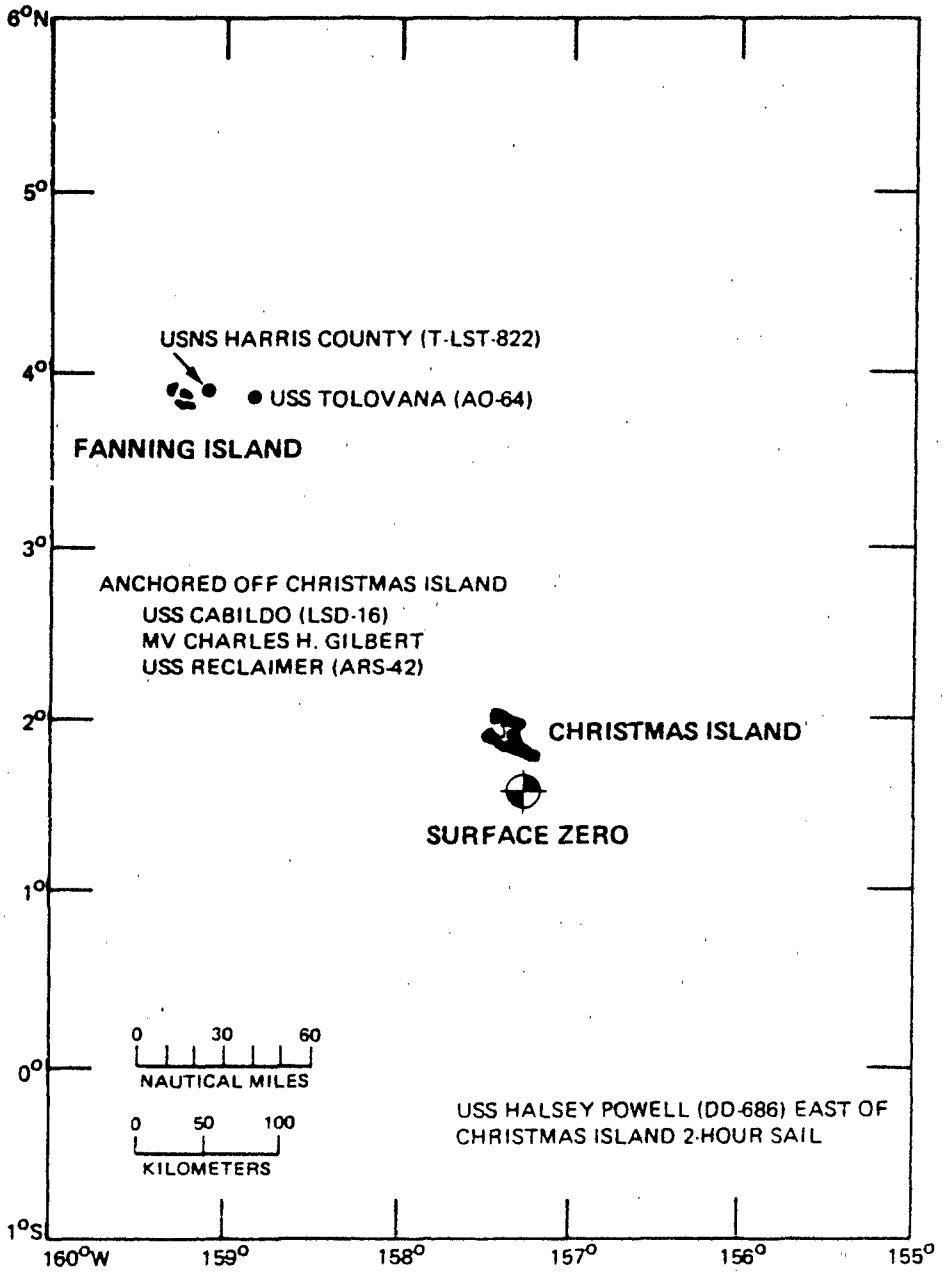


Figure 62. Ship positions, shot PETIT, DOMINIC.

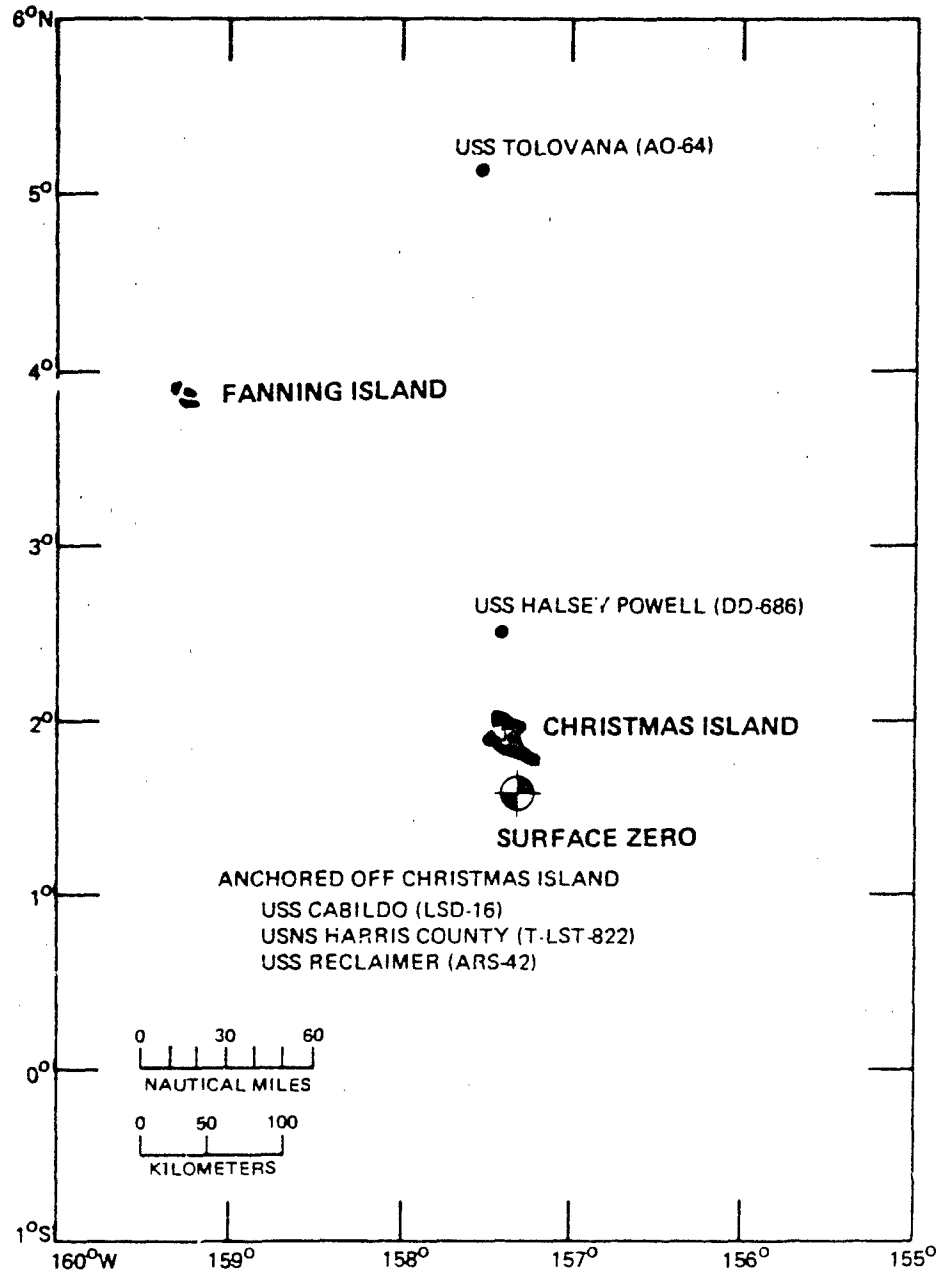


Figure 63. Ship positions, shot OTOWI, DOMINIC.

- Special DOD Support: Nine B-57 samplers collected samples at altitudes from 55,000 to 61,000 feet (16.8 to 18.6 km) from H+68 to H+123 minutes. Sampler B-57s also took measurements for the USWB Project Stemwinder. Six rockets were fired from Christmas Island A-site for sampling and three were recovered by Air Force H-21 helicopters. Firings were at H+11 minutes, but recovery times are unknown. Ship positions are shown in Figure 64.

BLUESTONE -- 30 June 1962, 0621 (1521 GMT)

This was the first drop mission for a new B-52 crew from SAC. The new crew had received extensive training at Kirtland AFB.

- LRL device; low megaton range yield
- DOD Projects: 4.2 and 7.5
- Special DOD Support: Eight B-57s sampled the cloud at altitudes from 47,000 to 61,000 feet (14.3 to 18.6 km) at times from H+70 to H+106 minutes. Aircraft also made measurements for the USWB Project Stemwinder. One rocket for device debris collection was fired at H+10 minutes and was recovered by Air Force helicopters. Ship positions are shown in Figure 65.

SUNSET -- 10 July 1962, 0733 (1633 GMT)

This shot had been postponed one day so as not to conflict with the STARFISH Prime shot at Johnston Island.

- LASL device; intermediate range yield
- DOD Projects: 1.2, 4.2, and 7.3
- Special DOD Support: Six B-57s sampled the cloud at from 48,000 to 61,000 feet (14.6 to 18.6 km). Ship positions are shown in Figure 66.

PAMLICO -- 11 July 1962, 0637 (1537 GMT)

This was the last shot at Christmas Island, and with its execution operations there ended except for rollup.

- LRL device; low megaton range yield
- DOD Project: 4.2
- Special DOD Support: Seven B-57s were used to sample the cloud. Ship positions are shown in Figure 67.

JOHNSTON ISLAND AIRDROPS

Four target areas were designated for the Johnston Island airdrops. They ranged from 250 to 400 nmi (463 to 741 km) from the island and were located from roughly east of the island clockwise around to south-southwest of the island. Target rafts similar to the ones used at Christmas Island were moored at the four target areas by JTG 8.3 (Reference C.1.L, p. B-4).

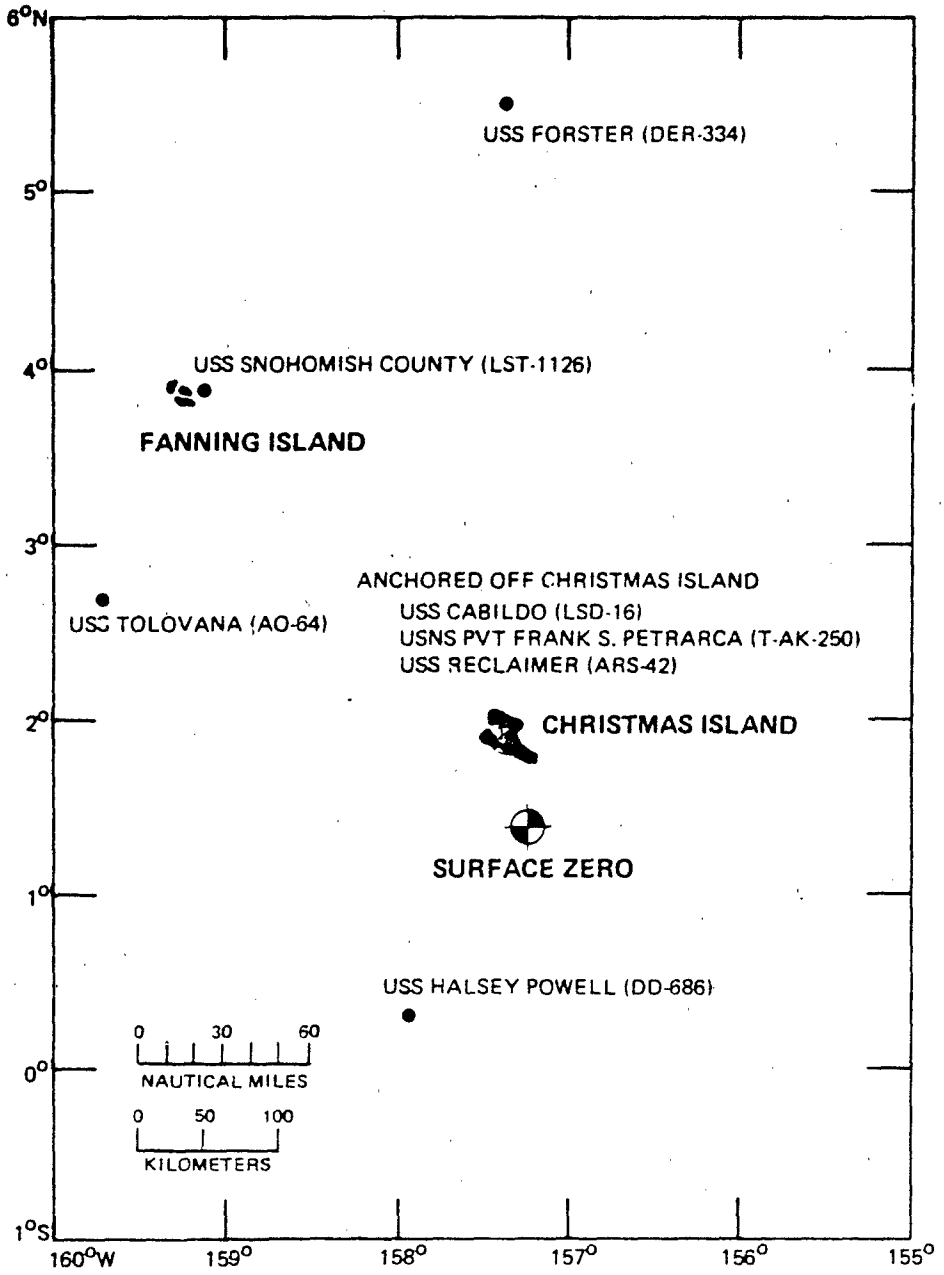


Figure 64. Ship positions, shot BIGHORN, DOMINIC.

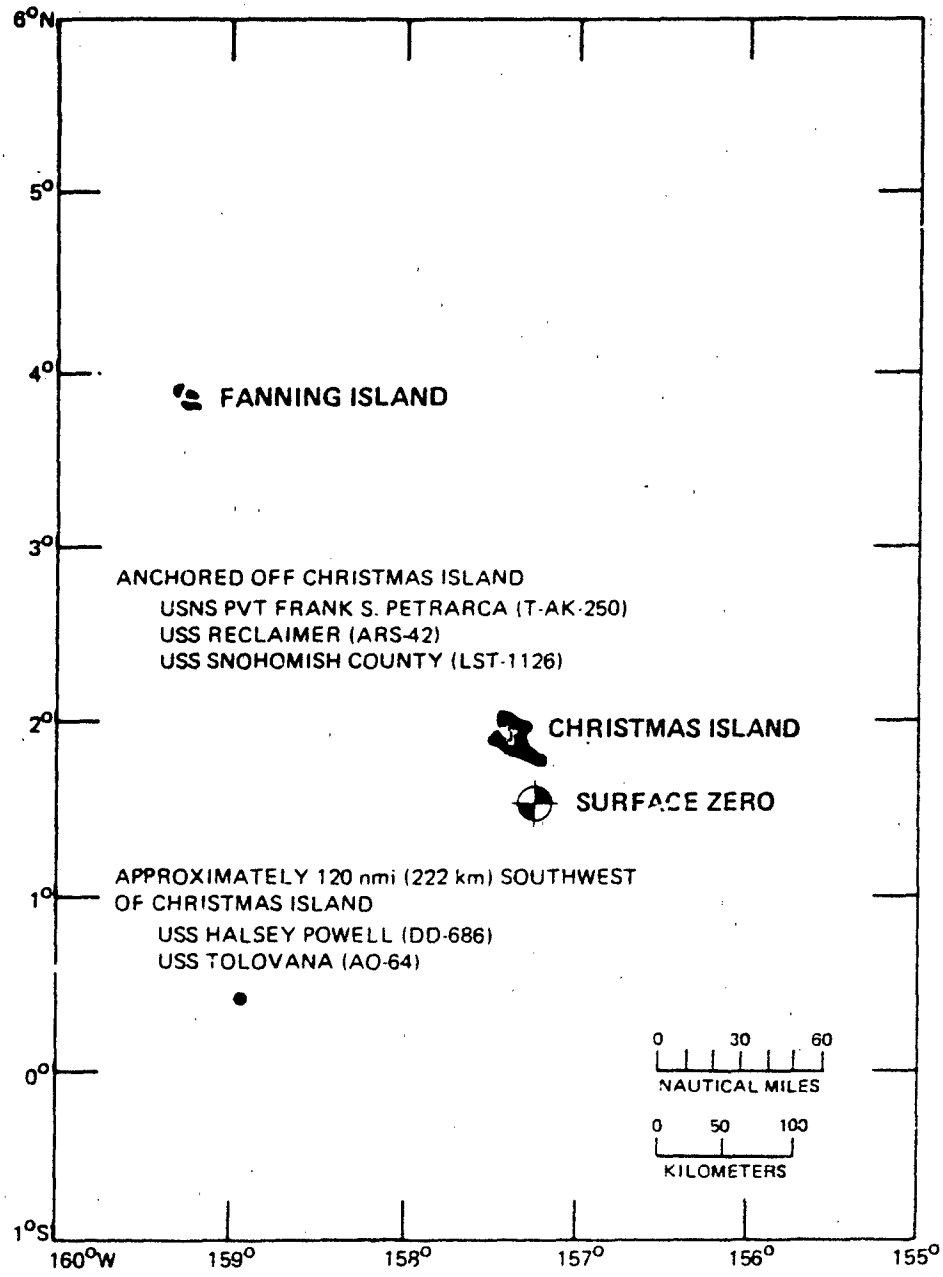


Figure 65. Ship positions, shot BLUESTONE, DOMINIC.

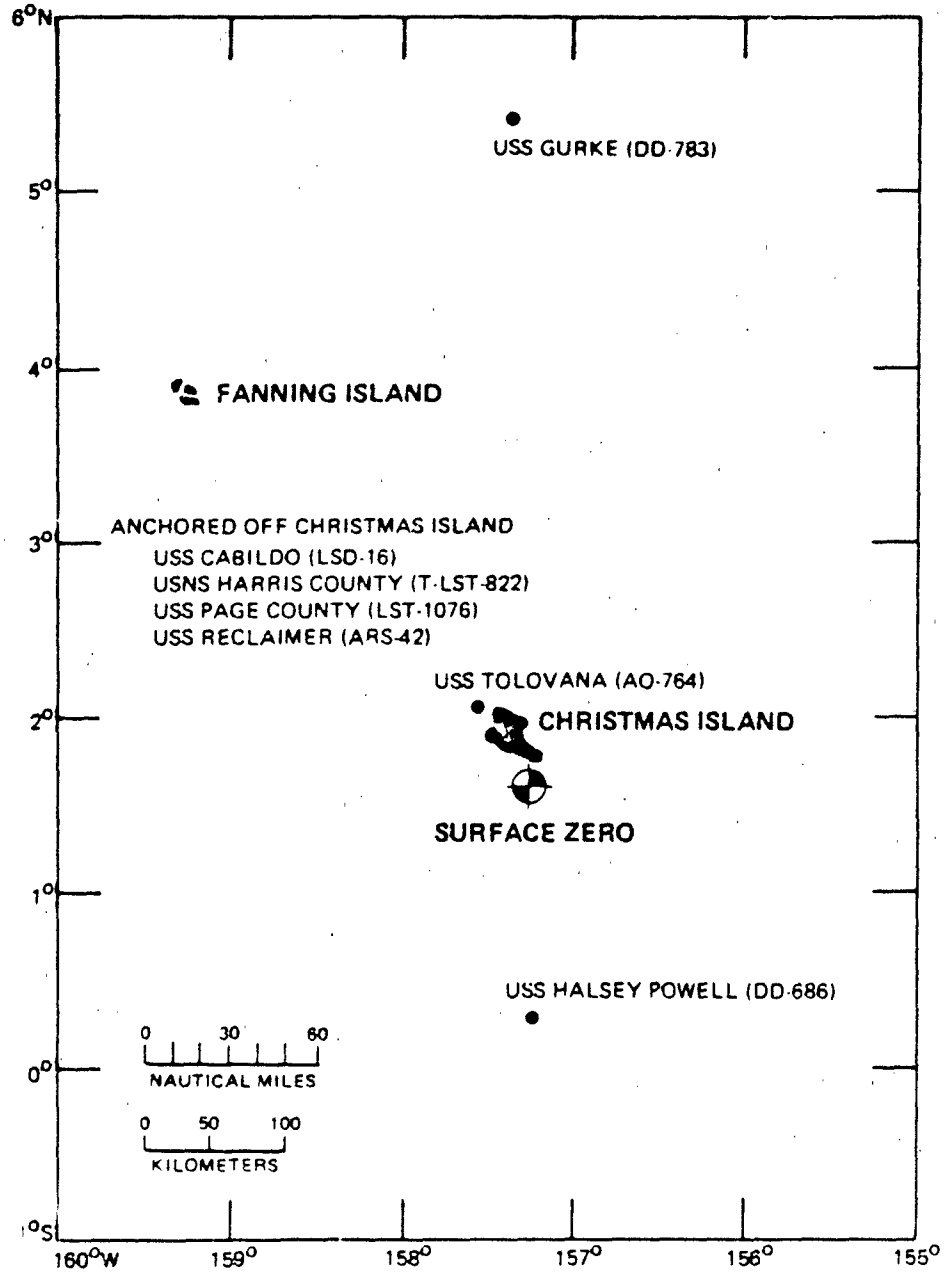


Figure 66. Ship positions, shot SUNSET, DOMINIC.

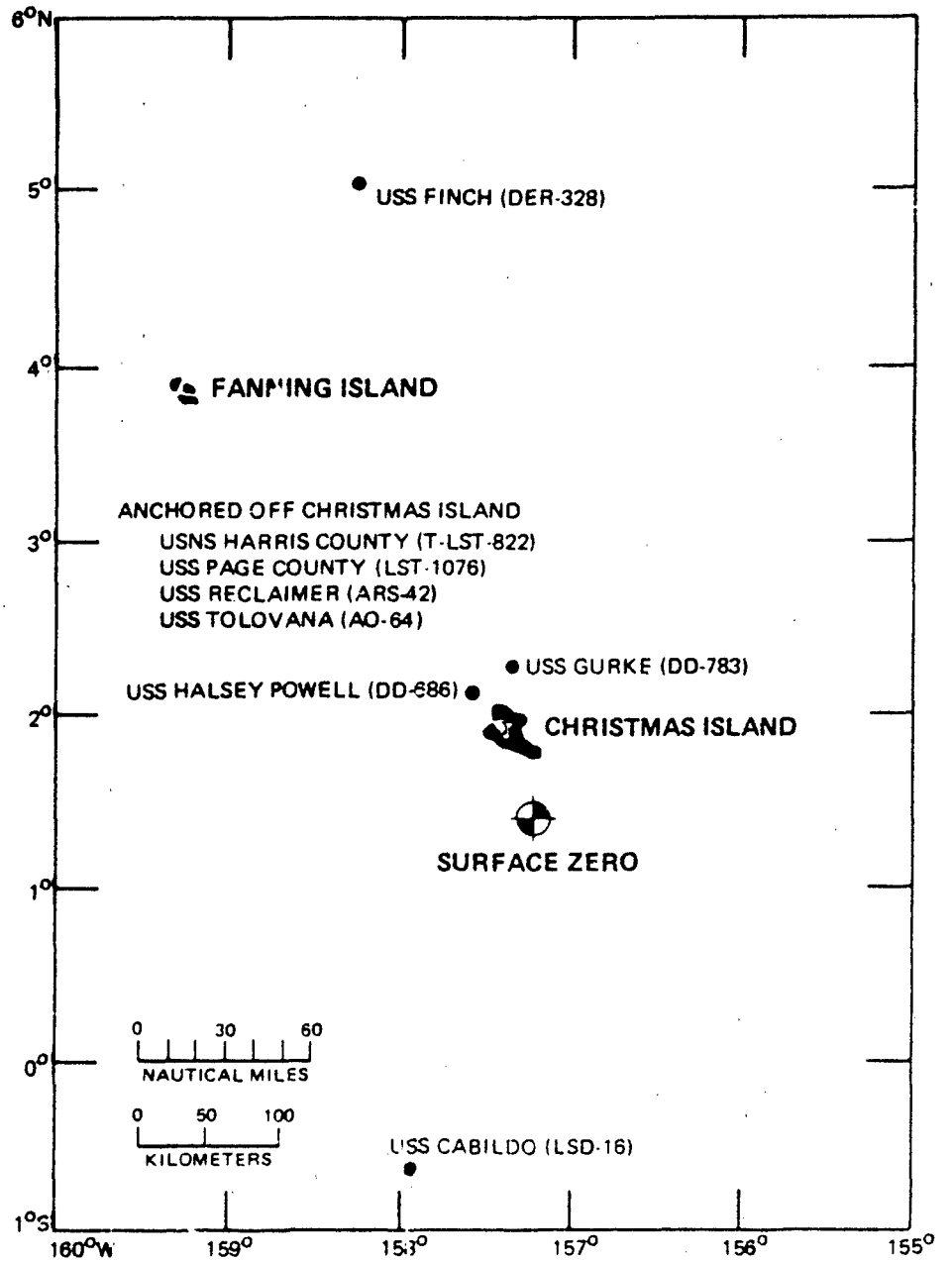


Figure 67. Ship positions, shot PAMLICO, DOMINIC.

The primary scientific platforms were the two C-130 aircraft that had been used for the earlier Christmas Island airdrops. The B-52 drop aircraft was also instrumented as for the Christmas Island shots with fireball photography cameras and other diagnostic equipment. The Air Force Special Weapons Center B-52 was the only B-52 used for the Johnston Island airdrops. Two KC-135 aircraft again were primarily photographic aircraft. For the Johnston Island drops, U-2 high-altitude reconnaissance aircraft and B-50s were used for weather determination. RC-121s were used as the AAOC. Eight B-57s were available for sampling the nuclear cloud debris. Four B-57s sampled on each of the five airdrops near Johnston Island. Two more were in the air as spares (Reference C.4.4.2, p. B-V). The B-52 drop aircraft, the two C-130s, and the B-57 samplers were based at NAS Barbers Point, and the P2Vs were based at Johnston Island. The other aircraft were based at Hickam AFB. The B-57 sampler controller was based at Johnston Island on shot days so that it would be capable of extended flying time in the burst area. It returned to Barbers Point periodically for routine maintenance. There were no ground-based instrument stations for these tests.

Table 16 shows the aircraft that were scheduled to participate on the five airdrop shots near Johnston Island.

Table 16. Planned aircraft participation for Johnston Island airdrops, DOMINIC.

Quantity	Aircraft	Mission
1	B-52	Drop aircraft
6	B-57D	Cloud sampling
2	C-130	Diagnostics
1	RC-54	Documentary photography
1	SC-54	Search and rescue
6	KC-135	Experiments and photography
1	C-135	Experiments and photography
2	RC-121	Airborne Air Operations Center
2	B-47	Radio relay and radio interference tests
1	WB-50	Weather reconnaissance
3	U-2	Weather reconnaissance
5	C-118	Retinal burn studies
Note a	P2V	Search and surveillance

Note:

[a]There were 26 P2Vs available based on Johnston Island. The number planned for each shot is unknown (Reference C.1.8, p. C-4).

Source: Reference B 4.14, pp. 2-6.

Participation of naval ships included four destroyers for Johnston Island danger area patrol (northwest, northeast, southeast, and southwest sectors) and a target raft ship. A range safety ship (USNS Range Tracker [T-AGM-1]) was moored at the Johnston Island pier. There were several additional Navy ships in the area participating in the high-altitude nuclear shots that were executed from Johnston Island during the same time period; some of these ships probably participated in experiments during the airdrop shots as well (see discussion on Projects 7.5, 7.6, 7.7, 7.8, 7.9, and 7.11 in Chapter 3). A Navy ship was sent to find fallout in the most likely direction as known from weather information; however, none was ever detected.

ANDROSCOGGIN -- 2 October 1962, 0818 (1618 GMT)

This was the first airdrop in the Johnston Island area. The LRL device used was of intermediate yield. One B-57 sampler (No. 876) lost engine number two but landed safely at Johnston Island (Reference C.4.1, p. 111). Ship positions are shown in Figure 68.

BUMPING -- 6 October 1962, 0503 (1603 GMT)

Diagnostic data was taken by USS Forster (DER-334) and by the two C-130s from NAS Barbers Point. The yield from this LRL device was low (Reference C.4.1, p. 111). The photographs of the samples being taken from the aircraft in Chapter 2 (Figures 30 through 33) were taken following this test. Ship positions are shown in Figure 69.

CHAMA -- 18 October 1962, 0501 (1601 GMT)

The yield of this LASL device was in the low megaton range. All diagnostic and effects aircraft obtained excellent data (Reference C.4.1, p. 115). Ship positions are shown in Figure 70.

CALAMITY -- 27 October 1962, 0446 (1546 GMT)

The yield of this LRL device was in the intermediate range. All diagnostic and effects aircraft obtained excellent data (Reference C.1.L, p. B-4-1). Ship positions are shown in Figure 71.

HOUSATONIC -- 30 October 1962, 0502 (1602)

This shot was executed on 30 October 1962. The yield of this LRL device was in the megaton range. All diagnostic equipment operated satisfactorily except the LRL Distance Measuring Equipment. Ship positions are shown in Figure 72.

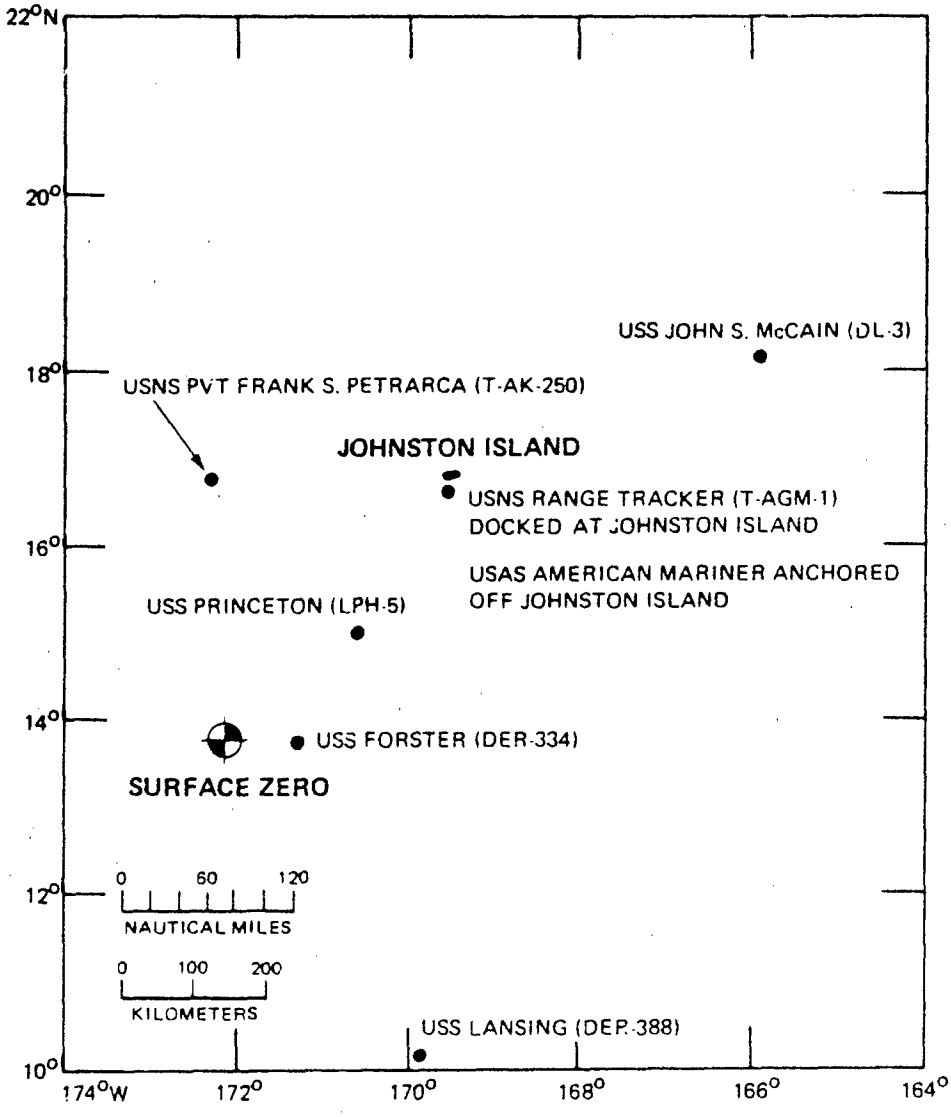


Figure 68. Ship positions, shot ANDROSCOGGIN, DOMINIC.

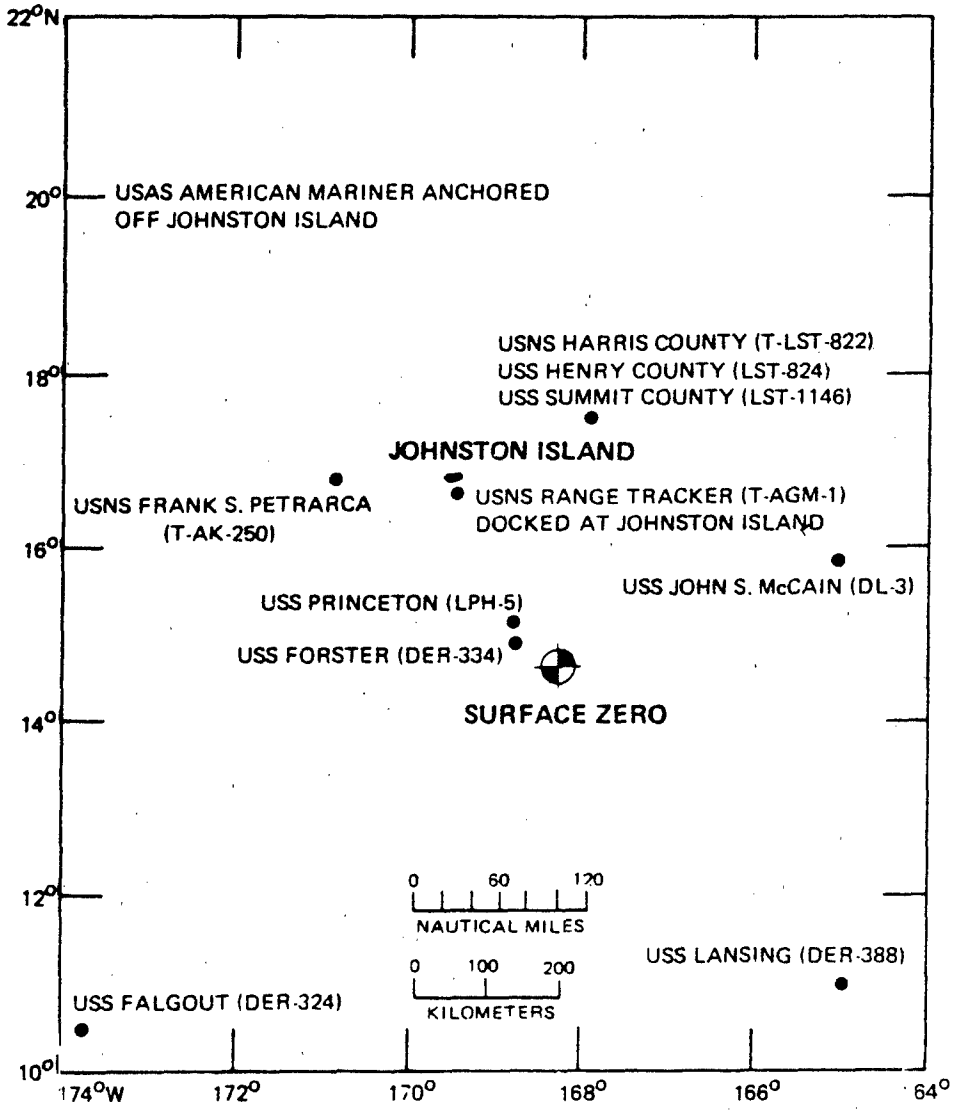


Figure 69. Ship positions, shot BUMPING, DOMINIC.

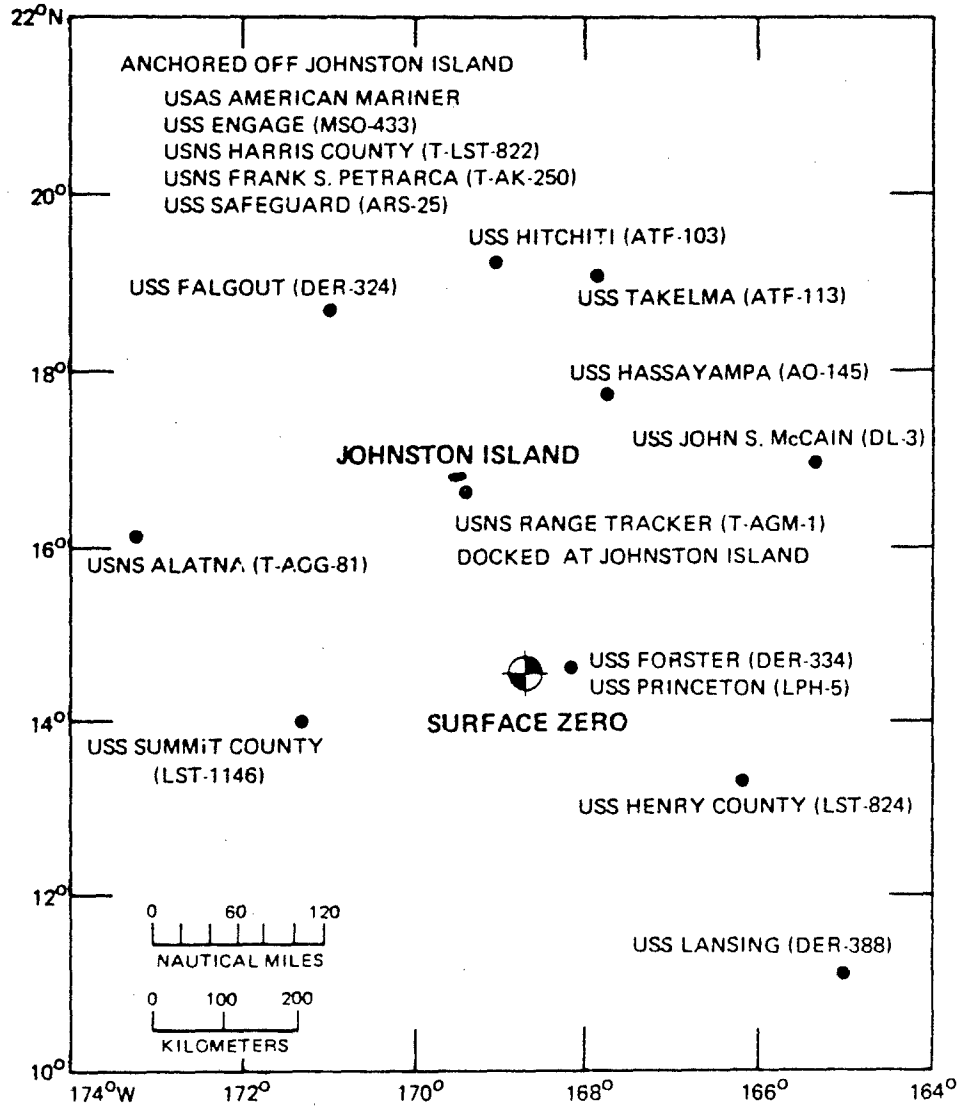


Figure 70. Ship positions, shot CHAMA, DOMINIC.

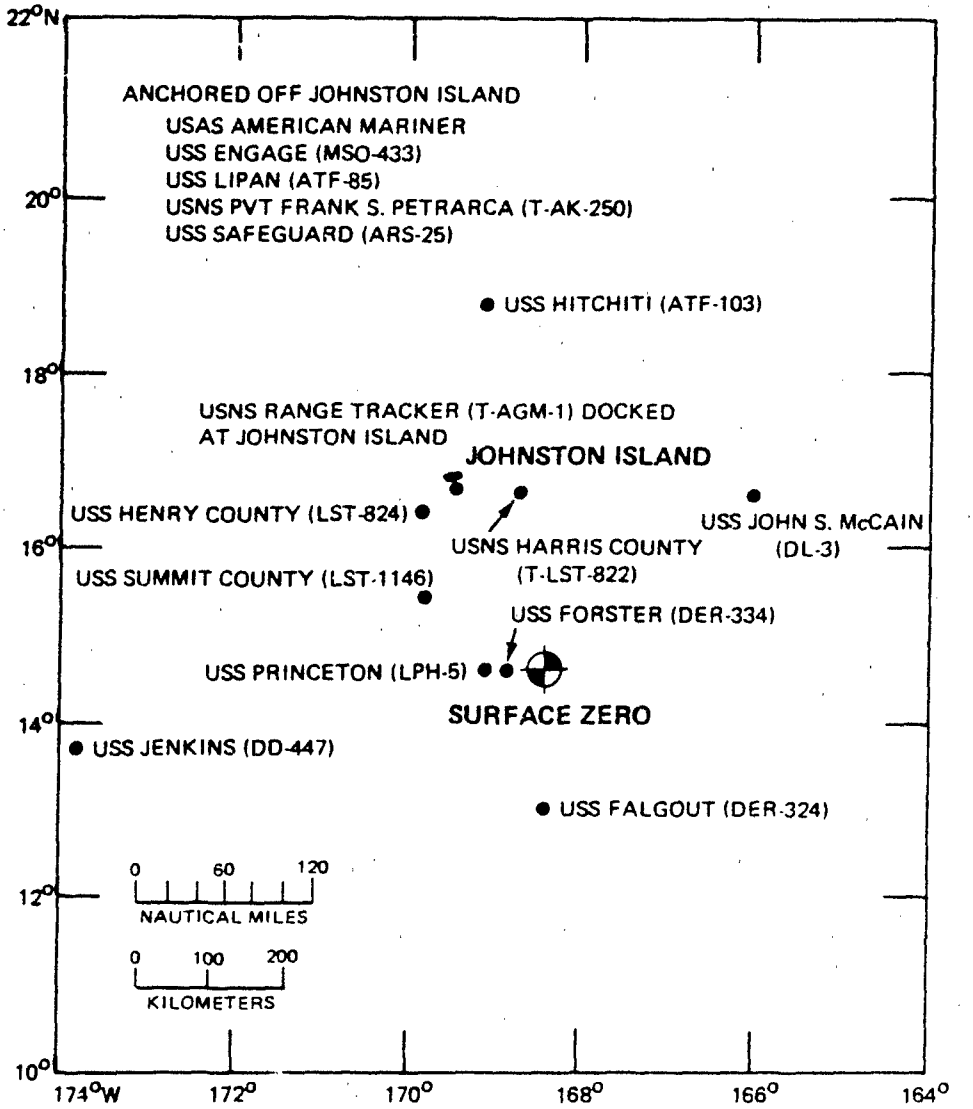


Figure 71. Ship positions, shot CALAMITY, DOMINIC.

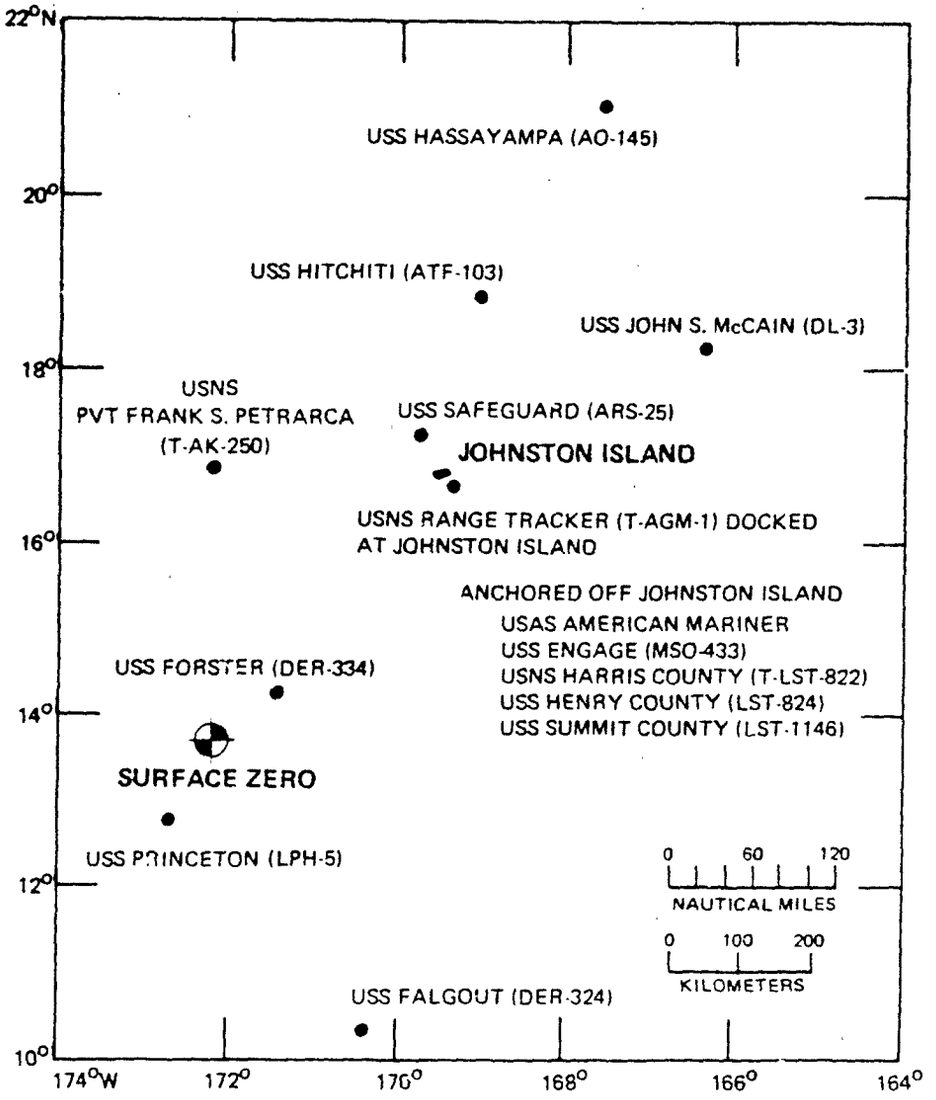


Figure 72. Ship positions, shot HOUSATONIC, DOMINIC.

CHAPTER 5

FRIGATE BIRD

INTRODUCTION

The FRIGATE BIRD event was an operational test of the Polaris weapon system. The primary objective was to prove the system when fired by a regular crew under conditions similar to those that might be encountered in time of war. A secondary objective was to prove the weaponized warhead. The test was a first in several respects:

1. The first firing of a Polaris with a nuclear warhead
2. The first test of the Polaris nuclear weapon packaged as a warhead
3. The first detonation of a nuclear warhead after ballistic reentry into the atmosphere
4. The first operational test of a U.S. or Free World strategic nuclear ballistic missile weapon system.

At 1417 on 6 May 1962, the submarine, USS Ethan Allen (SSBN-608), launched the missile while submerged about 1,500 nmi (about 2,790 km) east-northeast of Christmas Island. The warhead traveled about 1,020 nmi (1,890 km) toward the island, detonating as an airburst.

Before this operational test of the Polaris weapon system, there had been a number of Polaris underwater missile launch tests off Cape Canaveral downrange into the Atlantic Ocean. More significantly, the first generation of Polaris submarines, consisting of five boats, had completed at least one Polaris patrol before the end of 1961.

The first second-generation Polaris submarine, Ethan Allen, was commissioned in August 1961. Following five successful test missile launchings and immediately before going to its first patrol, Ethan Allen was ordered to the Pacific Ocean to be the firing submarine in shot FRIGATE BIRD.

The FRIGATE BIRD event was the capstone on the proof of the Polaris missile system. The Polaris weapon system had joined the long-range manned bomber force and the land-based intercontinental ballistic missile force to form the three legs of the deterrent triad.

The exceedingly complex Polaris weapon system was conceived in the summer of 1957 and throughout the development period, all of its subsystems were tested separately and in various combinations. Only the FRIGATE BIRD event, however, offered the opportunity for a test of the Polaris system from launch through detonation.

On 3 March 1962, apparently directed by the Joint Chiefs of Staff (JCS), the Chief of the Defense Atomic Support Agency (DASA) ordered the Polaris test added to the DOMINIC series. Commander Joint Task Force 8 (CJTF 8) and his staff were busy with preparation for the tests already scheduled. Consequently, planning for the Polaris test was assigned to Commander Joint Task Group 8.3 (CJTG 8.3), with assistance from the joint task force staff. Unspecified "urgent related considerations" indicated the test should be scheduled for early May, and 5 May was selected (Reference C.3.1, pp. G-4 and G-5).

ORGANIZATION AND RESPONSIBILITIES

The FRIGATE BIRD test was conducted by JTG 8.8. The task group was established only for this test and was made up of units drawn from various task groups of the joint task force and from other naval commands. CJTG 8.3 also commanded JTG 8.8. The organizations and participating units in FRIGATE BIRD were as follows (References B.3.2 and C.3.1):

Flagship and Range Safety Unit

- USS Norton Sound (AVM-1)

Launch Area Surveillance Unit

- USS Yorktown (CVS-10) with Carrier Anti-Submarine Warfare Air Group 55 (CVSG-55) aboard. CVSG-55 was made up of:
  - -- Air Anti-Submarine Squadron 23 (VS-23) with eight Grumman S2F antisubmarine aircraft
  - -- Air Anti-Submarine Squadron 25 (VS-25) with eight Grumman S2F antisubmarine aircraft
  - -- Helicopter Anti-Submarine Squadron 4 (HS-4) with 14 Sikorsky HSS-1N1 helicopters and 2 Sikorsky HSS-1 helicopters
  - -- Carrier Airborne Early Warning Squadron 11 (VAW-11) with six Douglas AD5W early warning aircraft

Destroyer Unit

- Destroyer Division 232
  - -- USS Maddox (DD-731) with Commander Destroyer Division 232 aboard
  - -- USS Brush (DD-745)
  - -- USS Samuel N. Moore (DD-747)
  - -- USS Preston (DDE-795)

Fleet Ballistic Submarine Unit

- Ethan Allen

Replenishment Unit

- USS Ponchatoula (AO-148)

JTG 8.3 Surveillance Group

- Land Based Naval Air Unit
  - -- Patrol Squadron 28 (VP-28) with six Lockheed P2V-5FS aircraft
  - -- Patrol Squadron 872 (VP-872) with four Lockheed P2V-5FS aircraft
  - -- Airborne Early Warning Barrier Squadron, Pacific, with two or three Lockheed WV-2 aircraft
- Surface Surveillance Unit
  - -- USS Southerland (DDR-743)
  - -- USS Falgout (DER-324)
- Burst Observation Unit
  - -- USS Medregal (SS-480) with Commander Submarine Division 11 aboard
  - -- USS Carbonero (SS-337)
- Photographic Task Unit
  - -- Mobile Photo Unit, Pacific Fleet
- JTG 8.4 (Air Force) participating in FRIGATE BIRD
  - -- 1 KC-135 sampler control aircraft
  - -- 8 B-57 sampler aircraft
  - -- 1 C-135
  - -- 2 C-130 diagnostic aircraft
  - -- 3 RC-121 air array control aircraft
  - -- 2 C-54 search and rescue aircraft
  - -- 1 WB-50 weather aircraft

Scientific Task Units

- TU 8.1.2 -- Lawrence Radiation Laboratory
- TU 8.1.3 - Field Command, Defense Atomic Support Agency
- TU 8.1.5 -- Edgerton, Germeshausen, and Grier, Inc.
- Joint Task Force Weather Central.

Norton Sound, Ethan Allen, Carbonero, and Medregal were added to JTF 8 only for FRIGATE BIRD. Yorktown and Destroyer Division 232 were added to the task force for both FRIGATE BIRD and SWORDFISH, the other naval systems test in DOMINIC. The other units at FRIGATE BIRD were also part of the joint task force for other shots.

No identifiable Army units participated in FRIGATE BIRD, although Army personnel may have participated as members of other organizations.

Responsibilities were apportioned among the various components of the joint task force as follows:

1. CJTF 8 was to have overall responsibility for conduct of FRIGATE BIRD and to exercise the overall command function from his headquarters on Christmas Island.

2. JTG 8.3 (Navy) was to:

   a. Exercise direct operational control of participating naval units, except those assigned to JTG 8.8

   b. Assume search and rescue (SAR) responsibility in the area between the Christmas Island danger area and the launch hazard area

   c. Conduct surveillance of the nuclear hazard area and, in cooperation with the commander of JTG 8.8, conduct surveillance of the trajectory hazard area to the limit of cruising radius of aircraft operating from Christmas Island

   d. Provide technical photography in support of JTG 8.8 as required.

3. JTG 8.4 (Air Force) was to:

   a. Exercise direct operational control of participating aircraft from JTG 8.4

   b. Provide cloud sampler, sampler control, and sample return aircraft to obtain cloud samples and deliver them to the designated Task Unit (TU) 8.1.2 personnel

   c. Provide aircraft for technical and documentary photography and for weapon diagnostic measurements

   d. Assume SAR responsibility for all joint task force aircraft in the Christmas Island danger area

   e. Assure movement control of all aircraft operating in Christmas Island danger area.

4. JTG 8.7 (Christmas Island Base Command) was to provide headquarters and base support for CJTF 8 including Joint Operations Center (JOC) and communications.

5. JTG 8.8 (FRIGATE BIRD Test Group) was to:

   a. Exercise direct operational control of participating naval units engaged in operations in the vicinity of the launch point

   b. Assume SAR responsibility in the launch area

   c. Conduct surveillance of launch hazard area and the trajectory hazard sector to the limit of cruising radius of S2F aircraft operating from Yorktown in the vicinity of the launch point

d. Provide range safety missile tracking facilities to permit destruction of missile, if required for safety

e. Provide technical photography of missile launch and documentary photography of preparations and launch to CTU 8.1.3.

6. TU 8.1.2 (Lawrence Radiation Laboratory) was to analyze cloud samples to verify warhead yield.

7. TU 8.1.3 (Field Command, Defense Atomic Support Agency) was to:

   a. Coordinate instructions for nuclear effects reporting and prepare such effects reports as required by the Defense Atomic Support Agency (DASA)

   b. Provide and coordinate documentary photography.

8. Task Unit 8.1.6 (Edgerton, Germeshausen and Grier) was to:

   a. Provide and operate the yield diagnostic instrumentation to be installed in Carbonero and Medregal to verify warhead yield

   b. Analyze the diagnostic data.

Safety Planning

FRIGATE BIRD operations focused on three areas, the launch hazard area, the nuclear hazard area, and the trajectory hazard sector. The launch hazard area was a circle with a radius of 100 nmi (185 km) centered on the launch point (12°32'N, 134°2'W). The nuclear hazard area was a circle with a radius of 120 nmi (222 km) centered on the intended surface zero (4°50'N, 149°25'W). The nuclear hazard area was in the northeast corner of the Christmas Island danger area, with its western half in the original danger area and its eastern half an extension made specially for FRIGATE BIRD (see Figure 73). Connecting the launch and nuclear hazard areas was the trajectory hazard sector, originating at the launch point and extending 4° on each side of the flight azimuth to a radius of 1,300 nmi (2,409 km).

CJTF 8 appointed a special group to study the safety aspects of the FRIGATE BIRD test. The results of the study were documented in a report dated 19 March 1962, titled "Safety Analysis, Polaris Operational Test Operation DOMINIC." This study is apparently no longer available and its authors cannot be identified. Consequently, its contents can only be inferred from the safety precautions actually taken.

FRIGATE BIRD was planned to detonate high enough so that its fireball would not touch the ocean surface. This prevented the involvement of seawater with device debris, which would have led to local fallout. Nevertheless, various measures were taken to ensure human safety.

The major objective of FRIGATE BIRD was to launch a Polaris missile under conditions as close as possible to wartime. For safety, however, several modifications were made to the four missiles that were to be available for the

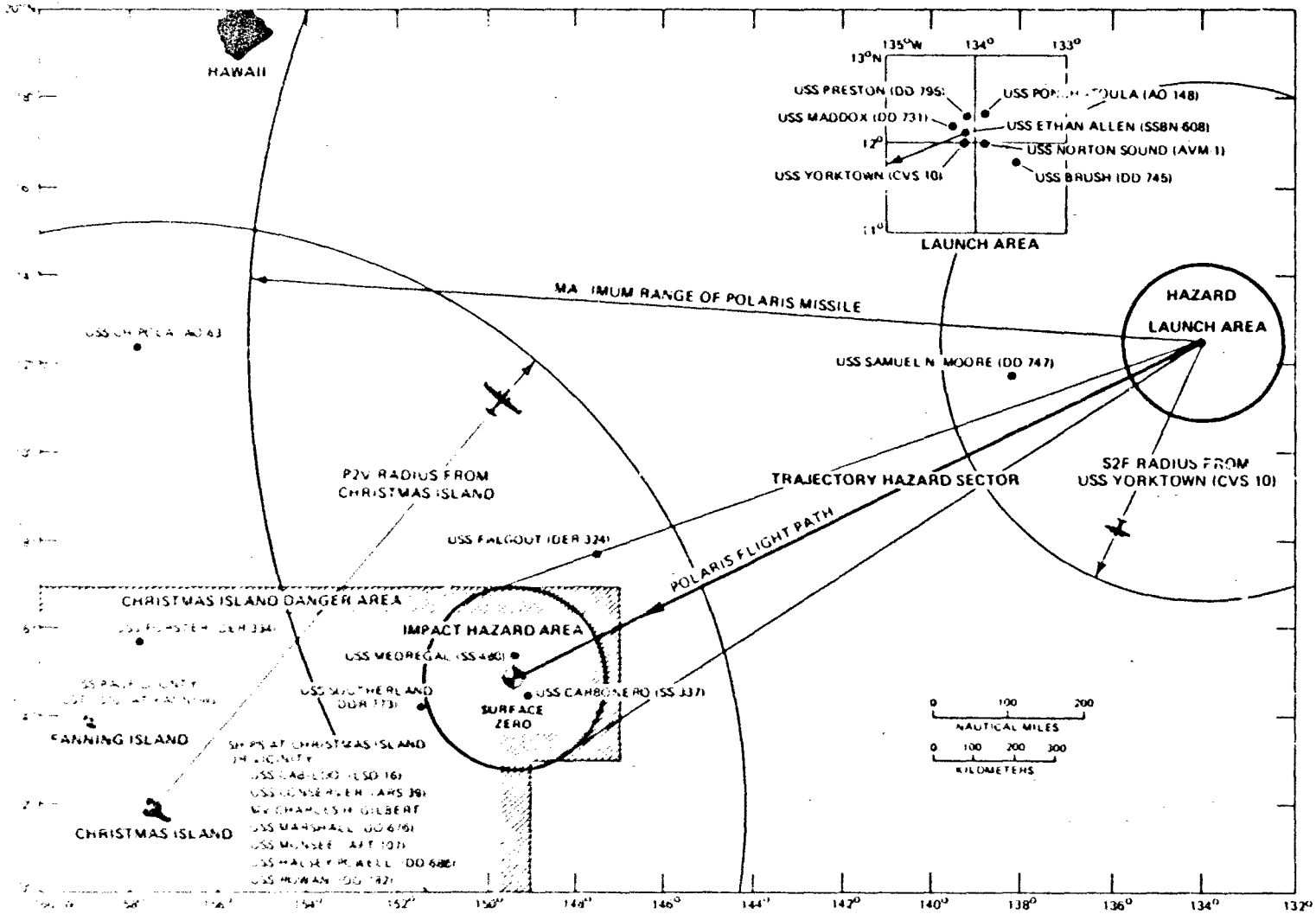


Figure 73. DOMINIC, FRIGATE BIRD operational area showing launch and impact hazard areas, trajectory hazard sector, and ship locations.

test, adding the tracking beacons and destruction systems and the batteries to power them. In addition, the missiles' surface detonation fuses were dismantled (Reference C.3.1, p. G-1-1). A detonation on the surface or below probably could produce heavy fallout, and this latter modification was intended to eliminate that possibility in case the airburst failed.

The planned launch point (12°32'N, 134°2'W) was selected so that the missile's longest possible flight would lead to an impact no closer than 5 nmi (8 km) from inhabited land (Reference B.8, p. A-3).

Five hazard areas were, in effect, specified. The nuclear hazard area, the launch hazard area, and the trajectory hazard sector have been described above. The booster impact area of 50 nmi (93 km) radius was within the launch hazard area and centered on the launch point. The malfunction impact limit lines originated tangent to the launch hazard area, extended 35° north and south of the intended flight path, and terminated at an arc 1,300 nmi (2,409 km) from the launch point. These lines and the 1,300-nmi (2,409-km) arc of the radius bounded a fifth hazard area, although it does not appear to have been referred to as such (Reference B.0.5 p. F-1).

Task force ships and aircraft were to patrol the nuclear, launch, and trajectory hazard areas. The missile was not to be launched if other than task force ships were in the launch or nuclear hazard areas or if unauthorized aircraft were in the air over the nuclear hazard area (Reference B.0.5, pp. F-2, F-13; Reference B.3.2, p. A-3).

Department of Defense (DOD) safety standards were used as the minimum criteria for evaluating the adequacy of nuclear safety for all activities performed during FRIGATE BIRD. These standards addressed arming and firing limits, not radiological safety. The DOD standards emphasized measures to prevent unauthorized or inadvertent arming, launching, or firing of the missiles. During any operation affording access to the missiles, a minimum of two authorized personnel had to be present. These personnel had to be capable of detecting incorrect or unauthorized procedures and be familiar with safety and security requirements. The number of persons with access to the missiles was to be kept to the minimum, consistent with the operations planned (Reference B.0.5, p. F-2).

Range safety was the immediate responsibility of the Missile Flight Safety Officer, stationed aboard Norton Sound. He had the authority and responsibility to terminate the flight by destroying the missile if any one of several situations arose (Reference B.0.5, p. F-3):

1. The tracking radar did not acquire the missile after it popped out of the water and started its powered flight downrange
2. The tracking radar lost contact with the missile
3. The missile flight path became such that the warhead would detonate outside of the nuclear hazard area.

For the conduct of FRIGATE BIRD, weather forecasts were needed for the launch, trajectory, and nuclear hazard areas. In addition, forecasts of en

route weather were needed for the aircraft based on Christmas Island and operating in or near the various hazard areas. Yorktown, Norton Sound, and Southerland were to launch and track weather balloons and take surface observations at regular intervals beginning 3 days before the shot. WB-50 weather reconnaissance aircraft, operating from Christmas Island, were to provide cloud surveillance information for the nuclear hazard area on shot day. Yorktown weather facility was to prepare the weather reports for operations in the launch hazard area. Joint Task Force Weather Central on Christmas Island was to prepare the forecasts for the nuclear hazard area (Reference B.0.5, p. E-1).

Operations

Movement of ships toward the launch area began on 16 April when Ethan Allen put to sea from Charleston, South Carolina. The submarine passed through the Panama Canal on 21 April and arrived in the launch area on 2 May. On 27 April the range safety ship, Norton Sound, sailed from Port Hueneme, California, with CJTG 8.3 aboard. On the same day Yorktown, in company with Brush, Maddox, and Hocre left Long Beach, California. Also on that day Preston left Long Beach separately. On 28 April Norton Sound rendezvoused with Preston and with Yorktown and her accompanying destroyers.

During the transit to the launch area, the elements of the task group practiced procedures required for a successful test. Yorktown and Norton Sound checked out and exercised Norton Sound's newly installed missile-tracking system. Two of Yorktown's S2Fs had been fitted with tracking beacons like those in the four test missiles. The aircraft flew missions to test the tracking system and to give system personnel practice in rapid acquisition of a target. Since the spot where the missile would emerge from the water would be known only approximately, the tracking personnel had to lock their radar onto the missile quickly, before it disappeared into the clouds. If they were unsuccessful, the Missile Flight Safety Officer was to order the destruction of the missile. In addition, Norton Sound's newly installed underwater telephone was tested in preparation for communication between the task group commander and the Missile Flight Safety Officer on board and the submerged Ethan Allen.

Yorktown, Norton Sound, and the destroyers arrived in the launch area on 2 May and rendezvoused with Ethan Allen. Falgout, Southerland, Carbonero, and Medregal arrived in the impact area on the same day (Reference C.3.1 pp. G-6 to G-9).

Communications problems plagued the rehearsal period. On 2 May the task force elements ran checks from test positions. Full rehearsals were conducted on 3 and 4 May. Personnel, ships, and aircraft appeared ready, but adequate communications between Norton Sound and Hq JTF 8 on Christmas Island could not be maintained. The communications problems had two major sources: (1) electromagnetic propagation anomalies present in the test area during the planned predawn launch time and for several hours thereafter, and (2) interference from other Pacific Fleet transmissions. While seeking a solution, the task group commander delayed the Polaris launch from 5 to 6 May. A two-part solution was worked out in which the launch was set for a later hour in the day and all Pacific Fleet transmissions on certain frequencies were halted, giving exclusive use to JTF 8 (Reference C.3.1 pp. G-10 and G-11).

Despite the prospect of marginal weather at both launch and impact areas, the detonation was set for 1100 on 6 May. About 1016, a 1-hour hold was ordered in anticipation of showers that could rain out radioactive material on fishermen near the nuclear hazard area. Search planes used the hold to further check on the fishermen's location and WB-50s continued charting the weather developments. Two 30-minute holds caused by the same problem followed at 1124 and 1200, pushing detonation time back to 1300. Various minor technical problems aboard the submarine, the need to reposition the sampler aircraft, and clouds in the launch area pushed back the launch still further. Finally local weather reconnaissance near the launch area indicated that at about 1417 a break in the clouds would occur for launch and detonation downrange at about 1430. At 1417:49 the missile was launched, and its warhead detonated in the air over the nuclear hazard area at 1430:16 (Reference C.3.1, pp. G-11 and G-12). Figures 74 and 75 show the missile on its upward flight, and Figure 76 shows the FRIGATE BIRD cloud.

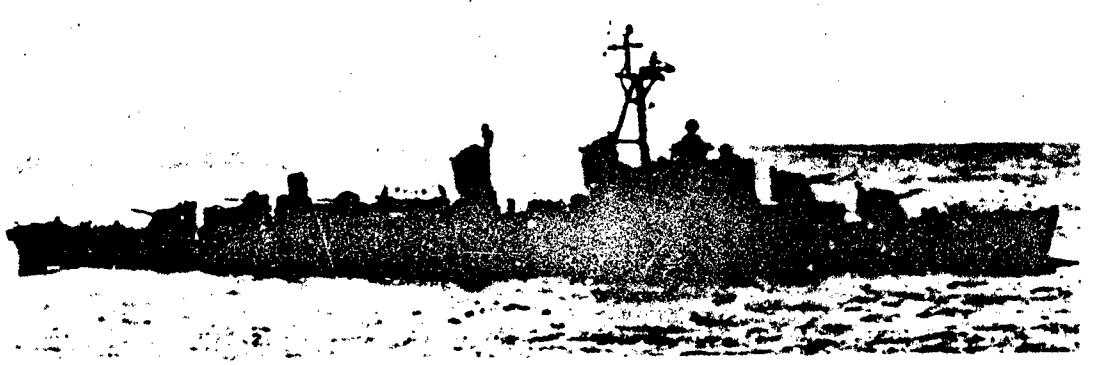


Figure 74. FRIGATE BIRD Polaris launch viewed from helicopter; USS Maddox (DD-731) in foreground, DOMINIC.

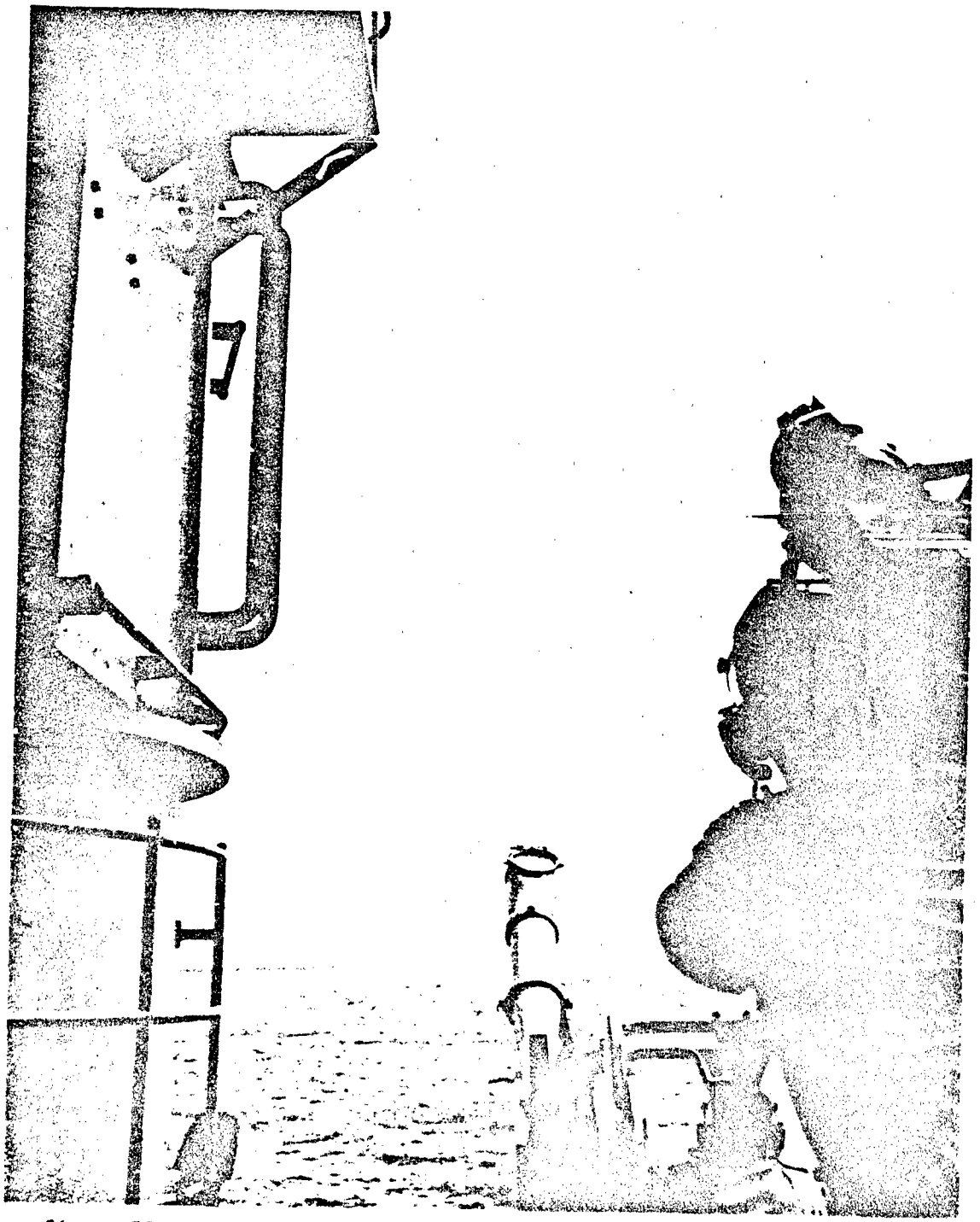


Figure 75. FRIGATE BIRD Polaris launch viewed from USS Maddox (DD-731), DOMINIC.

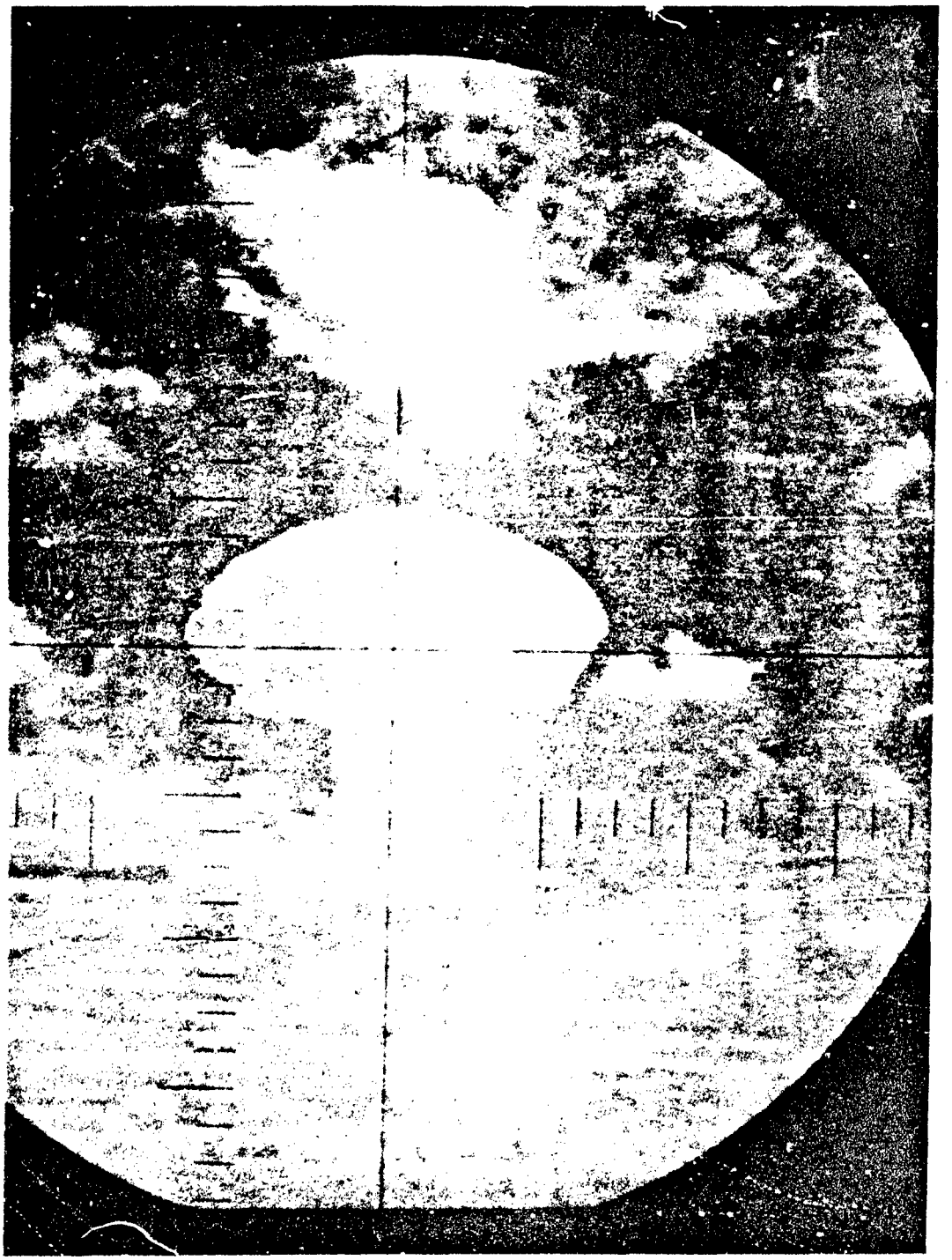


Figure 76. FRIGATE BIRD cloud as viewed through the periscope of USS Carbonero (SS-337), DOMINIC.

There was no experimental program as such on FRIGATE BIRD, although as part of the proof test of the system yield, measurements were made. These yield measurements were made by optical instrumentation in the submarines and aircraft and by cloud sampling aircraft. The sampling aircraft were B-57s based at Christmas Island. Cloud sampling began at H+70 minutes and continued for almost 2 hours (Reference D.6). Samplers and sampler control aircraft were probably not in the vicinity of the burst at burst time.

Documentary photography from a C-54 aircraft was planned, but there is no evidence that this took place.

The possibility of exposure to personnel on surface ships or aircraft in the area of the launch appears to have been nil. Of the ships present, only Norton Sound did not participate in any other test during DOMINIC, so only the badge readings from that ship can be attributed solely to FRIGATE BIRD activities. Three hundred and thirty-five men were badged on Norton Sound, but only one of the badges is recorded as showing any exposure and that was 0.038 R, an extremely low reading.

The deck logs of the four ships at the impact end of the test range mention no fallout. None of the badges issued to crewmembers of Medregal show radiation exposure and less than 10 percent of Carbonero badges show any; the maximum was about 0.021 R. The submarines, of course, were submerged at detonation time, but they surfaced later and rendezvoused with Southerland to transfer technical personnel, instruments, and exposed film to the latter ship. Because Falgout and Southerland participated in other shots during DOMINIC, radiation exposure to their personnel from FRIGATE BIRD cannot separately be identified.

The crews of the aircraft from JTG 8.4 participating in cloud sample collection over the impact area had potential for exposure. The Air Force 1211th Test Squadron provided the sampler planes and flight crews, and during the long return flight to Christmas Island (525 nmi [973 km]) the crews would have been exposed to the radiation emitted by weapon debris that may have stuck to the B-57 during the cloud penetration.

CHAPTER 6

SWORDFISH

INTRODUCTION

SWORDFISH, the fifth U.S. underwater nuclear test, was the detonation of a Navy nuclear antisubmarine rocket (ASROC). The ASROC is essentially a nuclear depth charge attached to a missile. On 11 May 1962, USS Agerholm (DD-826), steaming in an area about 370 nmi (about 685 km) west-southwest of San Diego, California, fired the ASROC at a target raft about 4,000 yards (3.7 km) distant. The target raft and the warhead detonated below the surface at 1302 local time, coordinates 31°14.7'N, 124°12.7'W.

Joint Task Group 8.9 (JTG 8.9), a subordinate organization of Joint Task Force 8 (JTF 8), conducted the SWORDFISH test. The task group was organized solely for the test, and it was made up of 19 ships, 2 submarines, some 55 naval aircraft, and 5,180 men, both civilian and military, drawn from the joint task force and other organizations as required (Reference C.1.D, p. B-2).

DEPARTMENT OF DEFENSE TASK GROUP SUPPORT

The Joint Chiefs of Staff (JCS) had directed the Commander JTF 8 (CJTF 8) to conduct an underwater nuclear weapon test using the ASROC, and he in turn had assigned the task to CJTG 8.3, the naval element of the joint task force. The staff of CJTF 8 did much of the initial planning for SWORDFISH. On 3 March 1962, CJTG 8.3 established Task Unit 8.3.4 (TU 8.3.4) to complete the planning for the test. JTG 8.9 was activated on 25 April as an additional command of CJTG 8.3. JTG 8.9 included all the JTG 8.3 assets assigned to the operation, plus elements of other commands as required (Reference C.1.D, p. B-6).

The organization of JTG 8.9, with participating units listed, is outlined below (Reference C.1.D, pp. B-4 through B-6 and B-12; Reference B.9, pp. 1-3):

JTG 8.9	CJTG 8.3 in his role as CJTG 8.9
TU 8.9.1	Operation SWORDFISH Test Directorate
TE 8.9.1.1	VELA Project Elements: USS Tawakoni (ATF-114), USS Arikara (ATF-98), USS Lipan (ATF-85), USS Cree, USS Gannet (MSC-290), and Chilean ATF Yelco
TE 8.9.1.2	Weather Reconnaissance Element: Patrol Squadron 46 (VP-46)
TE 8.9.1.3	Technical Photography Element: Detachment 35, Heavy Photographic Squadron Sixty-Two; (VAP-62); Marine Aircraft Repair Squadron 37; (MARS-37); and TU 8.3.6 (Mobile Photographic Unit, Pacific)
TE 8.9.1.4	Oceanographic Reconnaissance Element: USS Sioux and USC&GSS Pioneer

TE 8.9.1.5 Radiological Safety

TE 8.9.1.6 Submarine Training Element USS Sea Fox (SS-402)

TU 8.9.2 Scientific Unit

TE 8.9.2.1
TE 8.9.2.2 Naval Ordnance Laboratory (NOL)

TE 8.9.2.3 Naval Electronic Laboratory (NEL)

TE 8.9.2.4 Naval Radiological Defense Laboratory (NRDL)

TE 8.9.2.5 David Taylor Model Basin (DTMB)

TE 8.9.2.6 Bureau of Ships (BuShips)

TE 8.9.2.7 Edgerton, Germeshausen & Grier, Inc. (EG&G)

Other participating scientific organizations:

Woods Hole Oceanographic Institution (WHOI)

Texas A&M College

Office of Naval Research (ONR)

U.S. Coast and Geodetic Survey (USC&GS)

TU 8.9.3 SWORDFISH Operational Unit

TE 8.9.3.1 Weapon and Sonar System Test Element: Agerholm (with Commander Destroyer Squadron 5 embarked), USS Richard B. Anderson (DD-786), USS Hopewell (DD-681), USS Razorback (SS-394) (with Commander Submarine Division 51 embarked), and Sea Fox

TE 8.9.3.2 Towed Array Streaming Element: USS Monticello (LSD-35) with Marine Corps Medium Helicopter Squadron 363 (HMM-363) aboard, USS Bausell (DD-845), and USS Holala (ATF-105)

TE 8.9.3.3 Surveillance Element: USS Yorktown (CVS-10) (with Commander Carrier Division 19 embarked), carrying the Carrier Antisubmarine Warfare Group (Anti-Submarine Squadrons 23 and 25, Helicopter Anti-Submarine Squadron 4, and Carrier Airborne Early Warning Squadron 11); USS Maddox (DD-731) (with Commander Destroyer Division 232 embarked), USS Brush (DD-745), USS Samuel N. Moore (DD-747), and USS Preston (DD-795).

The role of the Army and Air Force in SWORDFISH appears to have been limited to a few individuals. No units of either service have been identified.

Participating personnel by branches of service or other major organizations were as follows (Reference C.1.D, pp. B-5 and B-6):

Navy	4,935
Marine Corps	30
Army	1
Air Force	15
Coast & Geodetic Survey	40
Chilean Navy (estimated)	75
Project civilians	84
Total	5,180

TEST OBJECTIVES

SWORDFISH was both a weapon system test and a weapon effects test. ASROC was rapidly coming into the Navy's weapons inventory and was programmed for wide deployment. A successful firing of an ASROC missile would prove the system in the hands of regular Navy crew under conditions similar to those that might be met in antisubmarine warfare.

The weapon effects program was designed, first, to gather data on the effects of an underwater nuclear explosion (both on the target and on the ships of an antisubmarine surface attack unit) and, second, to gain additional basic data on the phenomenology of underwater nuclear explosions and their effects.

The SWORDFISH scientific director divided the ASROC's effects geographically into two classes, onsite and offsite, offsite effects being those at more than 12 nmi (22.2 km) from surface zero. The experimental program strongly emphasized measurement of onsite effects to aid in rapid development of tactics for ASROC use against submarines. The SWORDFISH test was to help determine (Reference C.1.D, p. B-2; Reference C.2007, pp. 3-4):

1. The minimum delivery range that would leave the attacking destroyer's sonar in sufficiently good condition to permit an immediate second attack
2. The minimum range at which an attack could be launched and leave the destroyer's mobility intact, but risking casualties and damage to equipment
3. The restrictions imposed by radioactivity on the destroyer's subsequent maneuvers
4. The safe standoff distance for a submerged submarine launching an ASROC
5. The degree to which information from standard Navy high-explosive shock tests could be extrapolated to nuclear explosions.

Offsite experimental projects were designed to:

1. Investigate blast effects on strategic hydroacoustical systems

2. Improve the theoretical understanding of long-distance propagation of hydroacoustical signals and hence the ability to detect underwater nuclear explosions

3. Investigate the drift and diffusion of radioactive material created by the explosion and its influence on marine life.

TEST SITE SELECTION

A satisfactory test site required weather and physical characteristics that would permit maximum data collection. Moreover, it needed to be relatively isolated for protection of those not involved in the test and to minimize unauthorized observation. Of major importance in the SWORDFISH experimental program was unimpeded propagation of the shock wave and its reflection from the sea floor with a minimum of distortion and absorption so that both the direct and reflected shock waves would hit the hulls of JTG 8.9 ships. Consequently, test organizers looked for deep water over a fairly flat bottom, relatively free from sediment. The location also needed to be away from commercial fishing. Test planners feared a detonation in a commercial fishing area would result in catches with detectable levels of radioactivity (Reference C.2007, p. 73).

Initially, SWORDFISH was planned for an area between Johnston and Christmas islands. However, because of commercial fishing there, planners shifted their attention to the general area of the WIGWAM test in 1955. The location finally selected was somewhat to the north and east of the WIGWAM site. It met the criteria of weather, bottom configuration, water depth, and isolation. Pioneer mapped a section of the bottom in detail, planting a marker buoy designated Point Alpha (Reference C.2007, p. 73).

TEST ARRAY

SWORDFISH was distinguished from previous underwater tests in that the target array included active fleet ships equipped with modern weapons at distances from surface zero close enough to be considered tactically significant. Initially, the planners had hoped to have post-World War II destroyers and submarines, perhaps even a nuclear submarine, be part of the target array. They had to settle, however, for three modernized World War II destroyers equipped with ASROC (Agerholm, Anderson, and Bausell) in addition to the destroyer Hopewell and submarine Razorback, both also of World War II vintage.

The target-array elements were both towed and under their own power. Proceeding under their own power were Agerholm, Anderson, Hopewell, and Razorback, all instrumented to record various data. Anderson also served as the backup firing ship in case Agerholm was unable to launch its ASROC. Hopewell and Razorback were in the array primarily to play a role in the sonar experiments. Several other ships in the area of the detonation were instrumented, but they were not counted in the target array.

The towed portion of the array was used to position the ASROC target raft and many instruments. The ocean fleet tug, Molala, slowly pulled a buoyant polypropylene tow line just over 6 miles (10 km) long. The relatively light

weight of this tow line facilitated handling, and its buoyancy prevented it from dragging the instrument stations out of position (Reference C.2006, p. 47). The line was in sections so that it could be stored on reels of manageable size. At intervals along the line when it was streamed out behind Molala were eight instrumented coracles, two instrumented platforms, the unmanned destroyer (Bausell), the target raft, and a raft called the tar barrel, or smoke barrel, to mark the end of the tow line.

The type of coracle used in the towed array was a round fiberglass buoy with springs suspending its top and attached instrument well from its hull (Figure 77) (Reference C.2004, pp. 22 and 23).

TEST PREPARATIONS

From 19 April to 7 May 1962, men and equipment of JTG 8.9 were assembled in San Diego, California, with task group headquarters established at the Naval Repair Station, San Diego preparations for operations at the test site involved four major efforts: (1) construction of the towed array, (2) shipboard

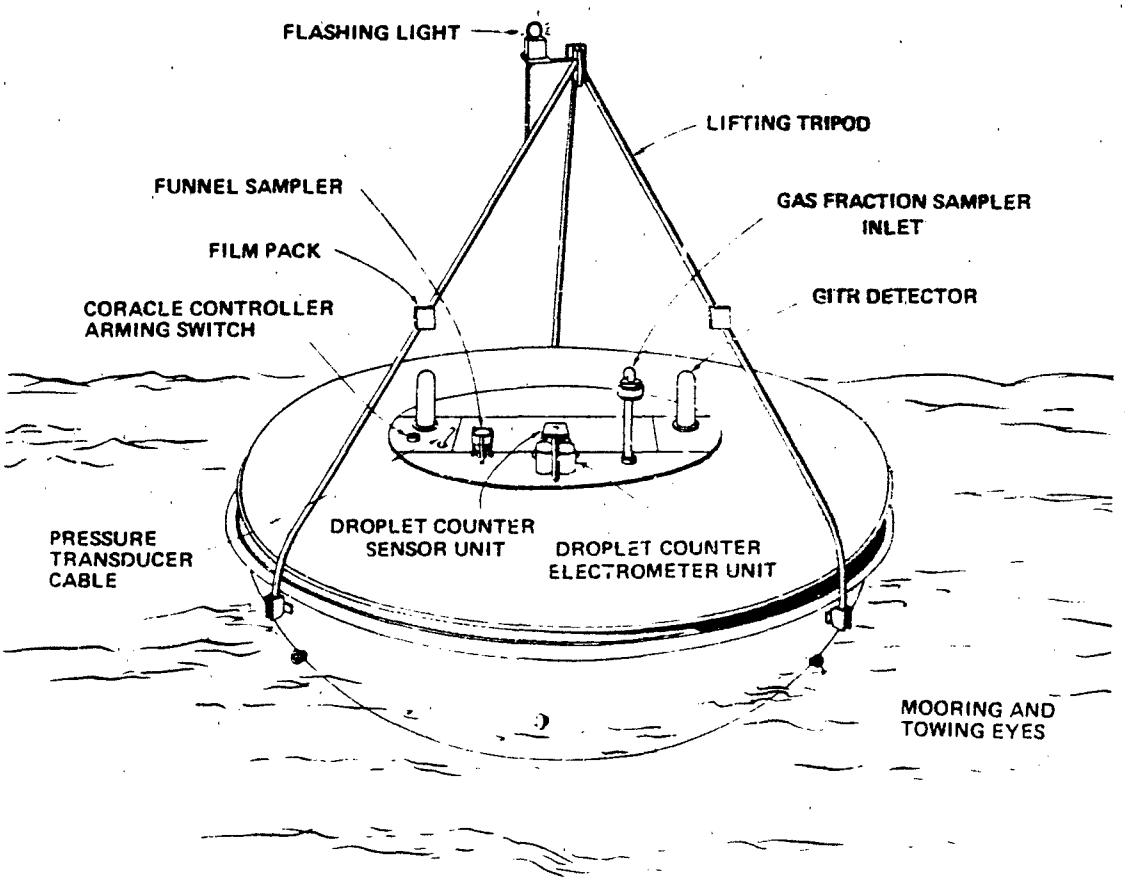


Figure 77. Coracle used for DOMINIC, SWORDFISH.

installation of project equipment, (3) ship inspections, modifications, and repairs, and (4) rehearsals at sea (Reference C.2007, pp. 78-79).

Two rehearsals with all units except the surveillance group were conducted in a training area near San Diego. The seaworthiness of the towed array was verified. Ships' crews were trained in required maneuvers. The timing system was tested, as was the scheme for coordinating the ASROC launch with the position of the aircraft over the surface zero (Reference C.2007, p. 80; Reference C.1.D, p. B-9).

SAFETY PLANNING

To provide for nuclear safety at peacetime test standards, CJTG 8.3 convened a safety committee of technical experts to examine every aspect of the potential nuclear hazard and to report to the task force commander and the Atomic Energy Commission (AEC). In a 26 March 1962 memorandum to CJTF 8, the committee reported that the test plans assured adequate safety. The test plans as approved by the committee assessed the risks of a wild missile or of a premature detonation close to the firing ship so small as to be accepted without special precautions. Because the ASROC warhead was to explode well below the surface, the water would absorb much of the blast energy. Nevertheless, two situations had to be considered in which the shock wave produced by the detonation would be a danger to the task group: (1) a major error in the missile's range or bearing, and (2) a detonation above the surface or at a shallow depth (Reference C.1.D, p. B-7; Reference C.2007, pp. 52-54).

To reduce the risk to an acceptable level, all ships were excluded from a zone extending from minimum to maximum delivery range and about 20° on each side of the line of fire. Although the chance of premature detonation was extremely small, guidelines were established to minimize the risks to personnel as well as to give further protection in case of a range or bearing error (Reference C.2007, pp. 53-55):

1. Shortly before launch all personnel except those needed for the test were to go below decks
2. Just before launch, topside personnel without high-density goggles were to turn away and keep their eyes closed until the ASROC's entry into the water was verified
3. Helicopters were to keep at least 9,000 yards (8.2 km) from the target raft
4. Aircraft directly above the target raft were to maintain an altitude of at least 18,000 feet (5.5 km)
5. All other aircraft were to stay at least 7,500 yards (6.9 km) from the target raft
6. The task group was to have the capability for predicting the fallout pattern of an accidental airburst to aid the ships in avoiding contamination.

Past underwater nuclear tests had revealed the base surge as a major potential source of radiological exposure. The SWORDFISH detonation would produce a

large base surge if it occurred approximately when and where planned. Consequently, the following guidelines were adopted to minimize personnel hazards from transient radiation borne by the base surge. Again range and bearing errors were a factor in the calculations (Reference C.2007, pp. 55-57):

1. No manned surface units were to be in a downwind semicircle, 90° to 270° from the expected surface zero.
2. No manned stationary units upwind were to be closer than 4,000 yards (3.7 km) and none crosswind closer than 5,000 yards (4.6 km) from the projected surface zero.
3. If wind speed were less than 8 knots (14.8 km/hr), close-in ships were to "maneuver appropriately." The meaning of this is not made clear in the source documents, but perhaps those in charge feared that too light a wind would allow the base surge to spread further upwind and crosswind than would be the case with a stronger wind.
4. The test would be delayed if the wind were less than 3 knots (5.6 km/hr).

During the buildup phase, four major tasks affecting radiation safety were completed: (1) writing of a radsafe annex for the SWORDFISH Operation Order, (2) procurement of instruments and equipment, (3) selection of qualified radsafe personnel, and (4) indoctrination and training of task group personnel (Reference C.2007, p. 226).

Although chances of a runaway missile or of a premature detonation were very small and the danger from the base surge could be handled fairly well by careful positioning of the ships, several postshot activities posed potentially formidable problems in radiological safety. Instruments had to be recovered from the various platforms and coracles. Water samples had to be obtained from the contaminated pool, the earlier the better, to determine device performance, and the radioactive pool had to be tracked.

The following exposure limits were set for the SWORDFISH operation (Reference B.9, p. R-I-1):

1. The Maximum Permissible Exposure (MPE) for personnel who had not reached their nineteenth birthday was not to exceed 1.25 R (gamma plus neutron)* in 13 consecutive weeks
2. The MPE for individuals who had reached their nineteenth birthday was not to exceed 3.0 R (gamma plus neutron)* in 13 consecutive weeks
3. At no time was an individual's cumulative lifetime exposure to exceed an amount determined by (N - 18) x 5 R, where N is the age of the individual in years at his last birthday

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* Such limits are usually given as gamma plus beta rather than gamma plus neutron; however, the source document clearly gives beta plus neutron.

4. No individual without a specific waiver was to be exposed to radiation unless he had reached his eighteenth birthday.

Film badges and standard Navy radiation exposure forms were issued for all project personnel, ships, and aircraft assigned to participate in or observe SWORDFISH. The badges were to be worn at all times once issued (Reference B.9, p. R-4).

Standards were set for maximum levels of radiological contamination on the skin and clothing of task group personnel. Standards were also set for the amount of radiological contamination allowed to collect in the evaporators used aboard ship to produce fresh water before consumption of the water was prohibited (Reference B.9, pp. R-6, R-I-1 and R-I-2).

Although the chance of an airburst was small, commanding officers were enjoined to ensure that all personnel within view of the burst turn away from the detonation point, close their eyes, and cover their eyes with their forearms to protect themselves from retinal burns. All hands not needed on deck were to be sent below and ordered to keep away from the portholes until after the blast (Reference B.9, p. R-7).

A radiological exclusion (radex) area was defined as an area with a radiation level of 0.010 R/hr gamma or 1,000 counts per minute (CPM) alpha per 55 cm^2. No individual with a total exposure of 2.5 R or greater for the preceding 13 weeks would be allowed to enter a radex area without the permission of the radsafe officer. No person was to enter an area with a radiation exposure rate exceeding 10 R/hr (Reference B.9, pp. R-7 and R-I-1). The towed array was automatically considered a radex area regardless of its radiation level.

All personnel enteting or leaving the towed array were to be processed through the decontamination center established on Monticello. Before going to the array, members of a recovery party were to receive protective clothing, radiation detection instruments, and the latest radex information from the center's radsafe staff. At least one radsafe monitor was to accompany each recovery party. Upon returning from the array, personnel were to be checked for contamination, decontaminated if necessary, and turn in their equipment. No contaminated clothing was to be worn in clean areas of the ship (Reference B.9, pp. R-7 and R-I-3).

Equipment from the target array brought aboard Monticello was to be placed in predesignated storage areas following decontamination if feasible. No equipment was to be worked on or removed from a contaminated storage area without permission from the task group radsafe officer or his representative. No equipment was to be released from the contaminated storage areas with removable contamination or exposure rates exceeding the established limits. Just what these limits were, however, is not clear (Reference B.9, pp. R-7, R-8, and R-I-4).

Good weather was vital to successful completion of the test. The following criteria for acceptable weather were established:

- Sea surface. Crest-to-trough wave heights less than 8 feet (2.4 meters)
- Surface winds. Steady with speed below 18 knots (33.4 km/hr), but not less than 3 knots (5.6 km)
- Cloud cover. Less than half the sky covered up to 20,000 feet (6.1 km) altitude.

Safety considerations required that fallout predictions be made to guide ship escape maneuvers in the event of an airburst. This required frequent, planned weather observations up to 20,000 feet (6.1 km) (Reference C.2007, p. 62).

On board Monticello the task group had its own weather forecasting unit, consisting of one officer and two enlisted men. They received data and forecasts from the U.S. Fleet Weather Facility. Daily weather reconnaissance flights were flown in support of SWORDFISH by VP-46 from Naval Air Station North Island, San Diego, California. Pioneer made regular surface observations and gathered data by radiosonde and pilot balloon. Sioux transmitted information from Point Baker (34°N, 126°W). Yorktown made radar wind balloon observations (Reference C.2007, pp. 214-216).

The usual need to keep unauthorized ships and aircraft away from the test area was increased during SWORDFISH by the decision to test without prior public announcement of a danger zone. Yorktown's Combat Information Center and aircraft probably bore the major burden of the surveillance effort. Surveillance for surface contacts was to extend to a radius of 50 nmi (92.6 km) and for air contacts to a distance of 100 nmi (185 km) from the planned detonation point (Reference C.2007, p. 64).

TEST OPERATIONS

On 4 May the task group units began departing San Diego for the test area, with the majority departing 7 May. The surveillance unit (Yorktown, Brush, Preston, Maddox and Moore) that was to assist in SWORDFISH also took part in FRIGATE BIRD about 1,250 nmi (about 2,315 km) south-southwest of the SWORDFISH test area. The Polaris test was conducted on 6 May, at which time the surveillance unit steamed for the SWORDFISH site. Aboard Yorktown was CJTG 8.3, who had served as CJTG 8.8 conducting the Polaris test and who was scheduled to head JTG 8.9 for SWORDFISH. Early on 9 May, all units other than those assigned to distant stations had assembled in the test area for pretest conferences and preparations. Commander JTG 8.3, now in his role as Commander JTG 8.9, transferred to Monticello (Reference C.1.D, p. B-11).

SWORDFISH was planned for 10 May, but marginal weather and a series of minor technical problems on Agerholm and on the lead A3D aircraft caused postponement of the event for that day and its rescheduling for the next.

The positions of the ships, aircraft, and towed array at shot time are shown in Figure 78. The projects that each participated in are also indicated in Figure 78. Positions of the ships, instrument stations, and aircraft are tabulated in Tables 17 and 18. Surface zero, the point directly above the

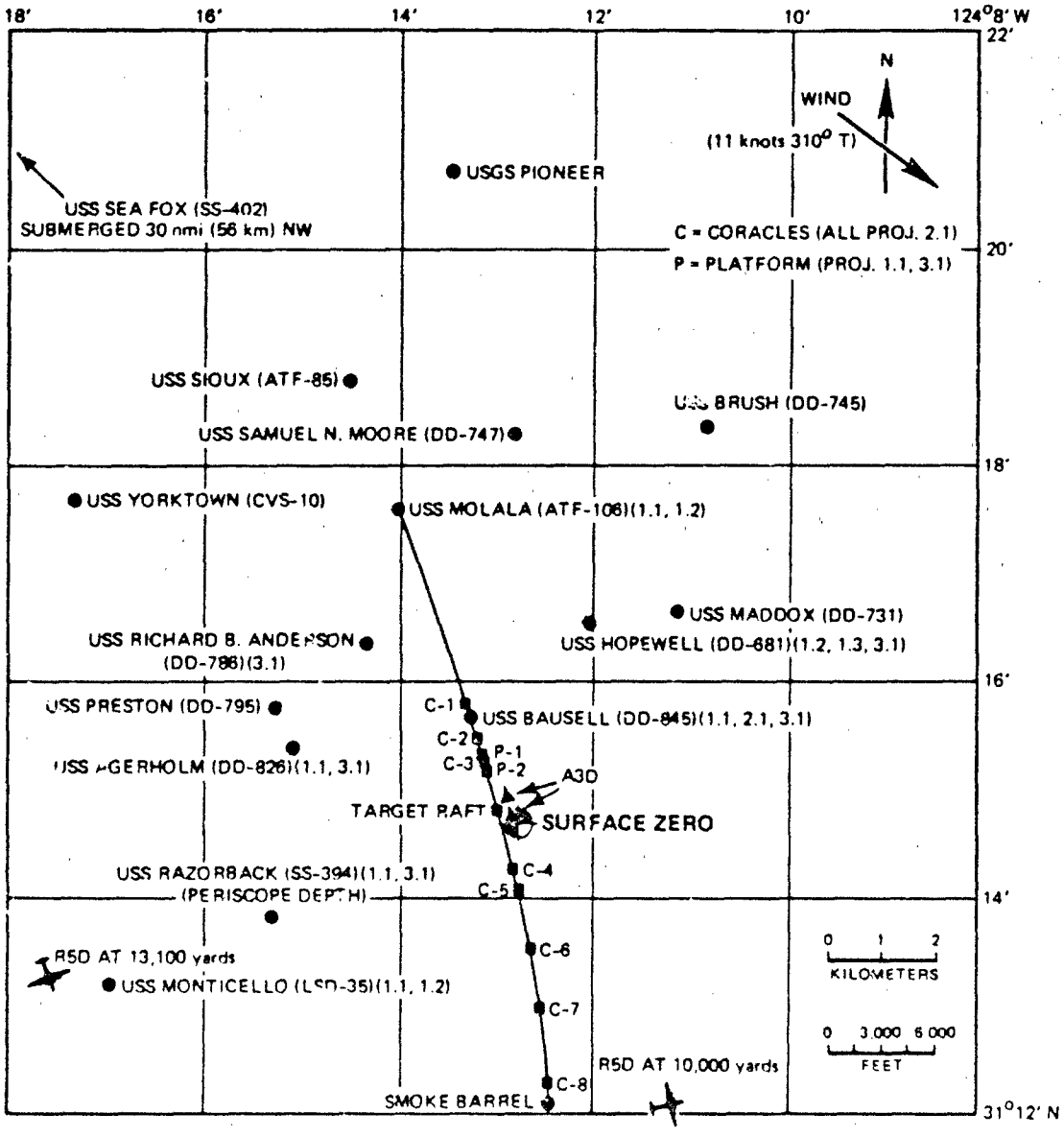


Figure 78. Positions of DOMINIC, SWORDFISH task group elements at shot time (source: Reference C.2007, p. 95).

Table 17. Positions of task group ships at shot time relative to surface zero, DOMINIC, SWORDFISH.

Array Element	Range[a] (yards)	Range[a] (km)	Bearing (degrees)
USS Bausell (DD-845)	2,200	0.671	338
USS Agerholm (DD-826)	4,348	1.325	298
USS R.B. Anderson (DD-786)	4,150	1.265	325
USS Sioux (ATF-75)	8,650	2.637	342
USS Hopewell (DD-681)	4,200	1.280	21
USS Razorback (SS-394)	4,600	1.402	251
USS Monticello (LSD-35)	7,940	2.420	250
USS Molala (ATF-106)	6,250	1.905	341
Platform 1[b]	1,427	0.435	335
Platform 2[b]	1,040	0.317	332
Target Raft[b]	348	0.106	306
Coracle 1[b]	2,475	0.754	337
Coracle 2[b]	1,771	0.522	337
Coracle 3[b]	1,393	0.425	335
Coracle 4[b]	810	0.247	181
Coracle 5[b]	1,190	0.363	176
Coracle 6[b]	2,297	0.700	171
Coracle 7[b]	3,447	1.051	169
Coracle 8[b]	4,930	1.503	168
Smoke Barrel[b]	5,230	1.594	167
USC&GSS Pioneer	12,600	3.840	356
USS Preston (DD-795)	4,700	1.433	300
USS Yorktown (CVS-10)	9,850	3.002	309
USS Brush (DD-745)	8,050	2.454	2
USS C.N. Moore (DD-747)	7,170	2.185	1
USS Maddox (DD-731)	4,800	1.463	36
Position buoy	3,120	0.951	126
Position buoy[b]	3,447	1.051	169
Position buoy	3,250	0.991	157

Notes:

[a]Position determined by radar except as noted.

[b]Position determined by aerial photography.

Source: Reference C.2007, pp. 97-98.

Table 18. Positions of aircraft relative to surface zero, DOMINIC, SWORDFISH.

Aircraft Type	Location Relative to Surface Zero
A3D	Altitude 20,000 feet (6.1 km), heading 330°T, 3,200 feet (975 meters) beyond surface zero
A3D	Altitude 20,000 feet (6.1 km), heading 330°T, 1,100 feet (335 meters) beyond surface zero
R5D	Circular flight path; altitude 10,000 feet (3.0 km), 31,300 feet (9.54 km) horizontal range, bearing 150°T
R5D	Circular flight path; altitude of 10,000 feet (3.0 km), 35,700 feet (10.89 km) horizontal range, bearing of 250°T

detonation, was about 350 yards (320 meters) southeast of the target raft. The rocket was fired from Agerholm (Figure 79) and entered the water a few yards closer to the target raft along the line of fire.

Hopewell's speed was about 4 knots (7.4 km/hr). Equipment shown in Figure 78 but not listed in Table 17 were the unmanned Project 1.3 submarine simulators and the Project 1.1 sonobuoys. The submarine simulators were submerged from 50 to 100 feet (15 to 30 meters) and traveling as indicated by the dashed lines in Figure 78. The black dot at the end of each dashed line indicates the approximate position of each of the simulators at detonation time. The sonobuoys were positioned in a line due west of the target raft. The sonobuoys' general position is indicated by the wavy lines on the left of Figure 78. All ships except Hopewell were essentially stationary, with speeds of 1 knot (1.85 km/hr) or less.

About 40 seconds after the ASROC missile was launched, its nuclear depth bomb exploded. A small fraction of a second after the burst, the slick, a rapidly expanding ring of darkened water at the intersection of the expanding spherical shock wave and the water surface, became visible to aircraft over the surface zero. Initially the slick had a well-defined edge but became diffuse as the radius increased (Reference C.2001, p. 61). In less than 1 second, the spray dome appeared, and within about 6 seconds its radius was nearly 1,000 yards (914 meters) and the spray dome reached a height of almost 750 feet (229 meters) (Figure 80). Radial water plumes broke through the spray dome about 7 seconds after the burst, reaching a maximum height of about 2,100 feet (640 meters) in 16 seconds. The plumes were the first radioactive material to appear above the water surface. As the spray dome and plumes fell back toward the water's surface, they formed the base surge, a flat doughnut-shaped cloud moving outward from the point where the spray dome had broken the surface. The base surge consisted of small water droplets and was radioactive. About 110 seconds after the detonation, the base surge reached its maximum upwind and crosswind distance of about 2,000 yards (1.8 km) from surface zero. At that time it

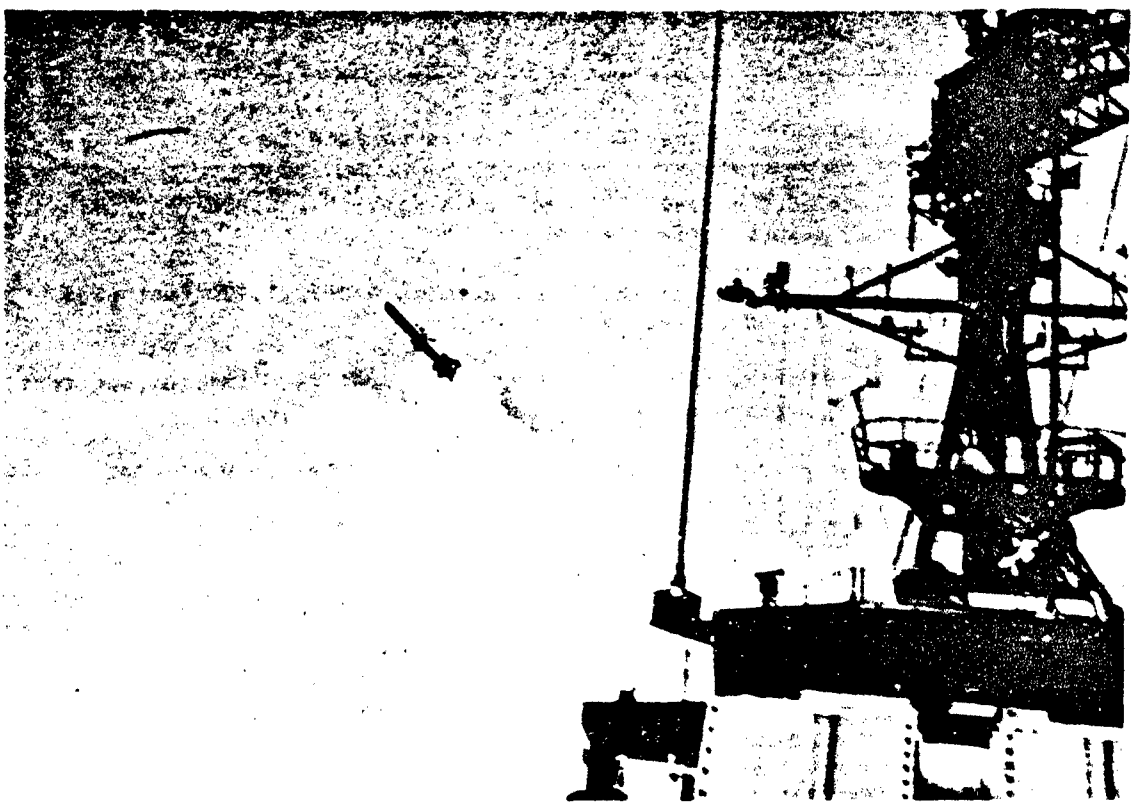


Figure 79. SWORDFISH ASROC missile launch from USS Agerholm (DD-826), Operation DOMINIC.



Figure 80. DOMINIC, SWORDFISH spray dome and plume with USS Agerholm (DD-826) in the foreground.

extended about 2,500 yards (2.3 km) downwind. The base surge remained visible for about 10 minutes, but it persisted as an invisible aerosol for at least 20 minutes (Figure 81). The foam patch visible on the surface as the base surge dispersed and evaporated had a radius of about 2,000 yards (1.8 km), about the same as the base surge except for its downwind extension. The foam patch remained visible from the air for several hours (Figure 82) (Reference C.1.D, pp. B-13 and B-16). Figure 83 is a plan view of the foam patch and base surge after 5 minutes.

Movements of Razorback, Agerholm, Anderson, and Hopewell for up to three-quarters of an hour after the shot are shown in Figure 84. Monticello and Molala moved very little. The upwind portion of the towed array, including Bausell, moved very little because it was still attached to Molala. The downwind portion of the towed array, consisting of a length of tow line and coracles 5, 6, 7, and 8, drifted southeast with the current. Coracle 4 and probably the target raft had become detached from the tow line. An RD5 aircraft from the Third Marine Air Wing apparently made the first effort to investigate the SWORDFISH radioactivity by flying over the pool of radioactive water at 3,000 feet (914 meters) 15 minutes after the shot. The radiation exposure rate "exceeded 50 r per hour." At 50 and 60 minutes after the shot, the aircraft flew over the pool at 1,500 feet (457 meters), detecting an exposure rate of 0.8 R/hr. Corrected for altitude attenuation, this does not correlate with the predicted values or those obtained by Sioux, but the record does not explain further. After returning to base at El Toro, California, the aircraft was monitored and no contamination was detected. The highest individual exposure reading among these crews was 0.149 R (Reference C.2007, p. 230).

Next to investigate the pool of radioactive water was Sioux, tasked, as part of Project 2.1, to collect water samples suitable for radiochemical analysis of the weapon's yield.

Preshot calculations by NRDL indicated the possibility of a radiation level of 1,000 R/hr near the surface of the pool 30 minutes postshot. Given certain assumptions about the mixing of the radioactive water with normal seawater, this level might decrease to 100 R/hr 1 hour after the shot and to 3 R/hr 2 hours after the shot. If the radiation level decreased at that rate, too long a delay in entering the pool could make it impossible to collect adequate water samples. Therefore, it was decided to approach the pool cautiously 30 minutes after the detonation (Reference D.5, Appendix 1, p. 2).

At 1310, with all personnel wearing protective clothing, all openings to the weather decks closed except two, and a variety of radiation detectors at the ready, Sioux, with crew reduced to 15, steamed toward the pool at 10 knots (18.5 km/hr). At 1318, with the pool about 2,000 yards (1.8 km) distant, the radiation level on the bridge began to rise from 0.0004 R/hr, and in the next few minutes, the rise accelerated. The ship's speed was 3 knots (5.6 km/hr). At 1321 the ship was at the edge of the pool. With the radiation reading on the starboard wing of the bridge at 0.300 R/hr and rising rapidly, the ship was advised to leave the pool. During the turning maneuver, the ship penetrated about 200 yards (183 meters) into the pool. The exposure rate rose to an estimated 1,000 R/hr, and one water sample was collected. Radiation levels decreased steadily as the ship proceeded away from the pool at flank speed, about 13 knots (24.1 km/hr) (Reference D.5, Appendix 1, pp. 3-4).

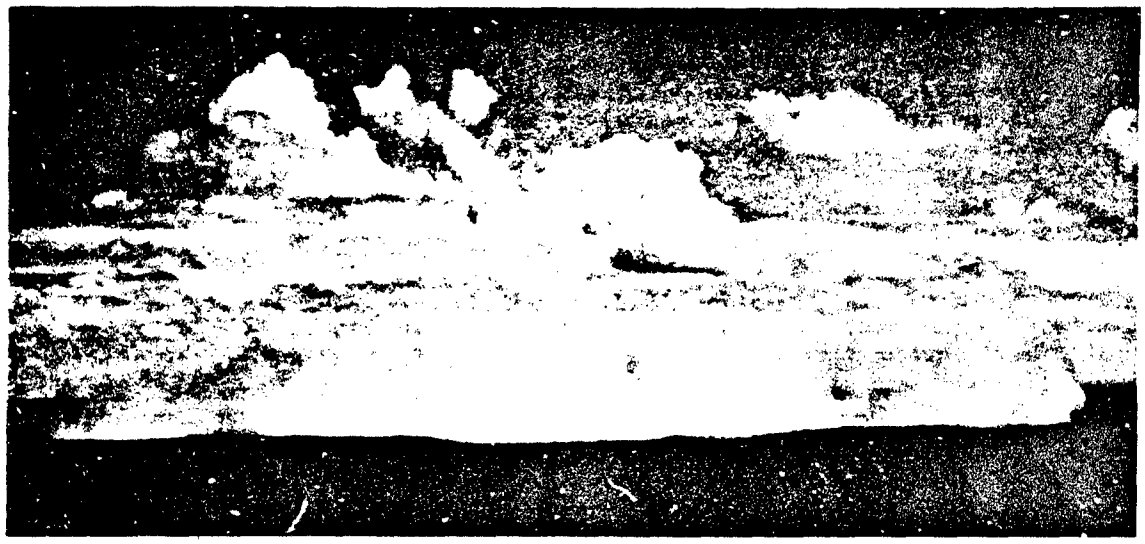


Figure 81. DOMINIC, SWORDFISH base surge. USS Preston (DDE-715) and USS Agerholm (DD-826) are in center foreground, and USS Bausell (DD-845) is to the left.

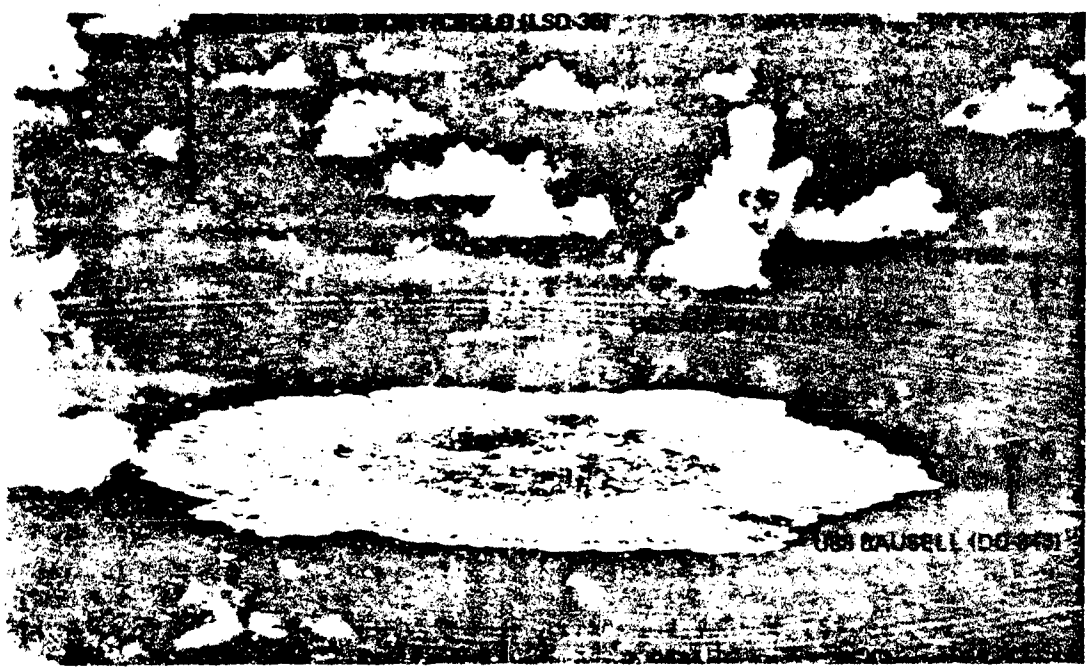


Figure 82. DOMINIC, SWORDFISH foam patch at about 6 minutes after burst. View is from southeast of burst with USS Bausell in right background.

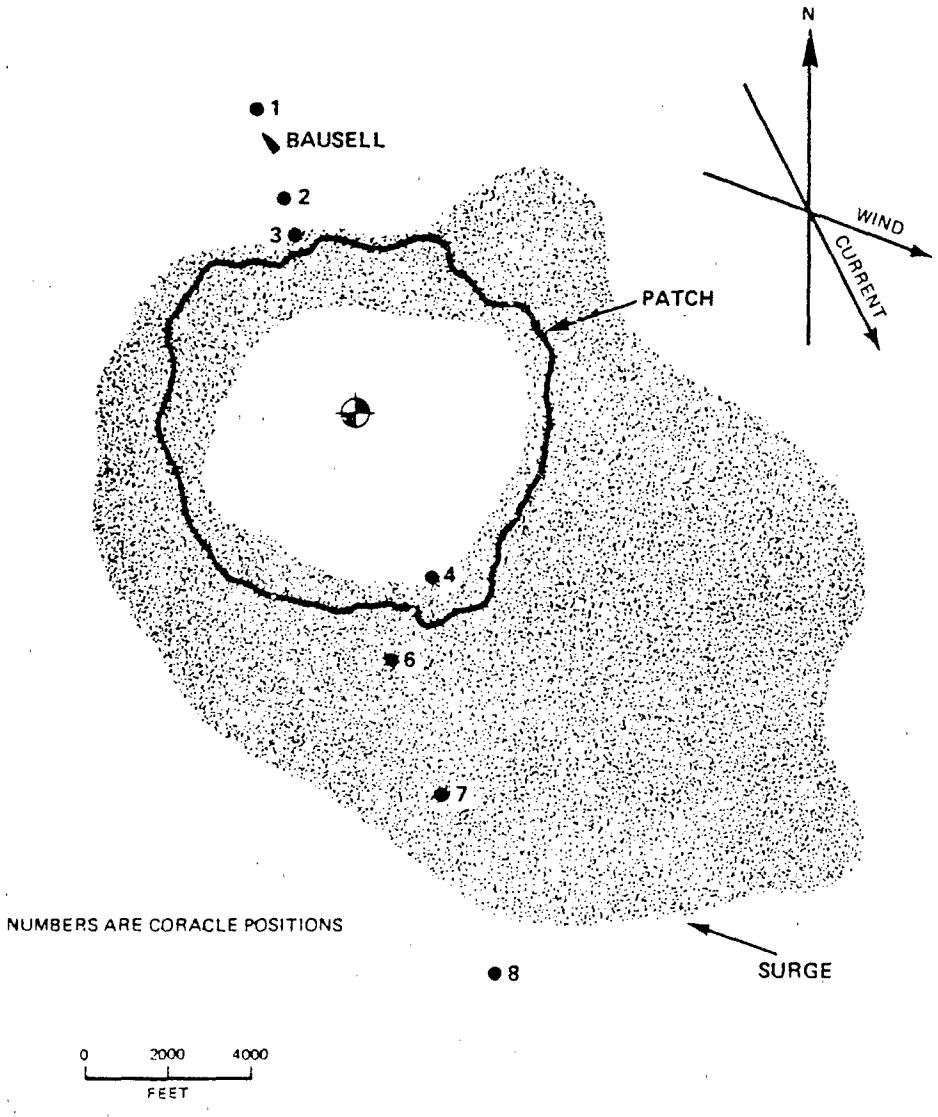


Figure 83. Position of DOMINIC, SWORDFISH foam patch and base surge 5 minutes after detonation (source: Reference C.2004, p. 61).

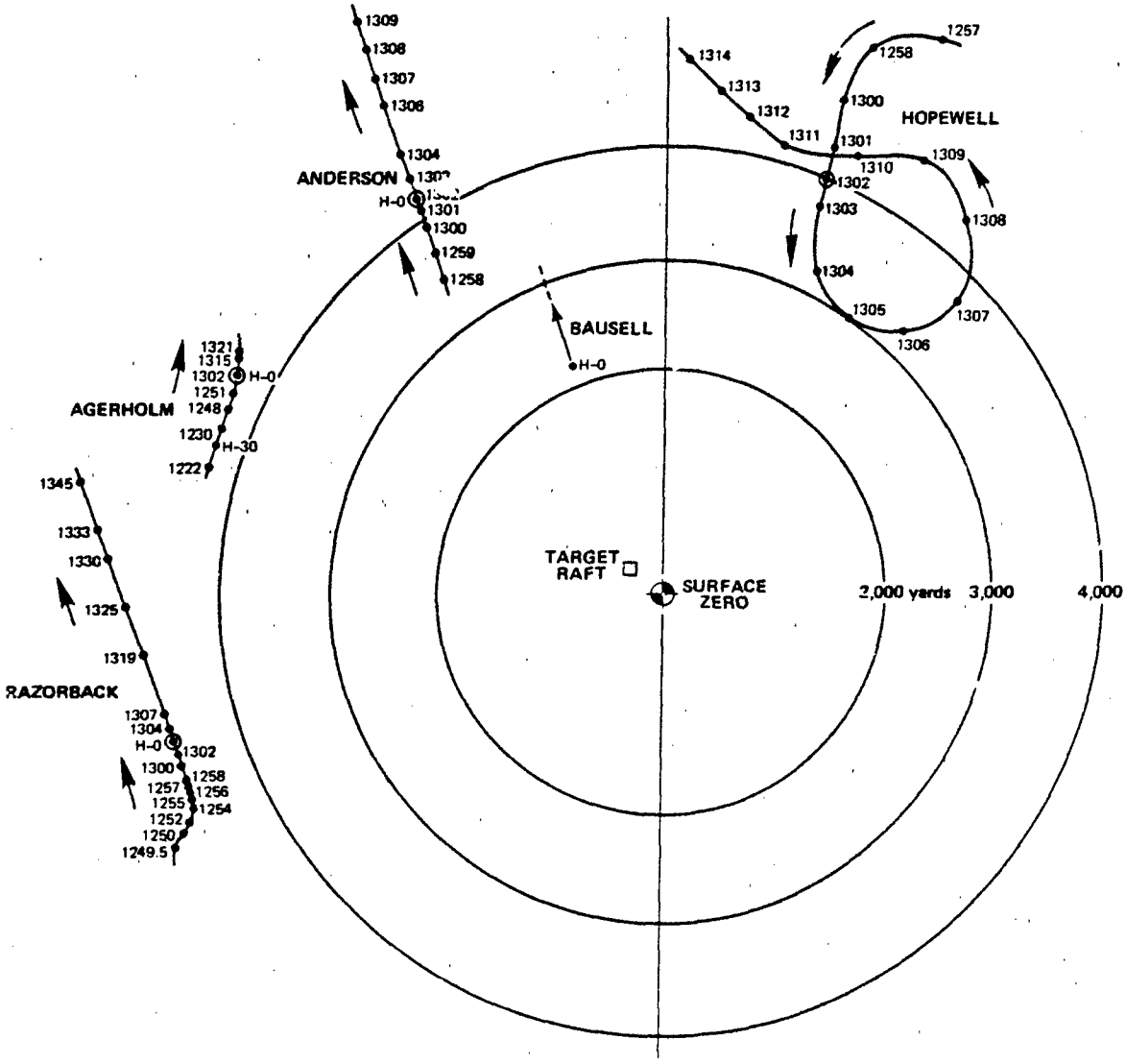


Figure 84. DOMINIC, SWORDFISH early postshot maneuvers of USS Razorback (SS-394), USS Agerholm (DD-826), USS Anderson (DD-786), and USS Hopewell (DD-822) (source: Reference C.2002, p. 36).

While within the pool, Sioux had encountered an invisible aerosol extending above the pool to a height of at least 30 feet (9.1 meters) (Reference C.2004, p. 45), leaving its weather decks with contamination that measured between 0.01 and 0.02 R/hr. The contamination on the weather decks was reduced by use of the washdown system. As of 1357, with the ship well clear of the pool, general radiation on the bridge was between 0.020 and 0.040 R/hr, but the source of that radiation is not made clear in the available documents (Reference D.5, Appendix 1, p. 4; Reference C.3.2, Sioux, 11 May 1962).

With only one sample of water collected and with nine of the personnel over or approaching the 3 R limit, the project officer requested an exposure waiver from CJTG 8.9. The limit was increased to 7 R (9 R according to one source), and by 1525 the ship had started another run at the pool. By 1553 high radiation levels were again encountered. By 1557 or shortly thereafter, the radiation level on the bridge rose to between 2 and 4 R/hr, implying a level in hundreds of roentgens per hour outside. Another water sample was taken, and Sioux departed the pool at best speed. No one aboard received more then 0.6 R during that run (Reference D.5, Appendix 1, pp. 6-7, Reference C.1.D, p. B-1-1).

Sioux collected a third water sample at 1710. Radiation in the bridge peaked at about 0.100 R, leading to an estimated exposure on the starboard wing well of between 1 and 10 R (Reference D.5, Appendix 1, p. 7).

The rest of Sioux's crew returned to the ship to replace the fifteen who had been aboard during the three incursions into the radioactive pool. AEC radiation monitors and NRDL personnel for the NRDL-AEC project came aboard with them. At 1808, the fifteen departed by boat to Monticello for decontamination. At least some of the crewmembers in exposed positions had shoes, hair, and hands contaminated up to 0.4 R/hr. Most personnel aboard Sioux probably did not have an opportunity to wash off their contamination before they left the ship for Monticello. They probably were accompanied by the three NRDL Project 2.1 personnel. The 15 crewmen returned to Sioux the next morning.

Following crew rotation, Sioux made an effort to track and map the pool to meet the objectives of the NRDL-AEC project, including the use of underwater detectors (Reference D.2, p. 21). At about 2300 on 11 May, the maximum exposure rate noted above the pool surface was 0.240 R/hr. Investigation of the pool for this project lasted until about 1300 on 12 May. The maximum exposure noted for all passes through the radioactive pool by Sioux for the NRDL-AEC project was 0.100 R (Reference C.2007, p. 232).

The ASROC overshot the target and consequently Bausell was farther from the surface zero than planned; therefore, the base surge did not reach the ship. Project personnel boarded the ship about an hour after the shot. It was not contaminated, even though the exposure rate on the fantail, the part of the ship closest to the detonation, had reached 44 R/hr shortly after the blast (Reference C.2007, p. 232; Reference C.1.D, p. B-18).

The target-array tow line had been parted, as planned, by an explosive charge on the upwind side of the target raft just before the ASROC launch. The two platforms (Projects 1.1 and 1.3), the first and second coracles (Project

2.1), and Bausell initially remained attached to the upwind segment of the tow line. Recovery personnel, including NOL monitors, boarded platform 1 from one of Monticello's LCMs about 1 hour and 20 minutes after the detonation, finding an exposure rate between 0.600 R/hr and 1.000 R/hr. Apparently the men did not stay, but withdrew to let radiation subside. Two hours after the shot, they hosed down the platform, reducing the exposure rate to 0.250 R/hr and allowing recovery of instruments to proceed.

About 1-1/2 hours after the shot, another LCM from Monticello brought a recovery party to platform 2, where they found a radiation exposure rate averaging 1.000 R/hr, with a maximum rate of 2.000 R/hr. About 1 hour and 10 minutes later, they hosed down the platform to reduce the radiation level and permit retrieval of instruments. After the gauge strings on each platform were raised, the platforms, still attached to a portion of the tow line, were pulled to Monticello by LCM where they were stored in the well deck. No work was done on the platforms until the ship arrived in San Diego. In port, alpha contamination was detected on the platforms at the waterline (Reference C.2007, p. 233; Reference B.9, p. A-3-6).

The eight coracles used for Project 2.1 presented some radiological problems. The base surge passed over coracles 3 through 8, leaving them with a general radiation level of 0.2 R/hr and contamination between the upper and lower sections that could not be hosed off. The pool of radioactive water reached coracles 3 through 6, leaving alpha contamination at the waterline (Reference C.2007, p. 234; Reference C.2004, pp. 56-63).

The LCMs were to tow the coracles to Monticello where they would be lifted aboard by the ship's crane if they were not too radioactive (Reference B.9, p. A-3-6). After-action reports do not indicate how coracles 1 through 3 reached Monticello, but they probably were towed there by one or both of the LCMs taking recovery parties to platforms 1 and 2. Still attached to the portion of the towed array downwind of the target raft, coracles 6 through 8 were towed to Monticello by another LCM that took hold of the smoke barrel, the raft used to mark the extreme downwind end of the array. Coracle 4 came loose from the tow line and was recovered and taken to Monticello. However, by 2022, Hopewell had sighted a coracle and by 2057 had pulled it alongside. The ship apparently stayed alongside for almost an hour. What happened to the coracle then is unrecorded, but Hopewell may have been keeping the coracle in sight until an LCM could take it in tow (Reference C.3.2, Hopewell, 11 May 1962).

Recovery of the tow line was both an operational and radiological problem. The available record does not make clear what happened to all of the slightly over 6 miles (10 km) of tow line. By 2047, Molala had taken on board the portion of the line probably running back to platform 1. The line was contaminated, but the degree of contamination is not recorded. The line was transferred to an LCM that took it to Monticello. On Monticello, personnel handling the line wore protective clothing, including plastic or rubber gloves, to prevent their becoming contaminated. Upon retrieval, the approximately 200 feet (61 meters) of line between platforms 1 and 2 measured about 2.5 R/hr. This length of line was set free to float until the next day. The next day Monticello began to recover a section of free-floating line, probably that which had joined platforms 1 and 2. It became fouled in the rudder and had to be

freed by a diver before recovery could continue. The recovered line had alpha and fission product contamination, and decontamination efforts were to no avail. Apparently the contaminated line was taken back to San Diego (Reference C.3.2, Monticello, 12 May 1962; Reference C.2007, pp. 234-235). Eventually, however, it was encased in concrete at San Diego and sunk at sea (Reference C.1.D, p. B-1-2). Information is lacking on the disposition of the line joining the smoke barrel and coracles 5 through 8.

According to the scientific director, facilities for personnel decontamination aboard Monticello proved barely adequate and a much larger facility could have been used. The recovered items added significantly to the background radiation. They hampered the monitoring of potentially contaminated personnel and demonstrated the need for a monitoring facility forward, away from the stored items.

A total of 500 pairs of coveralls, 300 towels, 300 pairs of shoes, 200 sets of underwear, and 100 pairs of gloves had been stockpiled on Monticello as radsafe clothing for personnel involved in recovery operations. These were nearly exhausted by the end of the operation (Reference C.2007, p. 235).

Hopewell also was active in recovery operations. Operations Order 1-62 called for Hopewell to recover the submarine simulators fired by Razorback for Project 1.3a (Reference B.3.1, p. A-3-5). Hopewell, however, was not to enter radioactive water until 1 hour before sunset if it became necessary to retrieve a simulator. A radsafe officer was to be on Hopewell to advise the captain during the search for the simulators. By 1314 the ship began to search for the simulators. At one point the ship's whaleboat was put into the water, but apparently that was in response to a false alarm. By 1617 a simulator had been sighted, and by 1658 it was hoisted aboard. It was not contaminated (Reference C.3.2, Hopewell, 11 May 1962; Reference C.2007, p. 233). The other simulator was not found. Apparently it sank from shock damage about 2 minutes after the blast (Reference C.2002, p. 7).

Hopewell's approach to the possible coracle 4 is described above. At about 2140 the ship began to search for a raft, although which one is not clear. At one point the deck log refers to it as the pitch barrel raft, implying the smoke barrel marking the extreme downwind end of the tow, and at another point the deck log refers to it as the target raft, implying the raft in the middle of the tow used by Agerholm as the aimpoint. After repeated attempts to sink the raft with small-arms fire, then with grenades, and then with fire from a 5-inch (12.7-cm) gun, Hopewell took the raft aboard and stowed it on the main deck. The log makes no mention of the raft being contaminated (Reference C.3.2, Hopewell, 11 and 12 May 1962).

When Monticello reached port, all contaminated items were removed and packaged for shipment or turned over to the naval repair facility for disposal. A radiation survey of all ships revealed no significant contamination except on Sioux, which had its lubrication oil coolers contaminated to a level of 0.003 R/hr. It was not necessary to deal with the problem directly. The ship's engineering officer was instructed to monitor the coolers when they needed to be taken apart for servicing (Reference C.2007, p. 236).

Of all the ships assigned to SWORDFISH, Sioux had the highest exposure to radiation. Table 19 shows the exposures of the 15 crewmen and 3 NRDL employees aboard during the water-sampling exercise. The CJTG 8.3 Final Report agrees with the NRDL employee's memorandum on the number of men with exposures over 2.5 R (Reference C.3.1, p. H-1-2). Entries on the medical forms (NAVMED 1432) of some Sioux crewmembers, however, show an exposure higher than on the Consolidated List (Reference C.1.2). This difference is discussed in Chapter 13.

Sioux's role in the subsequent NRDL-AEC pool monitoring and tracking project should have caused much less radiation exposure than the sampling; nevertheless, one NRDL man who may have been aboard is credited on the Consolidated List with an exposure of 1.620 R. The other NRDL men who may have been aboard had exposures of 0.320 R or less (Reference C.1.2, p. 165).

Pioneer also repeatedly entered the radioactive pool, but only after the radiation level was much reduced by decay and mixing with nonradioactive water. Of the 102 crewmembers, 53 had no exposures and 49 had 0.5 R or less. Hopewell ranged widely searching for the submarine simulator, locating the coracle, and recovering the smoke barrel. Although it might have entered radioactive water, the highest exposure among its crew was 0.276 R. Monticello probably did not enter radioactive water. Its LCMs, however, towed contaminated equipment. The equipment was taken aboard Monticello, and stored there until the ship returned to San Diego. The decontamination center was also on Monticello. Nevertheless, the maximum exposure among the Monticello crew, including that incurred during operations at Christmas Island, was 0.349 R.

Table 19. Personnel exposures on USS Sioux (ATF-75) during Project 2.1, DOMINIC, SWORDFISH.

Location	Dosimeter Readings (R)[a] First Penetration	Second and Third Penetrations	Total	Total from NAVMED 1432 (R)	Total from Consolidated List (R)
Bridge					
Notes b,c	>5[d]	0.4	5.4[d]	4.100[c]	4.100
	4.8	0.2	5.0	4.100	2.500
	4.4	0.6	5.0	4.150	2.500
	3.4	0.5	3.9	4.150	2.800
	3.2	0.6	3.8	2.800	2.850
	2.9	0.2	2.3	2.250	2.250
	2.7	0.2	2.9	0.780	0.780
	2.6	0.4	3.0	2.700	2.700
Radio Room	1.0	0.1	1.1	0.970	0.970
Motor Room					
	0.2	0.0	0.2	0.250	0.250
	0.2	0.1	0.3	0.000	0.000
	0.1	0.0	0.1	0.130	0.130
Engine Room	0.0	0.0	0.0	0.082	0.082
Motor Room, Engine Room, and Mess Hall					
	0.9	0.1	1.0	0.690	0.690
Fan Tail[b]	3.2	0.6	3.8	2.730	2.730
Fan Tail and Mess Hall					
	1.8	0.2	2.0	1.700	1.700
Shaft Alley					
	0.2	0.1	0.3	0.245	0.245
Note b	0.1	0.0	0.1	0.270	0.270

Notes:

[a] Dosimeters for all 18 personnel were reset to zero after the first penetration. They were not reset between the second and third penetration.

[b] Readings taken from dosimeters of Naval Radiological Defense Laboratory (NRDL) employees.

[c] This NRDL employee was wearing his NRDL badge in addition to his Joint Task Force 8 (JTF 8) badge. This NRDL badge was processed on 15 May by NRDL and read 8 R. This is about twice the reading of his JTF 8 badge, which read 4.1 R.

[d] Maximum reading of pocket dosimeters was 5 R; reading on the first entry can only be stated as 5 R or greater.

Source: Reference D.5.

CHAPTER 7

FISHBOWL -- HIGH-ALTITUDE EVENTS

CONCEPT OF THE HIGH-ALTITUDE TESTS

The FISHBOWL portion of DOMINIC consisted of five nuclear-device detonations at altitudes ranging from tens of kilometers to 400 km above Johnston Island. The devices were carried to their detonation altitudes by rocket-propelled missiles launched from Johnston Island. Measurements were made of the effects of the detonations on the ionosphere and its ability to support radiofrequency propagation, the performance of radio and radar systems, the response of the geomagnetic field, and various optical and thermal effects of the bursts.

Methods used in making these measurements usually did not cause exposure of test personnel to ionizing radiation from the detonation. Surface or airborne instruments recorded the measurements directly, or small rockets carrying sensors telemetered information to the recording stations.

There were, however, several experiments that were placed in pods attached to the launching missile. These pods were designed to separate from the missile at predetermined altitudes so that they would be at prescribed distances from the device when the nuclear warhead detonated. The pods were 80 inches (2 meters) long and were fitted with a variety of instruments to measure the output of the device and its effects. Figure 85 shows a launch missile with the pods attached. Several of the experimental projects had instruments in these pods. The pods parachuted to the open ocean where they were retrieved by Navy ships and Marine Corps helicopters. The pods were returned to Johnston Island where the experimental agencies retrieved their instrumentation. This operation was closely controlled because the pods became radioactive when exposed to the radiation from the detonations. Their radioactivity measured 8 hours after detonation varied from 2 to 14 R/hr for the different pods.

Attempts were made to sample the device debris directly using rockets, but these collectors were never recovered during the FISHBOWL shots.

Surface and Aircraft Stations

Surface and aircraft experimental stations were located throughout the Pacific Basin. Some were under the burst at Johnston Island, some were on other islands (including the Hawaiian Islands, Midway, and Wake), some were airborne, and some were on task force ships.

The Earth's magnetic field rises from the magnetic north and south poles and reaches to great heights (several Earth radii) over the magnetic equator. This field is often represented by "lines of force" that are shown closely spaced in the polar regions and widely spaced over the magnetic equator (Figure 86). The closeness of these lines in this representation depicts the

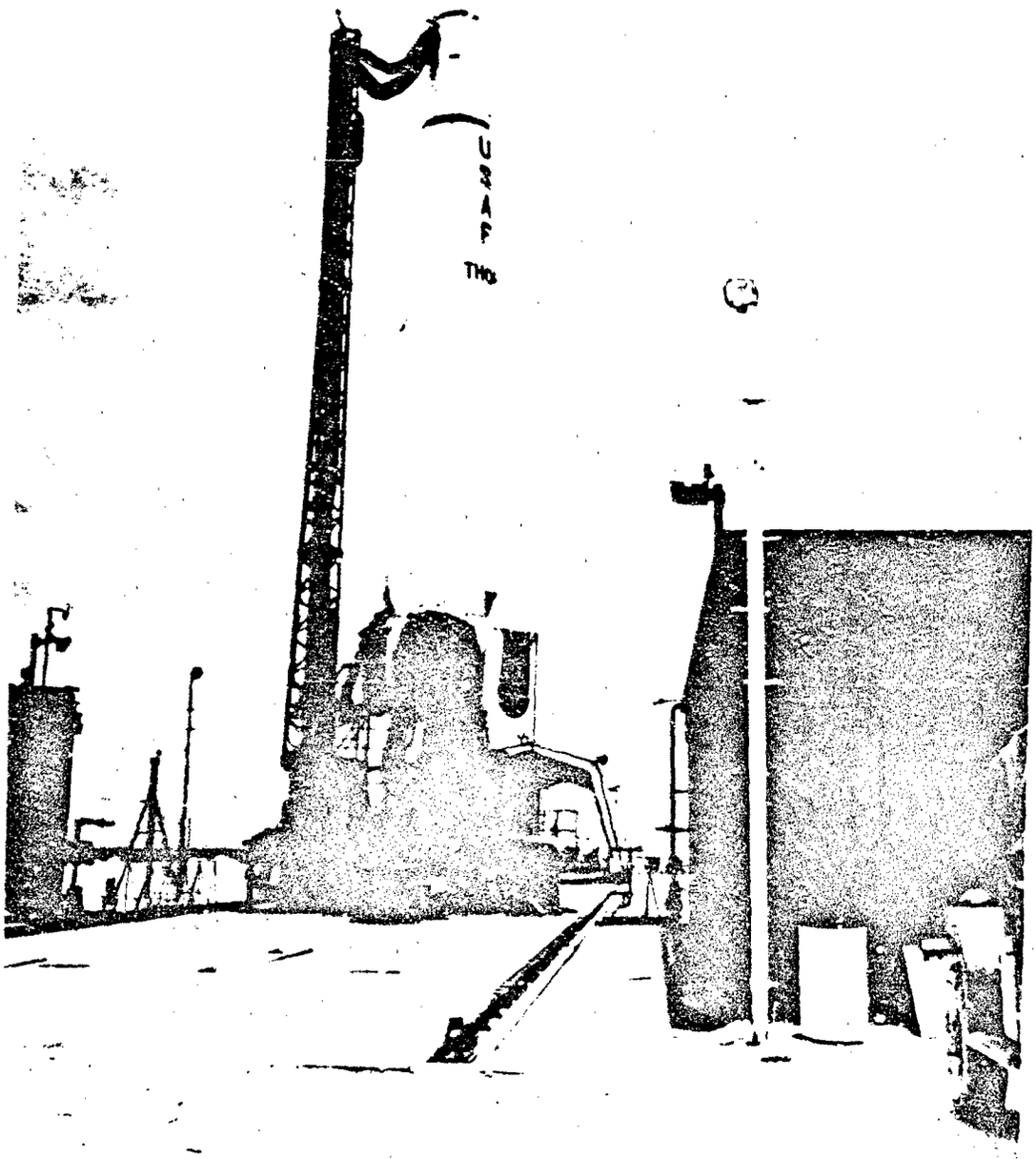


Figure 85. Thor on launch pad. Dark objects around the base are instrument pods. The Thor was used for launch of STARFISH, BLUEGILL, and KINGFISH shots of Operation DOMINIC.

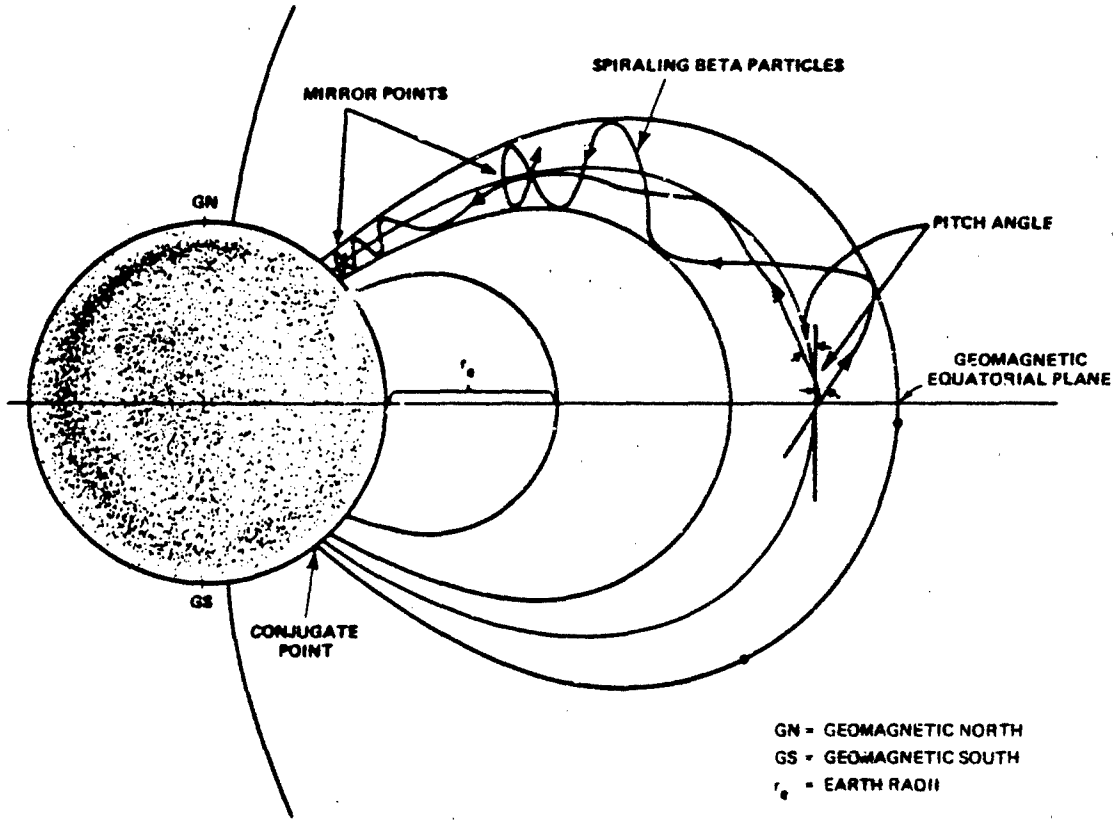


Figure 86. Earth's magnetic field.

strength of the field, with closely packed lines at the poles indicating high field strength and widely spaced lines over the equator indicating lower field strength. Electrically charged particles spiral around these lines. The size of their spiral depends on the particle energy and on the strength of the field. At the magnetic equator, where the field is weakest, the spirals are large, but as they move toward the poles the spirals tighten as the field strength grows. The spirals finally tighten to a point at which the particles are reflected back up the field line and spiral toward the other pole. The place at which a particle reflects is called a mirror point. The mirror points at the north and south end of the field line are often referred to as the conjugate points, and the area beneath the southern points is referred to as the Southern Conjugate Area (SCA).

Areas selected for instrumentation sites in the SCA were Tutuila (American Samoa), Viti Levu in the Fiji Islands, and Tongatabu in the Tonga Islands. Rarotonga, Canton, and Palmyra were also instrumented to observe phenomena from locations that viewed the magnetic field lines from the side or from beneath. Two ships were located in this area: the motor vessel (MV) Acania, which was instrumented by Project 6.9, and the leased civilian tug Mauna Tele used by Project 6.5b. The civilian tug Hifofua replaced Mauna Tele after July 1962.

In addition to the land and shipboard stations, Joint Task Group (JTG) 8.4 (Air Force) operated one KC-135 and two RC-121s in the area from a base at Nandi in the Fiji Islands. Both of the RC-121s at Nandi returned to their home base at McClellan AFB, California, on 29 October 1962 because of higher priority requirements; thus, they were not present for the last two high-altitude events, KINGFISH and TIGHTROPE (Reference C.2053, p. 50; Reference C.4.3.2, p. 13). Because of their great distance from the danger areas associated with DOMINIC tests, personnel working south of the equator were not badged.

Because southern conjugate operations were primarily associated with Department of Defense (DOD) experiments (Task Unit [TU] 8.1.3), the Weapons Effects and Test Group (WETG) at Field Command, Defense Atomic Support Agency (DASA), was responsible for administration and support of personnel and facilities. The 25th Infantry Division from Schofield Barracks, Hawaii, established a radioteletype communications network using AN/GRC-26s between all sites and the worldwide military communications network, except for Rarotonga, which had a voice link only. The Military Air Transport Service (MATS) set up C-124 or C-118 flights at 6-day intervals to support all six island locations. Overall, a total of 33 DOD experimental projects were represented in the SCA, and personnel totals there peaked at about 350 (Reference C.2053, pp. 51-52).

Launch Missiles

Two missile-launched high-altitude tests had been conducted from Johnston Island in 1958, but for DOMINIC the launch point was moved from the point near the eastern end of the small island used in 1958 to a point on the northwest corner. The missile used was also different than the one used in 1958. The Thor, an Air Force liquid-fueled, intermediate range ballistic missile was selected for its ability to carry the three instrumentation pods in addition to the nuclear warhead (see Figure 85). Thor was manufactured by the Douglas Aircraft Company, and a contingent of men from that organization as well as from the Air Force Space Systems Division (SSD) serviced and launched them. Thor was used on BLUEGILL, STARFISH, and KINGFISH events.

A Nike-Hercules missile was used to launch the TIGHTROPE device to its detonation altitude (Figure 87). The Army Missile Command (AMC), designated TU 8.1.7, was given responsibility for providing and launching this missile. The missile was an antiaircraft missile, slightly modified by adding a command arm-fire capability and an automatic disarm feature. The 2nd Missile Battalion, 52nd Artillery Regiment, from Ft. Bliss, Texas, launched the missile at Johnston Island. Another Nike-Hercules missile was used by a scientific project and carried a radar beacon to an altitude close to the detonation point (Reference C.1.L, p. C-9-2).

A Strypi rocket (XM-33) was used to launch the CHECKMATE device to its detonation altitude (Figure 88). Sandia Corporation, TU 8.1.4, was given the responsibility to obtain, modify, assemble, and launch the Strypi rocket. Two Recruit booster rockets were attached to the base of the Strypi rocket to provide additional thrust (Reference C.1.L, p. C-8-2).

A variety of small rockets was used to carry instrument packages to proper altitude. TU 8.1.3 was responsible for managing and controlling the small

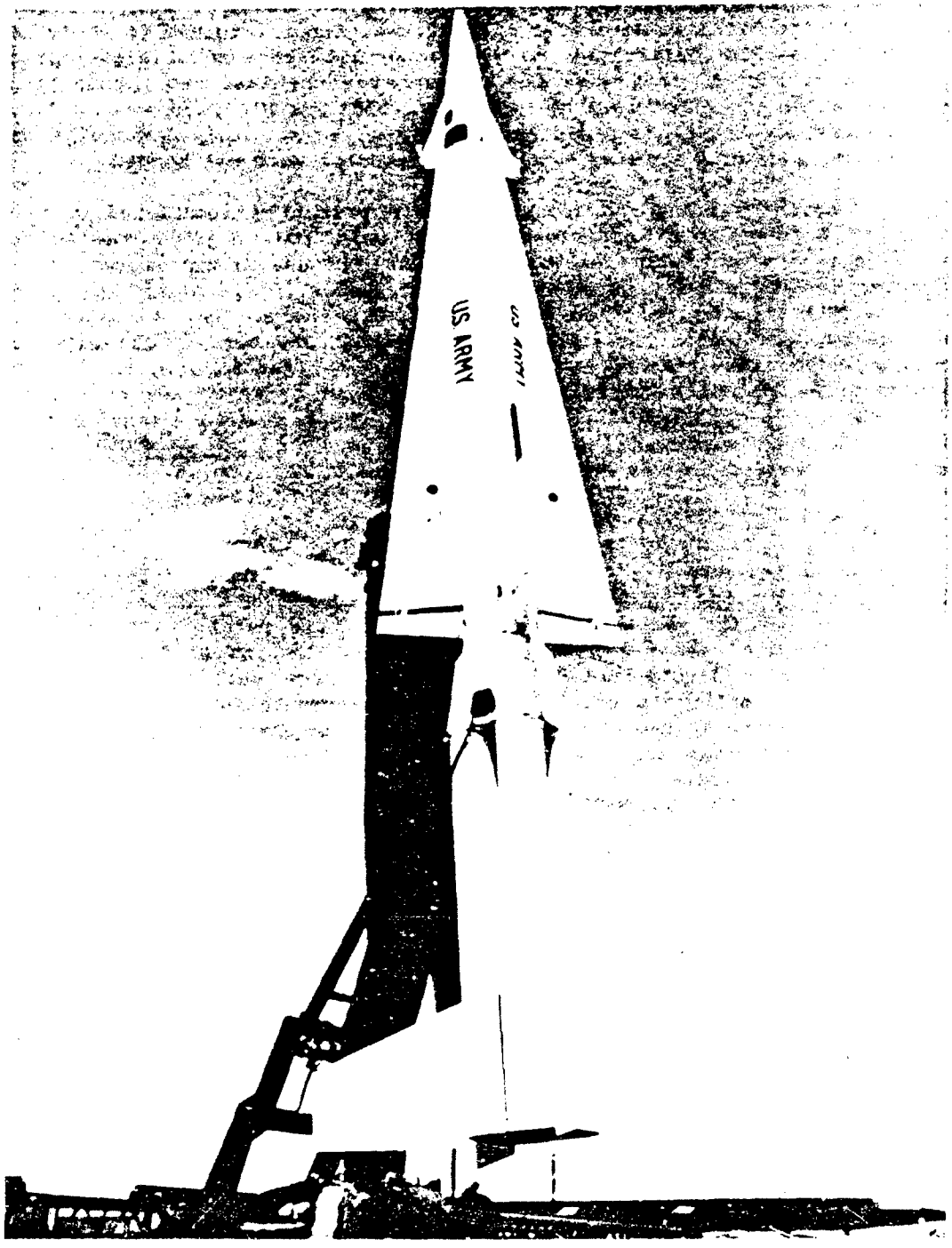


Figure 87. Nike-Hercules used for launch of TIGHTROPE shot, Operation DOMINIC.

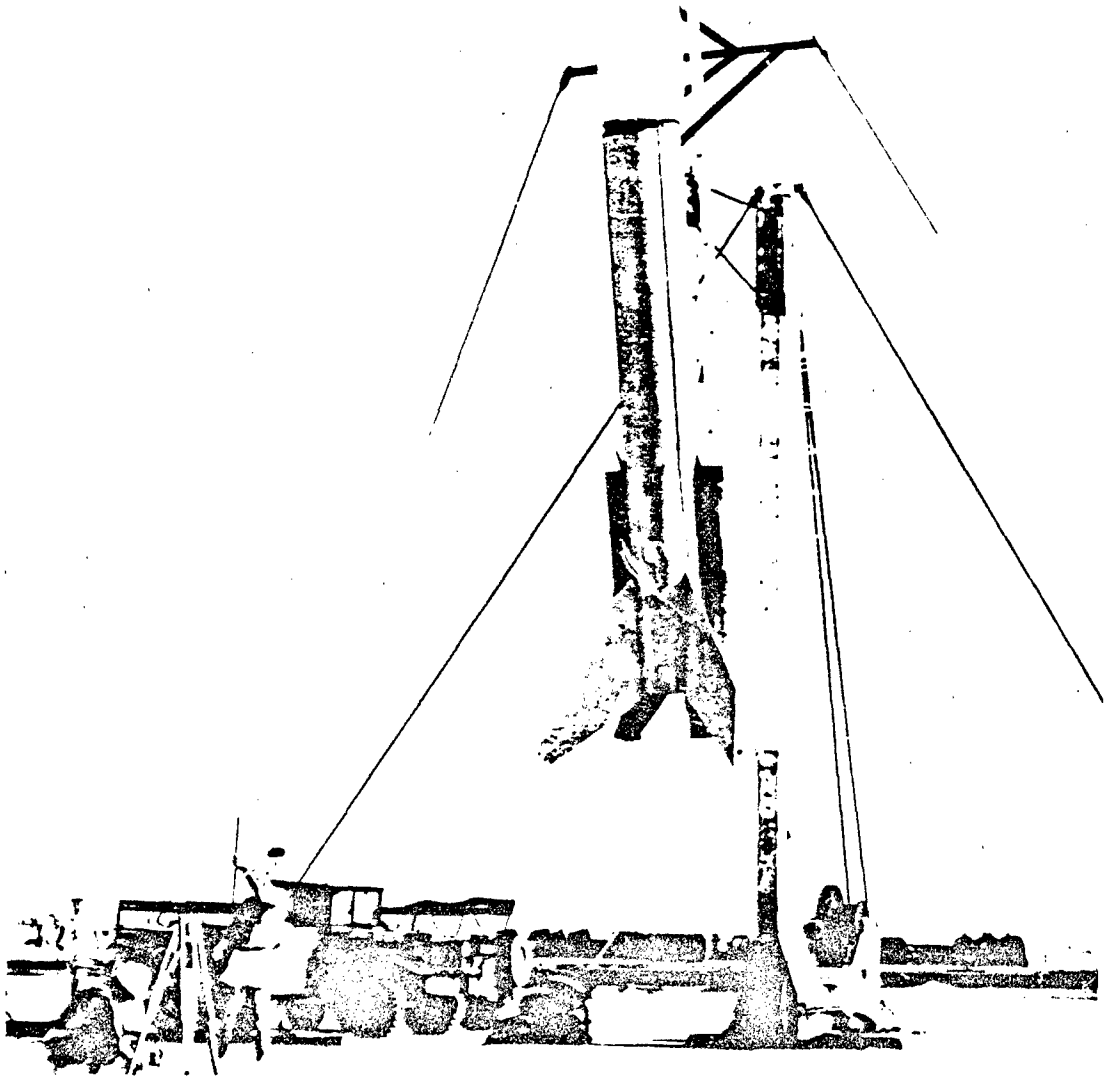


Figure 88. Strypi missile with Recruit boosters used for CHECKMATE shot, Operation DOMINIC.

rocket program. A TU 8.1.3 Small Rocket Officer was formally appointed to oversee the many operational and safety aspects associated with the numerous small rockets. Rockets used included the Javelin, Nike-Cajun, XM-33, Nike-Apache, Honest John-Nike, and Speedball. The rocket launchers were located along the south side of the runway at Johnston Island. The KINGFISH shot had the largest number of small-rocket launches (29) from Johnston Island. Figure 89 shows some of the rockets on Johnston Island. Small rockets were also launched from Barking Sands, Kauai, carrying similar instrumentation during each of the five high-altitude events (Reference C.2053, p. 45).

ORGANIZATION AND PERSONNEL

After the last Christmas Island test, Hq Joint Task Force 8 (JTF 8) was relocated at Johnston Island. WETG at Field Command, DASA (TU 8.1.3) played a major role in the FISHBOWL tests as it was responsible for the management of the DOD experimental program.

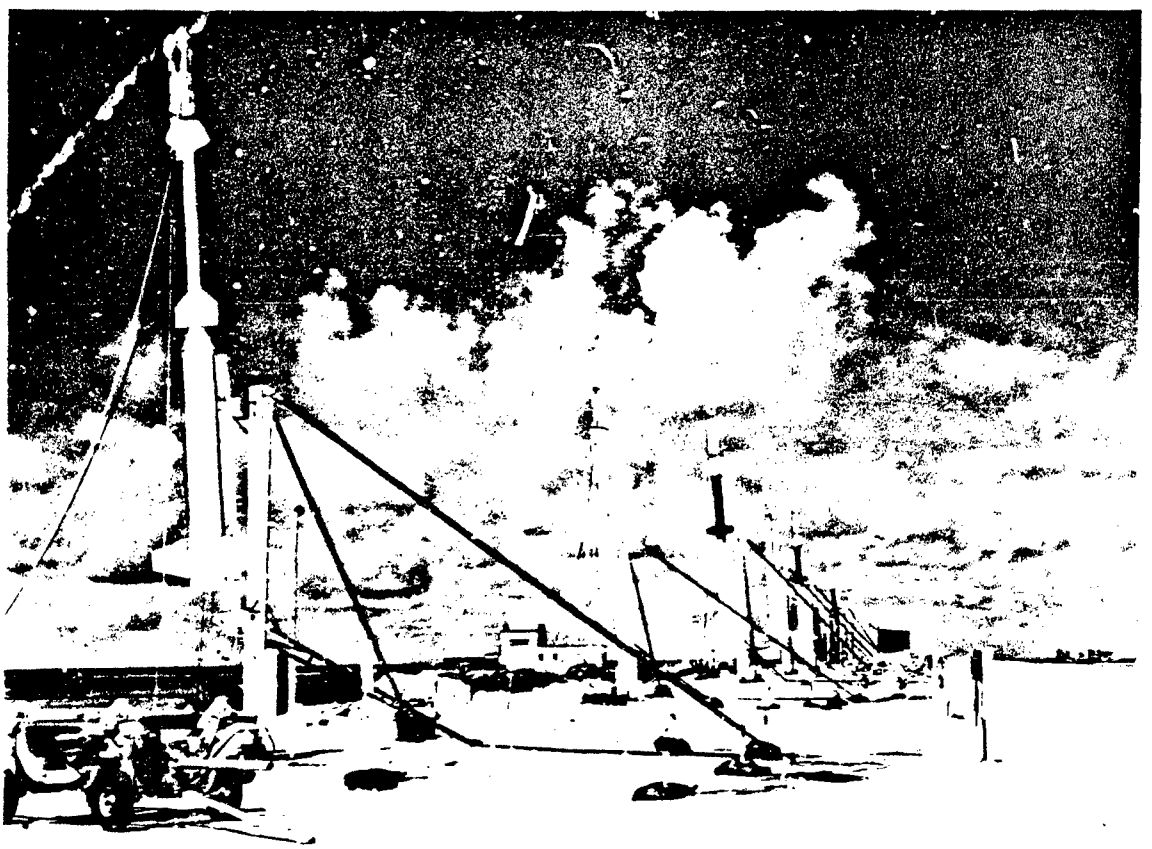


Figure 89. Array of instrument rockets used during Operation DOMINIC at Johnston Island.

The total number of men on Johnston Island during the FISHBOWL tests is not clearly established in any of the sources. All nonessential personnel were evacuated from Johnston Island for each test as a safety precaution since Johnston Island is small (Figures 10 and 11) and missile malfunctions were possible and did occur. The number of nonessential personnel varied from over 800 to under 500 (Reference C.1.B), but the number of essential personnel is not recorded. In the similar 1958 high-altitude Johnston Island tests, the number left on Johnston Island during the shots was about 175. However, the 1962 tests were more complex, using more small rockets and more surface experiments. In addition USNS Range Tracker (T-AGM-1) remained at the Johnston Island pier throughout DOMINIC, and some portion of its crew must also have remained on board during the shots. There were also other larger shipboard contingents that should be added to the total JTF 8 personnel involvement in the area.

The method of evacuation was by LCU and helicopter to USS Iwo Jima (LPH-2). Personnel were taken from the LCU to the ship by a cage lifted by a crane, dubbed the "purple people eater" (Figure 25). During the October-November phase of FISHBOWL, rough seas prevented LCU transfer and all evacuation (maximum of 787 for KINGFISH) was conducted by Marine Corps helicopters.

NAVY PARTICIPATION

The Navy was heavily involved in the FISHBOWL tests. It operated the 20 P2V aircraft that patrolled the danger area and searched for the instrumented pods and nosecones in the open sea. The Navy also operated several ships in the Johnston Island area that were used for danger area surveillance, weather reporting, instrumentation platforms, pod and nosecone recovery, and range safety. TU 8.3.6, the Johnston Island Operations Unit, exercised operational control over local naval air and surface forces. Ship rotation was commonplace; a total of 54 ships (a few were not Navy vessels) were used during FISHBOWL. Table 20 lists these ships.

The scientific ships shown in the table participated in the DOD experimental program and were specially instrumented for their missions. Navy pod-recovery tugs were also specially outfitted to handle the radioactive missile pods. Using Marine Corps helicopters, the tugs, and a destroyer, the Navy recovered these pods and returned them to Johnston Island. Missions of each Navy unit is further discussed in Chapter 9.

AIR FORCE PARTICIPATION

The Air Force played a major role in the FISHBOWL tests. Its aircraft were used as instrument platforms to measure device performance and to measure the effects of the detonations on various military systems. U-2 high-altitude reconnaissance aircraft and lower-altitude WB-50s provided detailed weather coverage. A weather observation station on Johnston Island made hourly surface observations and 4 to 8 rawinsonde observations per day. It managed and executed many of the DOD experimental projects. It was also responsible for providing the Thor missiles and their associated safety, launching, and pod carrying controls.

Table 20. Ship participation in DOMINIC, FISHBOWL tests.

Ship	Mission	Months on Station (1962)
USS Abnaki (ATF-96)	Logistics	Oct - Nov
MV Acania	Scientific (Southern Conjugate Area)	Apr - Nov
USNS Alatna (T-AOG-81)	Logistics	Mar - Aug
USS Arikara (ATF-98)	Logistics/pod recovery	Feb - Jul
USAS American Mariner	Scientific	Apr - Nov
USS Cabildo (LSD-16)	Logistics	Jul - Aug
USS Chemung (AO-30)	Underway replenishment	May - Jun
USS Chickasaw (ATF-83)	Pod recovery	Jun - Aug
USS Chipola (AO-63)	Underway replenishment	May - Jul
USS Conserver (ARS-39)	Nosecone recovery	Mar - Jul
USS Deliver (ARS-23)	Logistics	Jan - Mar
USS Engage (MSO-433)	Pod recovery	Sep - Nov
USS Falgout (DER-324)	Surveillance	Apr - Aug
USS Floyd County (LST-762)	Logistics	Nov
USS Fort Marion (LSD-22)	Scientific	Apr - Jul
USNS Frank S. Petrarca (T-AK-250)	Scientific	Jul - Nov
USS Fortify (MSO-446)	Surveillance and nosecone recovery (Kauai)	Sep - Oct
USS Grapple (ARS-7)	Pod recovery	Apr - Jun
USS Grasp (ARS-24	Harbor preparation	Jan - May[a]
USNS Harris County (T-LST-822)	Logistics and Scientific	Feb - Nov
USS Hassayampa (AO-145)	Underway replenishment	Jul - Nov
USS Henry County (LSD-824)	Scientific	Aug - Nov
SS Mifofua[b]	Scientific (Southern Conjugate Area)	Sep - Nov
USS Hitchiti (ATF-103)	Scientific	Sep - Nov
SS Impervious (MSO-449)	Surveillance and nosecone recovery (Kauai)	Sep - Oct
USS Inflict (MSO-456)	Scientific	Apr - Jul
USS Iwo Jima (LPH-2)	Evacuation	Apr - Jul
USS John S. McCain (DL-3)	Pod recovery	Apr - Nov
USS Jenkins (DD-447)	Surveillance	May - Nov
USS Jerome County (LST-848)	Logistics	Feb - Jul
USS Lansing (DER-388)	Surveillance	Sep - Oct
USS Loyalty (MSO-457)	Scientific	Apr - Jul
MV Malie[c]	Logistics	Oct
USS Mataco (ATF-86)	Pod recovery	Apr - Jul
USS Mauna Tele[b]	Scientific (Southern Conjugate Area)	Jun
USS Moctobi (ATF-105)	Logistics	Mar - May
USS Newell (DER-322)	Surveillance	Apr - Jul
USS O'Bannon (DD-450)	Surveillance	Apr - Jul Oct
USS Oak Hill (LSD-7)	Scientific	May - Aug
USNS Point Barrow (T-AKD-1)	Scientific	Mar - Dec
USS Polk County (LST-1084)	Scientific	Jun - Aug
USS Princeton (LPH-5)	Evacuation	Sep - Nov
USNS Range Tracker (T-AGM-1)	Range safety	Jan - Nov
USS Safeguard (ARS-25)	Pod recovery	Aug - Nov
USS St. Clair County (LST-1096)	Logistics	Sep
USS Sioux (ATF-75)	Pod recovery	Apr - Aug
USS Snohomish County (LST-1126)	Logistics	Jan - Aug
USS Summit County (LST-1146)	Scientific	Aug - Nov
USS Takelma (ATF-113)	Pod recovery	May - Dec
USS Taylor (DD-468)	Surveillance	Apr - Nov
USS Tawakoni (ATF-114)	Nosecone recovery	Apr - May
USS Ute (ATF-76)	Surveillance (Kauai)	Apr - Jun
USS Walker (DD-517)	Scientific	May - Jun
USS Wexford County (LST-1168)	Logistics	Nov

Notes:

[a] On station from December 1961.

[b] Leased civilian vessel.

[c] Commercial tug.

Source: Reference C.1.8, Table 5.

JTG 8.4 Op Plan 4-62, dated 18 May 1962 (Reference B.4.10), indicates that the aircraft listed in Table 21 would participate in the high-altitude tests. Actual aircraft participation is presented to the extent known in the individual shot discussions in this chapter.

Table 21. Planned Air Force aircraft participation for DOMINIC, FISHBOWL shots.

Number Available	Type Aircraft	Mission
6	RC-121	AAOC[a] and Scientific
2	SC-54	Search and Rescue
8	WB-50	Weather Reconnaissance
1	RC-54	Documentary Photo
6	KC-135	Scientific
1	C-135	Scientific
5	C-118	Medical Effects
2	B-47	Radio Relay
3	U-2	Weather and Photo
2	C-130	Warhead Diagnostics

Note:

[a]Airborne Air Operations Center.

Source: Reference B.4.10, pp. 10-11.

OPERATIONS

Plans originally called for three shots, BLUEGILL, STARFISH and URRACA, with a Thor-certification, nonnuclear missile launch called Tigerfish. Tigerfish was successfully launched on 2 May 1962. The Thor missile and associated telemetry and tracking equipment functioned as desired. A primary objective of Tigerfish was to proof-test the pod system. All three pods were recovered but because of a failure in the recovery system, two pods sustained impact damage. Tracking data indicated that pod ejection from the Thor missile and placement with respect to the nuclear burst (simulated for this shot) was good (Reference C.2053, p. 103). JTG 8.3 and JTG 8.4 used the Tigerfish test to practice placement of ships and aircraft in their proper positions at detonation time.

BLUEGILL (2 June 1962)

The BLUEGILL event was the first missile launch with a nuclear warhead in DOMINIC. The missile was launched from Johnston Island shortly after midnight. The missile apparently flew a normal trajectory; however, the tracking system lost it. As there were ships and aircraft in the vicinity and no way to predict whether the trajectory was safe, CJTF 8 ordered the missile with its warhead destroyed. No data for experiments were obtained since no nuclear detonation occurred (Reference C.1.L, p. C-1-2).

The Thor missile carried three instrumentation pods, one of which had ejected before the missile had to be destroyed. All three pods were successfully recovered and returned to Johnston Island by the Navy. No missile debris was sighted.

The aircraft shown in Table 22 flew missions this BLUEGILL event.

Table 22. Air Force aircraft participation in DOMINIC, BLUEGILL.

Aircraft			
No.	Type	Call Sign	Mission
2	B-47	Baxter/Byron	Communications relay
2	WB-50	Calcimine	Weather reconnaissance
1	SC-54	Caustic	Search and rescue
5	C-118	Caboodle	Retinal burn study
2	RC-121	Abusive	Airborne Air Operations Center
4	RC-121	Lambkin	Burst effects, communications Relay and radar tracking
2	C-130	Hewstone	Diagnostic aircraft
1	KC-135	Cognac	Communications relay
1	KC-135	Kibosh	Diagnostic aircraft
1	KC-135	Cordova	Propagation test aircraft
3	KC-135	Kettle	Photographic aircraft
1	U-2	White Spot	Sampler aircraft

Source: Reference C.4.1, p. 75.

STARFISH (19 June 1962)

The STARFISH event was the second high-altitude launch attempted during DOMINIC. The launch was executed just before midnight. The Thor missile with two experimental reentry vehicles replacing two of the three instrument pods flew a normal course for about 59 seconds after liftoff. At that time the rocket motor stopped and the Range Safety Officer ordered the missile and warhead destroyed. The missile was between 30,000 and 35,000 feet (9.1 and 10.7 km) when it was destroyed. One of the reentry vehicles, the instrument pod, and missile parts fell on Johnston Island (Reference C.2053, p. 104). A substantial amount of debris fell on and in the water around Johnston Island. Figure 90 shows some of this debris. Navy Explosive Ordnance Disposal and Underwater Demolition Team swimmers spent 2 weeks recovering debris from the lagoon waters around the island. They recovered approximately 250 pieces of the system, some of which were plutonium-contaminated (Reference C.1.B.



Figure 90. Debris that fell on Johnston Island from the first DOMINIC, STARFISH launch.

p. BB-21). Nonessential personnel had been evacuated from Johnston Island aboard Iwo Jima, as they were for all Johnston Island shots.

Aircraft participation in this STARFISH attempt was similar to that shown for BLUEGILL (Table 22).

STARFISH Prime (8 July 1962, 2300)

This event was the first successful high-altitude nuclear detonation of DOMINIC. The Thor missile was launched from Johnston Island near midnight. Three instrumentation pods were attached to the Thor missile. All systems functioned properly and the 1.4-MT device detonated at an altitude of 400 km. All three instrument pods were recovered from the open sea by the Navy, one by ship and two by helicopter. A total of 27 small rockets of all kinds were launched from Johnston Island to obtain experimental data from the shot, beginning 2-3/4 hours before the detonation and continuing through D+1 (Reference C.2053, p. 104).

The large amount of energy released at such a high altitude by the detonation caused widespread auroras throughout the Pacific area, lasting in some cases as long as 15 minutes; these were observed on both sides of the equator. In Honolulu an overcast, nighttime sky was turned into day for 6 minutes (New York Times, 10 July 1962). Observers on Kwajalein 1,400 nmi (about 2,600 km) west reported a spectacular display lasting at least 7 minutes. At Johnston Island all major visible phenomena had disappeared by 7 minutes except for a

faint red glow. The Earth's geomagnetic field also was observed to respond to the burst.

Nonessential personnel on Johnston Island, numbering 559, had been evacuated aboard Iwo Jima the day before the shot and returned on D+1 (Reference C.1.A, p. 49).

Twenty-one JTG 8.4 aircraft participated in STARFISH Prime. Positions for the 15 aircraft in the array are shown in Figure 91. Ship positions are shown in Figure 92. In addition to the air-array aircraft, which required precise positioning, two RC-121 Airborne Air Operations Centers (AAOC), two WB-50 weather planes, one SC-54 search and rescue (SAR) aircraft, and one U-2 aircraft participated. Three aircraft were below the equator (off the chart).

On 13 July, 4 days after the shot, the U.K. satellite, Ariel, was unable to generate sufficient electricity to function properly. From then until early September things among the satellite designers and sponsors were "along the

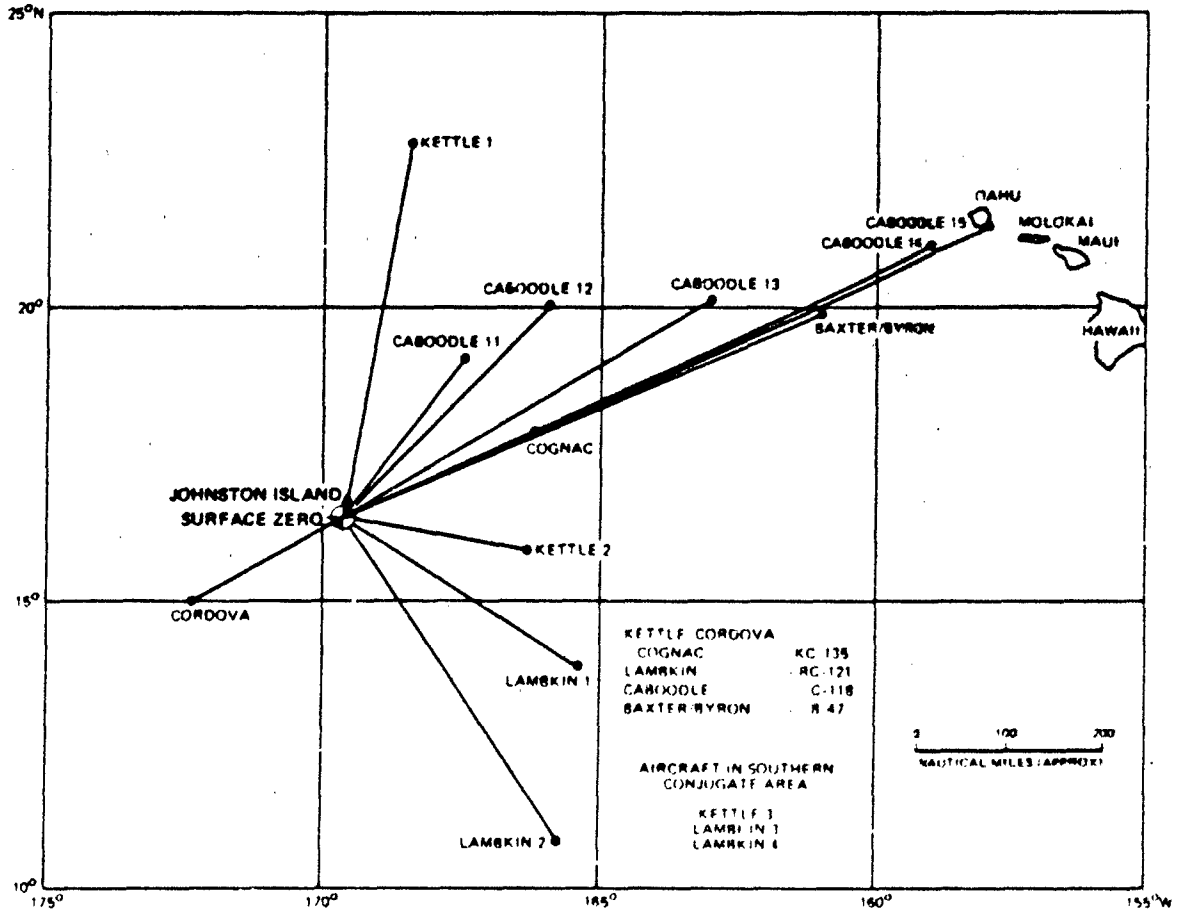


Figure 91. Aircraft in the air array for DOMINIC, STARFISH Prime (source: Reference C.2053, Appendix E).

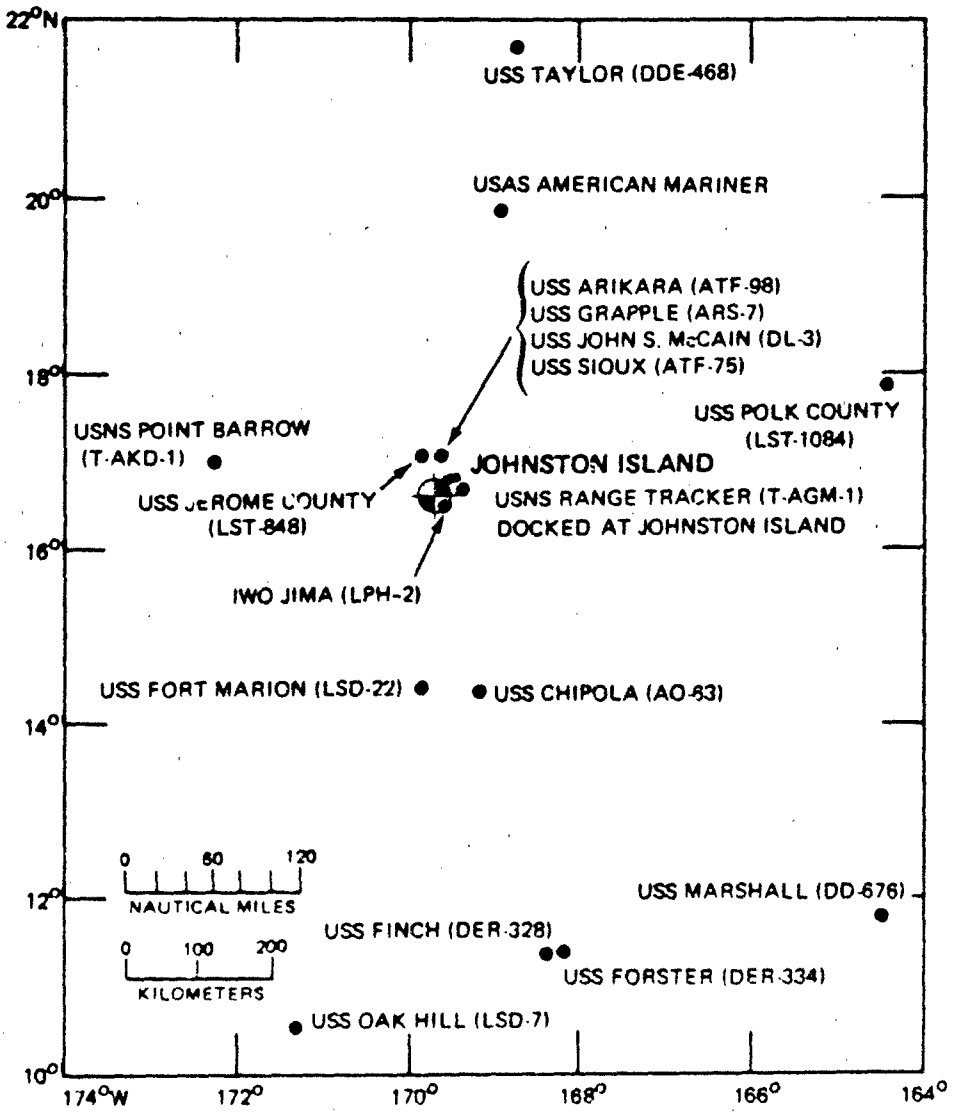


Figure 92. Ship positions, DOMINIC, STARFISH Prime.

lines of the old Saturday matinee one-reeler" as the solar panels on several other satellites began to lose their ability to generate power (Reference D.15, p. 2). The STARFISH detonation had generated large quantities of electrons that were trapped in the Earth's magnetic field; the trapped electrons were damaging the solar cells that generated the power in the panels.

BLUEGILL Prime (25 July 1962)

On the second attempt to launch the BLUEGILL device, one pod and two RVs, each heavily instrumented, and the warhead itself were mated to the missile. This was the second shot that attempted to launch RVs along with an instrumented pod. The missile malfunctioned after ignition but before leaving the launch pad. The Range Safety Officer destroyed the nuclear warhead by radio command. The Thor missile then blew up, which caused extensive damage to the launch pad and associated equipment. Although destruction of the warhead prevented any possible nuclear explosion, it caused extensive alpha contamination of the launch pad. Contaminated debris was also scattered throughout the area of the pad enclosed by the concertina wire. Burning rocket fuel, flowing through the cable trenches, caused contamination of the trenches and the interior of the revetments and all of the equipment contained in them. Prevailing winds (15 knots [27 km/hr] from the east) carried contamination downwind of the launch area. The launch area was fortunately placed, basically on the downwind end of the island. Figure 93 is a photo of the launch pad from slightly north of the direction from which the wind blew. Had the launch position been that used in the 1958 rocket launches, the area of contamination would have involved the central section of the island.

Figure 93. Thor launch pad for BLUEGILL Prime on Johnston Island viewed from the nurtheast looking almost downwind.

Figures 94 and 95 show the damaged launch stand, and Figure 96 shows the results of an initial radiological survey conducted the morning following the warhead destruction. The readings were taken using PAC-3G and PAC-1S alpha meters. Readings over 1,000,000 counts per minute (CPM) were obtained. This was a major contamination problem and it was necessary to decontaminate the entire area before the badly damaged launch pad could be rebuilt (Reference C.1.N, p. A-13).

OPERATIONS PAUSE

With the launch pad contaminated and out of commission, test operations necessarily stopped. During this period the task force dispersed, with most personnel returning to their home stations to await and prepare for the resumption of the tests. Preparations required activities both at Johnston Island and in replanning test operations at the home stations.

Launch Pad Decontamination

TU 8.5.1 (Holmes & Narver) supplied the labor force and radsafe supervisory personnel during the cleanup and reconstruction phase. It took 3 weeks of cleanup efforts to reduce the alpha contamination to a level that did not constitute a health hazard. During this period the following measures were implemented (Reference C.1.N, p. A-13):

- A radiological exclusion (radex) perimeter was established around the contaminated area
- A personnel decontamination station was used for all personnel entering and leaving the area
- Continuous air sampling was conducted adjacent to the decontamination tent and at locations within the radex perimeter to measure the airborne contaminants
- All persons entering the area wore full protective clothing.

A systematic plan was implemented to remove debris and topsoil (coral), add new coral, decontaminate the revetments and paved areas, fix radioactivity by painting and recovering surfaces, and dispose of waste at sea. The following actions were taken to decontaminate the pad (Reference C.1.N, p. A-13):

- All contaminated coral areas were sprinkled with oil to contain the spread of contaminated dust. Roughly 2 inches (5 cm) of topsoil (coral) was bulldozed over the embankment into the lagoon waters at the northwest corner of the pad.
- The concrete pads were scrubbed with detergents and solvents to remove all loose contamination. The pad under the launch mount was coated with epoxy paint. Other concrete areas, including the fuel-tank pads and liquid-oxygen-tank pads, were covered with epoxy or latex paint to fix any remaining contamination.
- Revetments were washed, scrubbed, and painted.

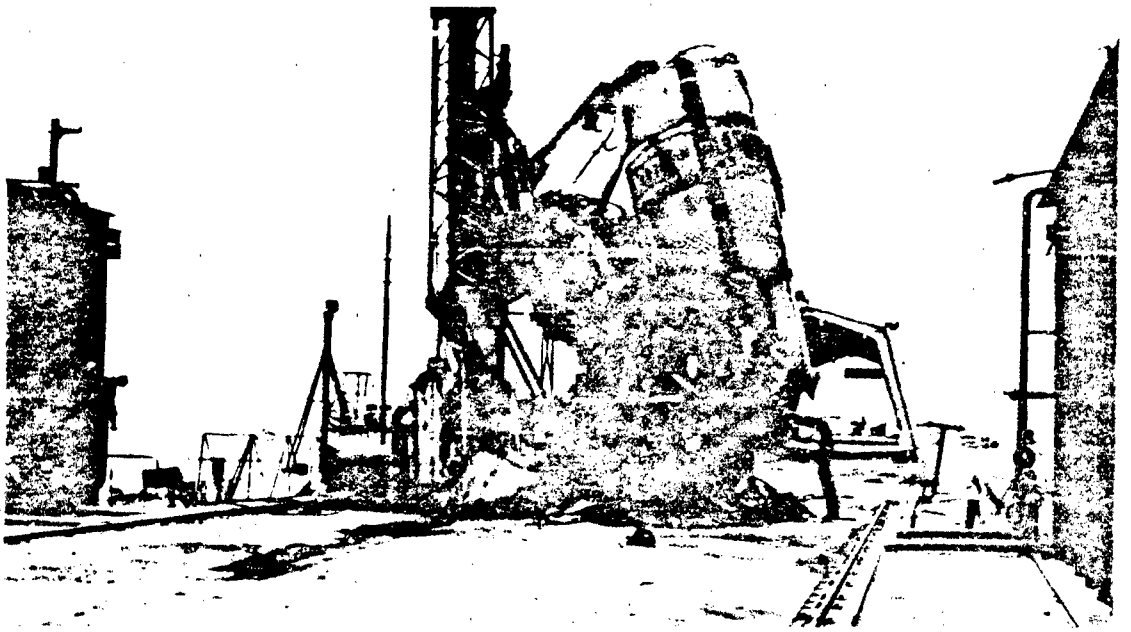


Figure 94. Thor pad after BLUEGILL Prime fire, Johnston Island, Operation DOMINIC. Compare with Figure 85 from nearly same point of view.

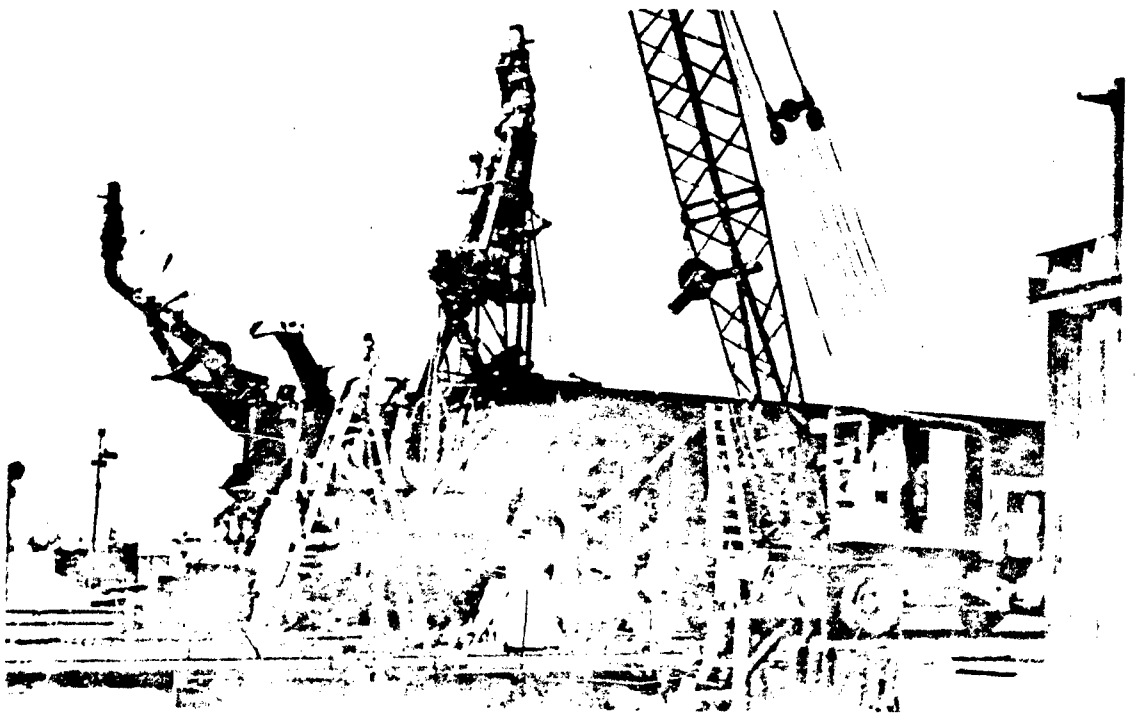


Figure 95. Cleanup of Thor pad following BLUEGILL Prime fire, Johnston Island, Operation DOMINIC.

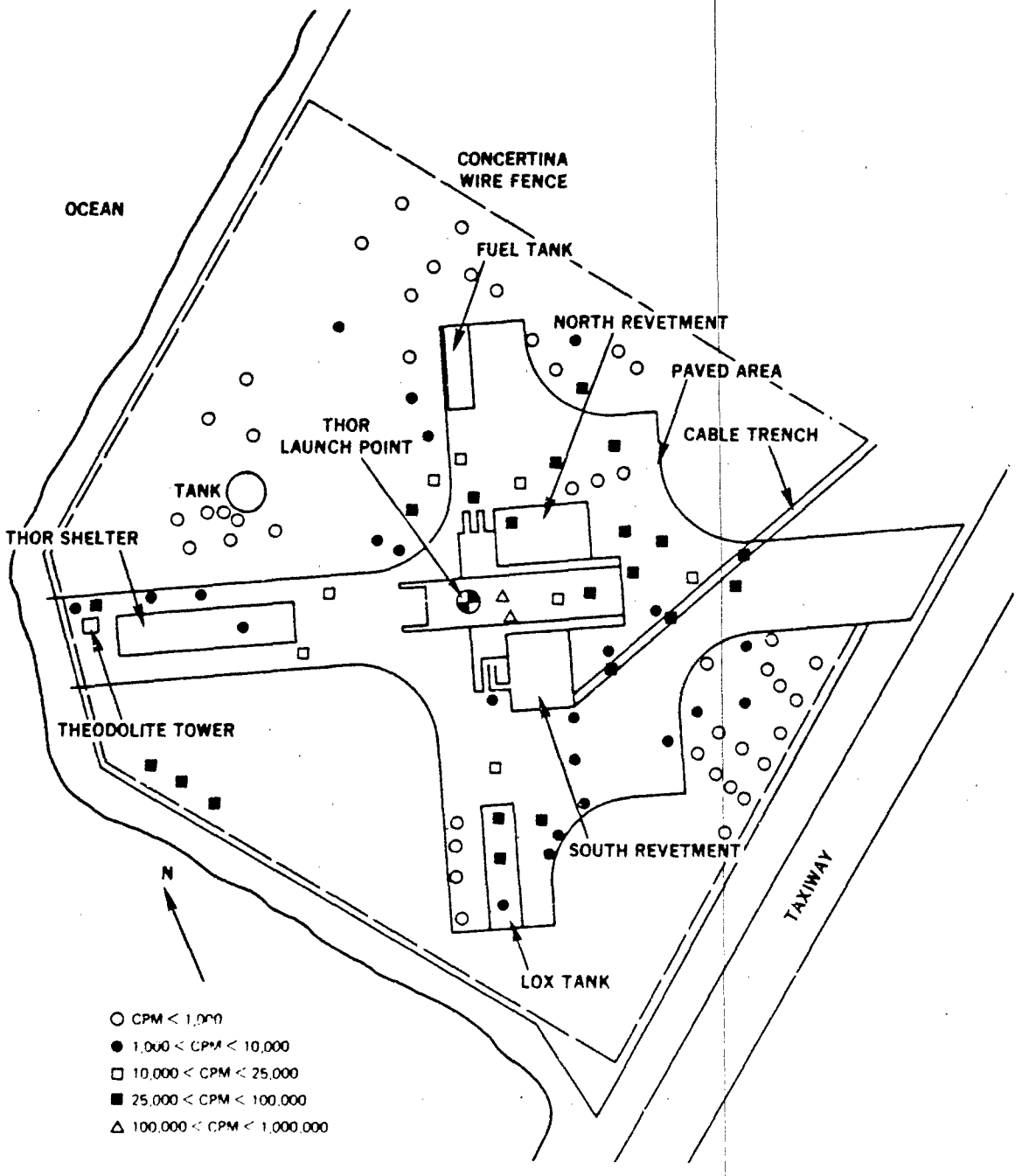


Figure 36. Initial radiological survey of the Thor launch pad following DOMINIC, BLUEGILL Prime (source: Reference C.2052).

- The bottoms of all cable trenches were covered with 1 inch (2.5 cm) of concrete and the sides were washed, scrubbed, and painted. Cable trench covers were replaced if contaminated. Existing cable conduit pipes were sealed at each end with concrete or steel plate and replaced with new pipes.
- The missile shelter was scrubbed and scraped to bare metal and repainted. The wooden ties supporting the shelter rails were covered with concrete.
- All electrical ground connection wells were filled with concrete.
- All expansion-joint grouting on the concrete pad was removed and replaced.
- All tools, equipment, etc. that could not be decontaminated were buried at sea in accordance with AEC standards.
- The long-range theodolite tower and the camera tower were scrubbed and repainted.

After about 2 weeks of decontamination efforts, the levels of radioactivity were as shown in Figure 97. These readings were taken after debris had been removed and everything had been washed, scrubbed and cleaned, but before painting. The readings were taken on 6 August and there were still areas above 100,000 CPM -- high levels of contamination. Information on contamination levels after 6 August is not available, except for some readings taken late in November (3 weeks after the last event at Johnston Island). During the cleanup, meticulous care was taken to ensure personnel safety. Full protective clothing was worn, including respirators (Figure 98). Figure 99 shows the soil removal and replacement process and the driver of the front loader is properly clothed including full head covering. Returning workers underwent nose swipe tests as a check on any possible inhaled contamination (Figure 100). Contaminated clothing was dumped in barrels at the edge of the contaminated area for separate laundry (Figure 101).

The two revetments at the launch pad were surveyed 23 November and readings from 0 to 20,000 CPM were recorded (see Figure 102). Because of the continuing alpha contamination around the pad, a continuous surveillance system was instituted that included daily inspections of the launch pad area, spotchecks of shoes of individuals as they left the area, and periodic checks of the dining facility (alpha-emitting contamination is a medical problem only if it enters the body). Loose or chipped paint or concrete was dumped in the ocean, and the exposed areas were repainted. After each missile firing, radsafe personnel inspected the area for evidence of exposed contaminated coral or other contamination problems (Reference C.1.N, p. A-17).

Replanning the Operation

The enforced pause allowed the DOD to replan the remainder of the FISHBOWL series. The URRACA event was cancelled to avoid further damage to satellites and three new shots were added (Reference D.15, p. 363). Whether due to the lackluster Thor performance or to an insufficient supply of them, different missiles, the Army Nike-Hercules, were made ready for two of these new events.

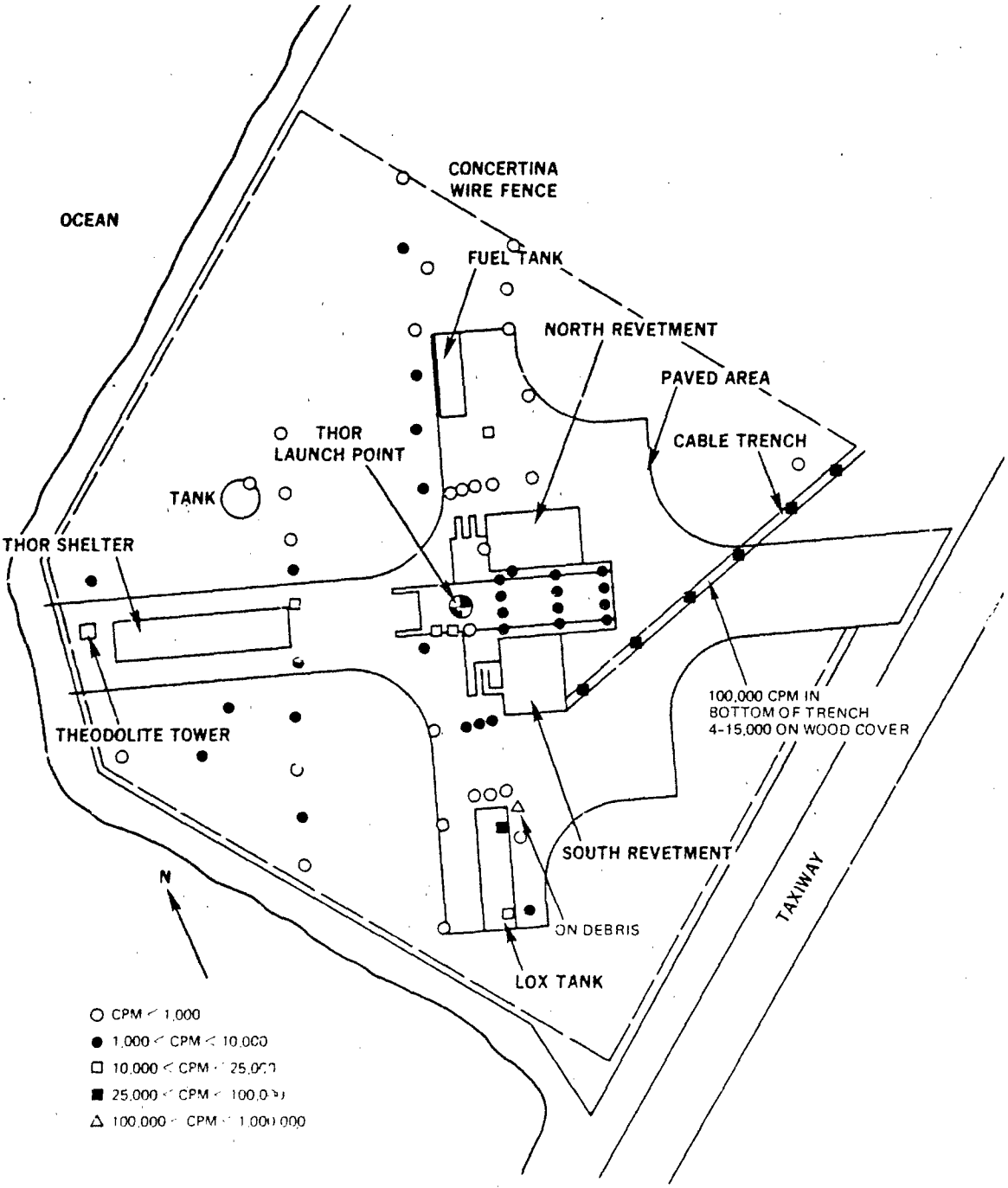


Figure 97. Thor launch pad contamination levels after 2 weeks of decontamination efforts, DOMINIC (source: Reference C.2052).

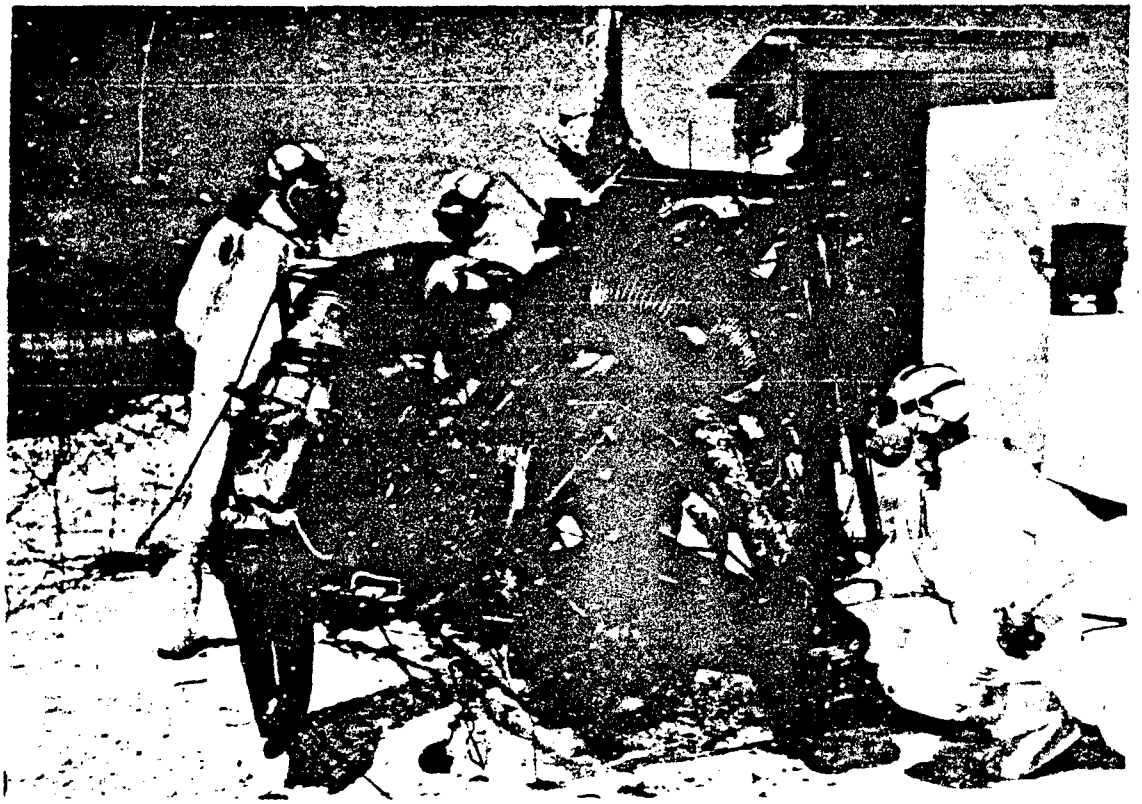


Figure 98. Inspection of Thor engine parts following BLUEGILL Prime fire on Johnston Island, Operation DOMINIC.

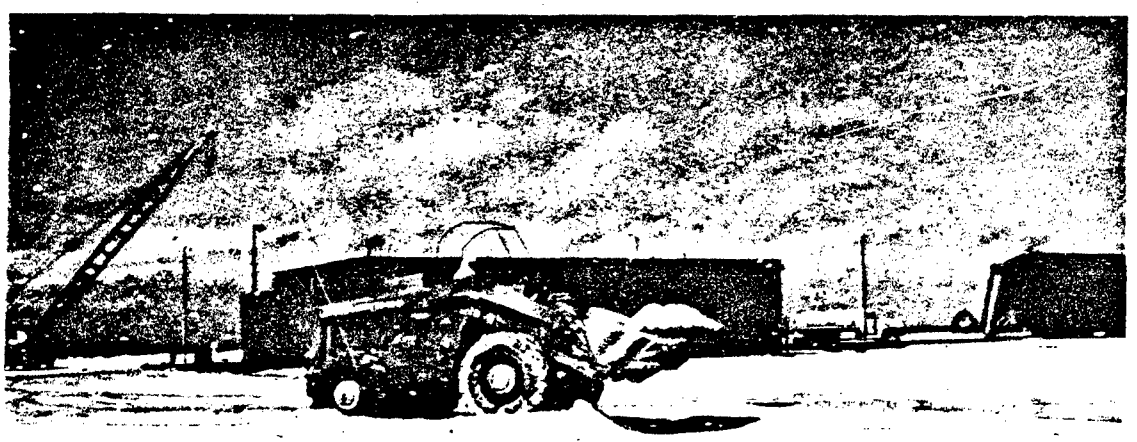


Figure 99. Loader moves contaminated soil near Thor launch pad during cleanup operations, Johnston Island, Operation DOMINIC.

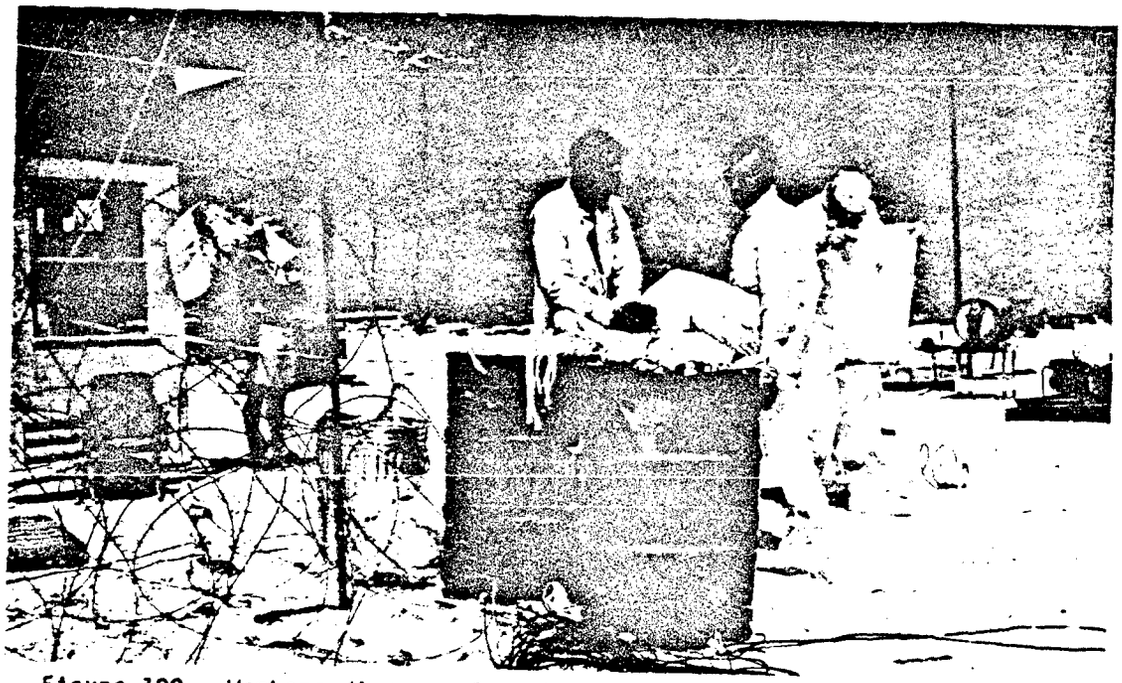


Figure 100. Workers dispose of protective clothing before showering when leaving Thor launch pad cleanup area on Johnston Island.

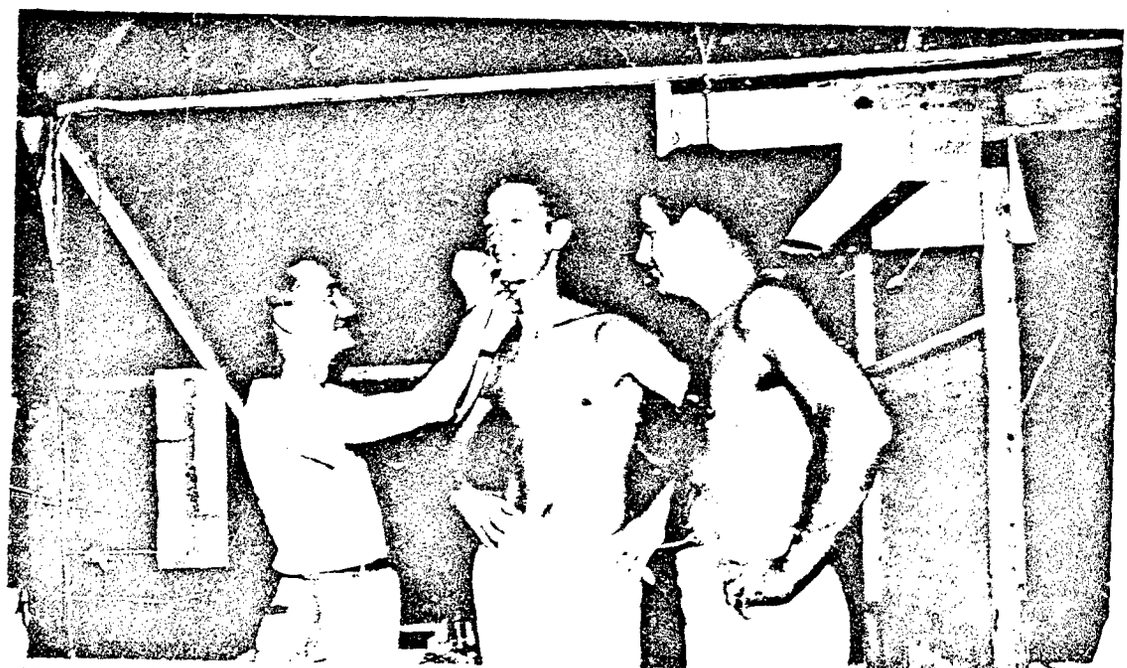


Figure 101. Workers cleaning up Thor launch pad receive nose-swipe tests for inhaled contaminants, DOMINIC.

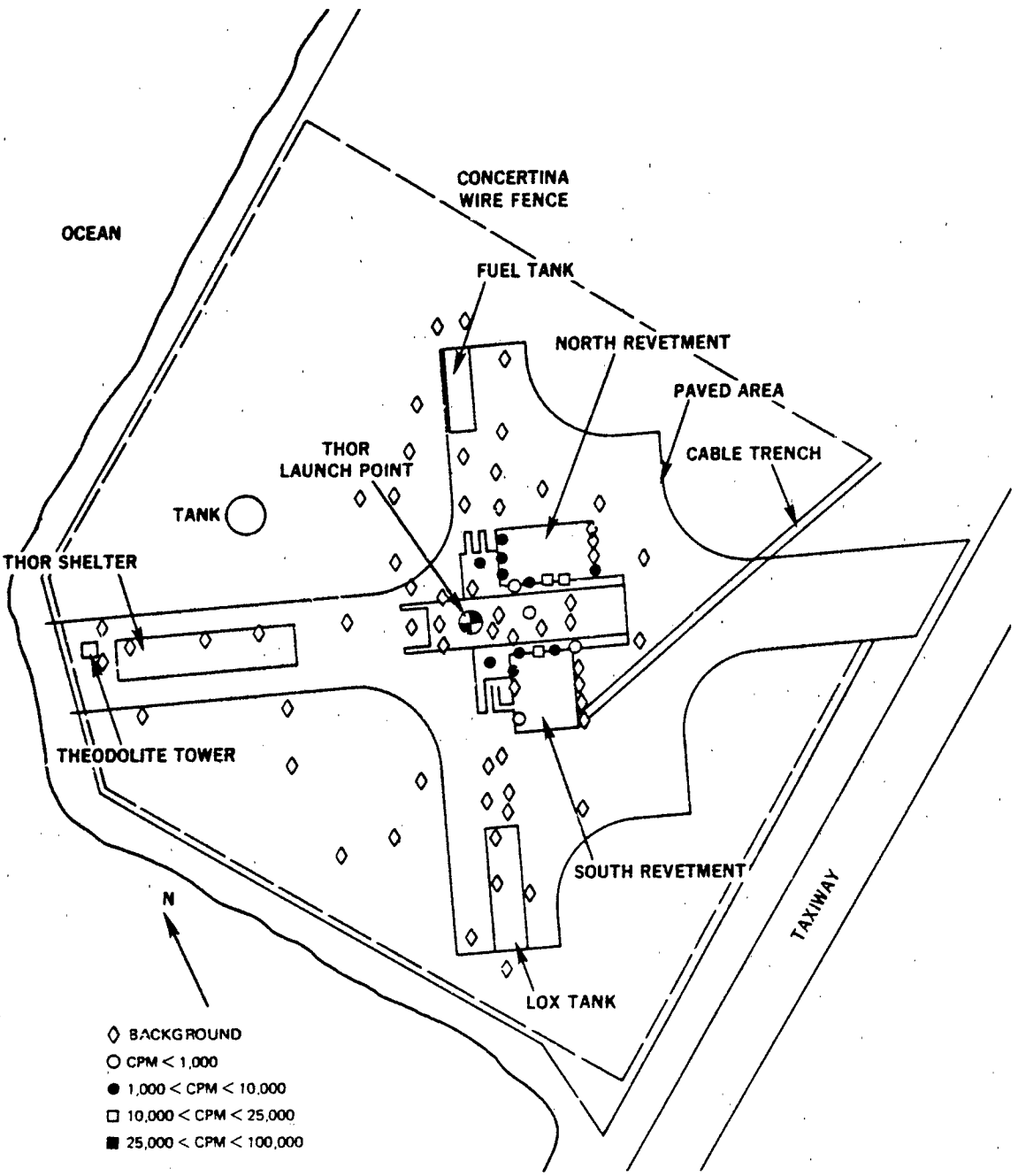


Figure 102. Thor launch pad contamination levels, 23 November 1962 after DOMINIC (source: Reference C.2052).

An Air Force official issued a public statement on 27 July stating that the Thor failures should not be equated with the state of U.S. military preparedness, pointing out that several of the Thor failures were related to pod and exhaust flame interactions or other causes not related to the Thor's military use (New York Times, 27 July 1962).

BLUEGILL Double Prime (15 October 1962, 2130)

Eighty-two days after BLUEGILL Prime failed, a third attempt to execute BLUEGILL was made just before midnight. A second launch pad had been installed in the interim as a backup in case of another accident. Three heavily instrumented pods were attached to the Thor missile as part of the experimental program. The missile malfunctioned shortly after launch, requiring the Range Safety Officer to order the destruction of the warhead approximately 95 seconds after launch. All three pods were recovered.

During this period the Nike-Hercules missile had two certification firings. Both of these firings ended in automatic self-destruct of the missile because of command guidance beacon loss for more than the preset time allowed. As a result of this problem the Thor was selected for the next BLUEGILL attempt (Reference C.I.L, p. C-3-1).

CHECKMATE (19 October 1962, 2230)

Preparations by Sandia Corporation to launch the first low-yield shot of the high-altitude series paralleled the BLUEGILL Double Prime preparations. Thus, 5 days after BLUEGILL Double Prime failed, CHECKMATE was ready for launching. The launch vehicle was a modified XM-33 rocket, designated Strypi. Because of its small size and payload capacity in relation to the Thor missile, it carried no instrumented pods. Also, it required additional thrust from two Recruit booster rockets that were attached to its base.

The CHECKMATE device was successfully launched using the Strypi. Yield and burst altitude were very close to those desired. Nearly all projects reported outstanding success in obtaining diagnostic data. Weather conditions were excellent in the Johnston Island area, allowing good optical data to be taken. Observers on Johnston Island saw a green and blue circular region surrounded by a blood-red ring formed overhead that faded in less than 1 minute. Blue-green streamers and numerous pink striations formed, the latter lasting for 30 minutes. Observers at Samoa saw a white flash, which faded to orange and disappeared in about 1 minute.

Ten small instrumentation rockets were fired from Johnston Island and twelve from Barking Sands, Kauai. Three of the small rockets launched from Johnston were used in an attempt to sample the nuclear cloud. None of the three was successfully recovered (Reference C.I.L, p. C-8-1).

All nonessential personnel (787) were evacuated to the amphibious assault ship, USS Princeton (LPH-5), by helicopter before the shot and returned the day after the shot.

Positions of aircraft in the air array to gather scientific data or for control purposes are shown in Figure 103. In addition to those shown in Figure 103, two WB-50 weather aircraft, one SC-54 SAR aircraft, and one U-2 participated. Two RC-121s and one KC-135 again participated below the equator. Ship positions are shown in Figure 104.

BLUEGILL Triple Prime (25 October 1962, 2359)

The fourth attempt to launch the BLUEGILL device using a Thor missile was successful. Observers at Johnston Island saw a brilliant white flash, and a noticeable thermal pulse could be felt on bare skin. A slightly distorted bright moon-like sphere was observed -- yellow at first and gradually showing hues of green, pink, and violet -- and blue-purple streamers were formed. At 10 minutes the glow was bright enough that a watch could be read in the dark and it persisted for at least 30 minutes. At Samoa, observers saw a pink band at the horizon, which faded after about 10 minutes to gray.

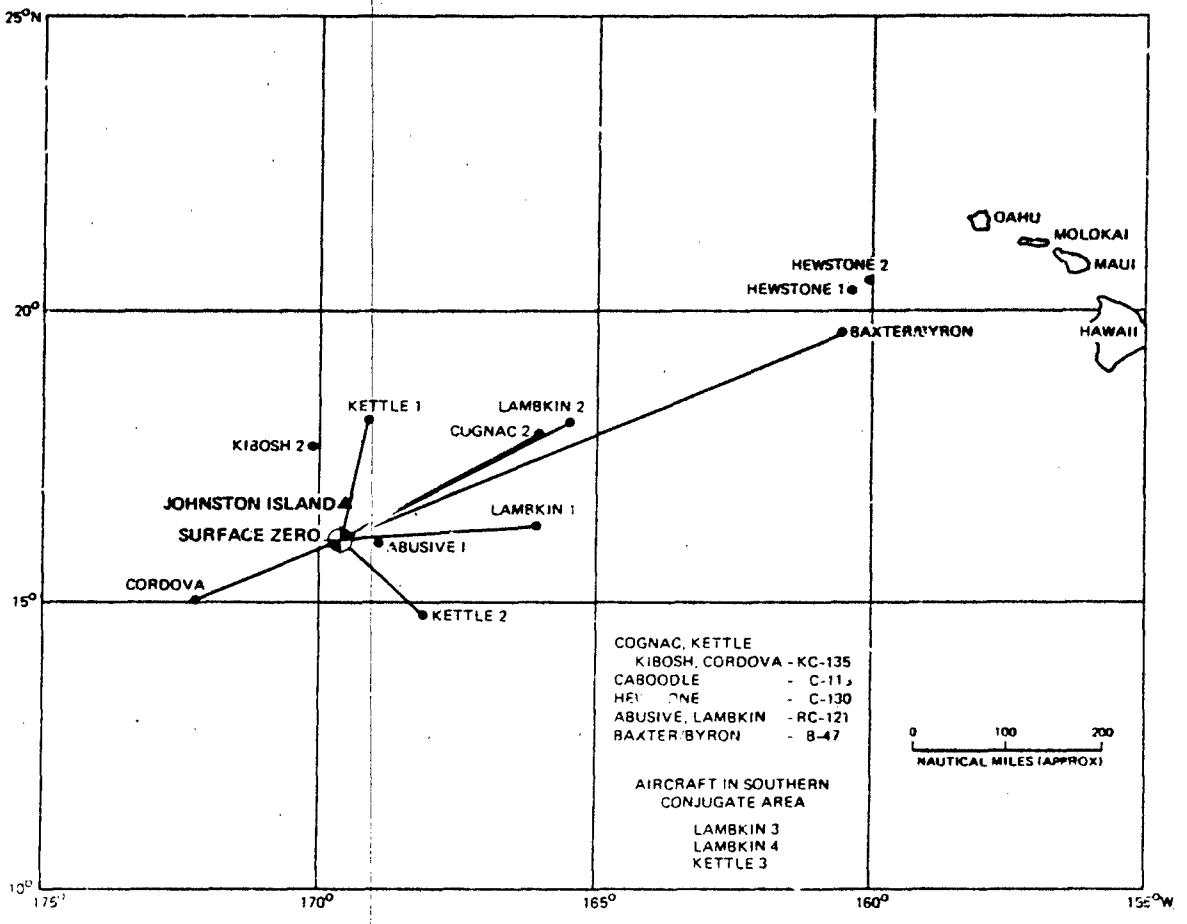


Figure 103. Aircraft array for DOMINIC, CHECKMATE, (Source: Reference C.2053, Appendix E).

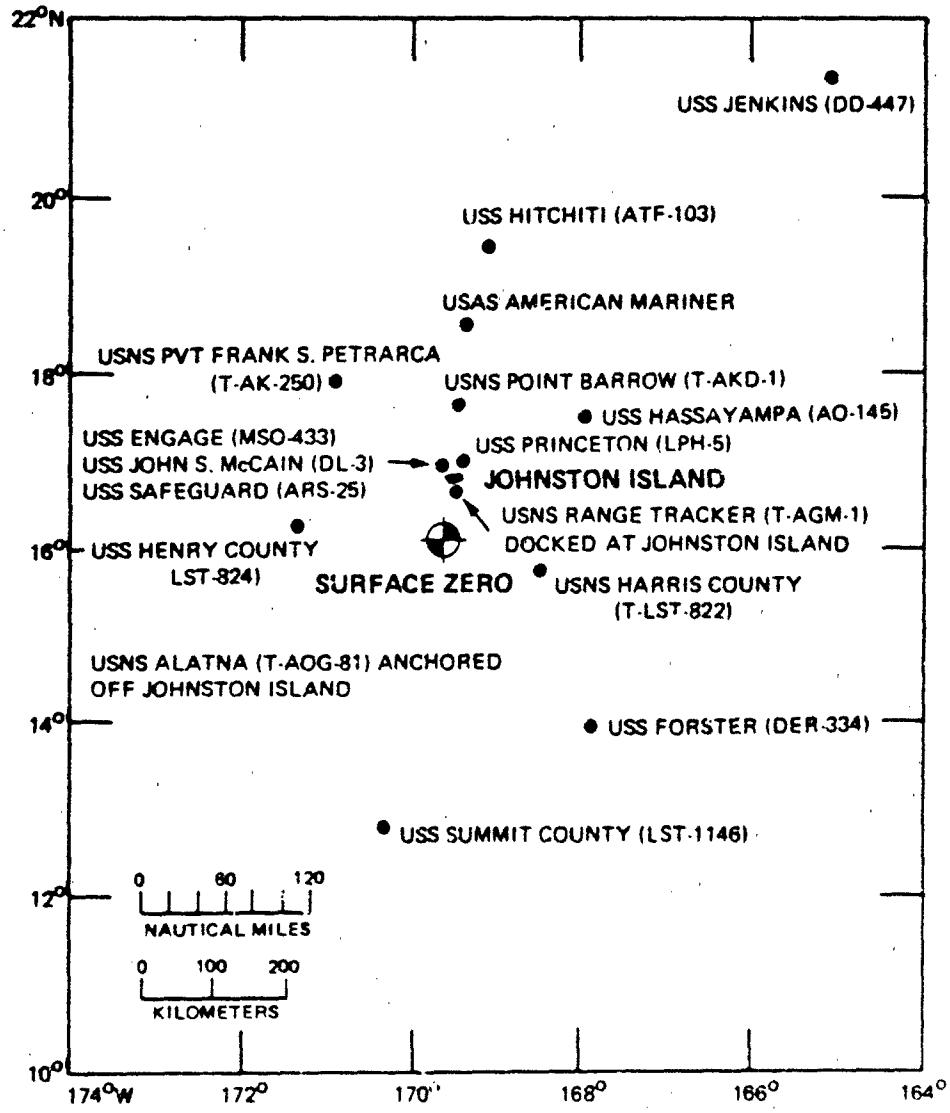


Figure 104. Ship positions, DOMINIC, CHECKMATE.

Scientific experiments were quite successful, including photography. The weather was exceptionally clear. Three instrumentation pods were carried aloft by the Thor missile. They functioned properly and were subsequently recovered by the Navy and returned to Johnston Island. All three pods were radioactive; the highest reading was 14 R/hr, measured 8 hours after detonation (Reference C.1.L, p. C-4-1).

Twenty-eight small instrumentation rockets were launched from Johnston Island, including two for sampling the nuclear cloud debris. The nosecones from these two sampling rockets were not recovered (Reference C.2053, p. 247).

All nonessential personnel (803) were evacuated from Johnston Island to Princeton before the shot and returned the next day.

Two men on Johnston Island sustained burns on the retinas of their eyes. One Air Force enlisted man was wearing protective goggles, but the lenses were in the up, or nonprotective, position. He had lost track of the countdown and was walking toward his preassigned position. As he reached up to adjust the lenses, the detonation occurred. Following the shot he observed blurring and a dark spot in front of each eye. He was transferred to Tripler General Hospital for a 29-day stay and was later cared for at the Air Force School of Aerospace Medicine (AFSAM) at Brooks AFB, Texas. His central vision was impaired and initially his vision was 20/400 O.U. His vision improved during his stay at Tripler and was 20/30 in both eyes on leaving. At AFSAM his vision continued to improve and was 20/25 O.U. for distance and 20/20 O.U. for near in 1963 (Reference D.13, p. 136).

A Navy enlisted man had his goggles in the ready position on his forehead. He stated that he was looking straight ahead when the detonation occurred. He then looked up and down rapidly. He had an immediate after-image of a large, round, white ball, which lasted for an hour but returned when he awoke early the next morning. At Tripler his central visual acuity was less than 20/400. The best visual acuity was 20/60 to 20/70 looking off-center. His vision did not improve either at Tripler or at AFSAM. However, the patient noticed an increased ability to compensate for the loss of central visual acuity (Reference D.13, p. 136).

There is a remote possibility that the burns of both men could have resulted from a reflection rather than a direct image. Such reflections could come from a wristwatch face or a variety of shiny metal or glass surfaces (Reference D.16, p. 74).

The Air Force arrayed 22 aircraft for the detonation as shown in Figure 105. Other aircraft participating included Air Force WB-50s and U-2s (weather), Navy P2Vs (surveillance and pod recovery), and Marine helicopters (pod recovery).

Nine Navy ships were positioned to gather scientific data. Their locations are shown in Figure 106.

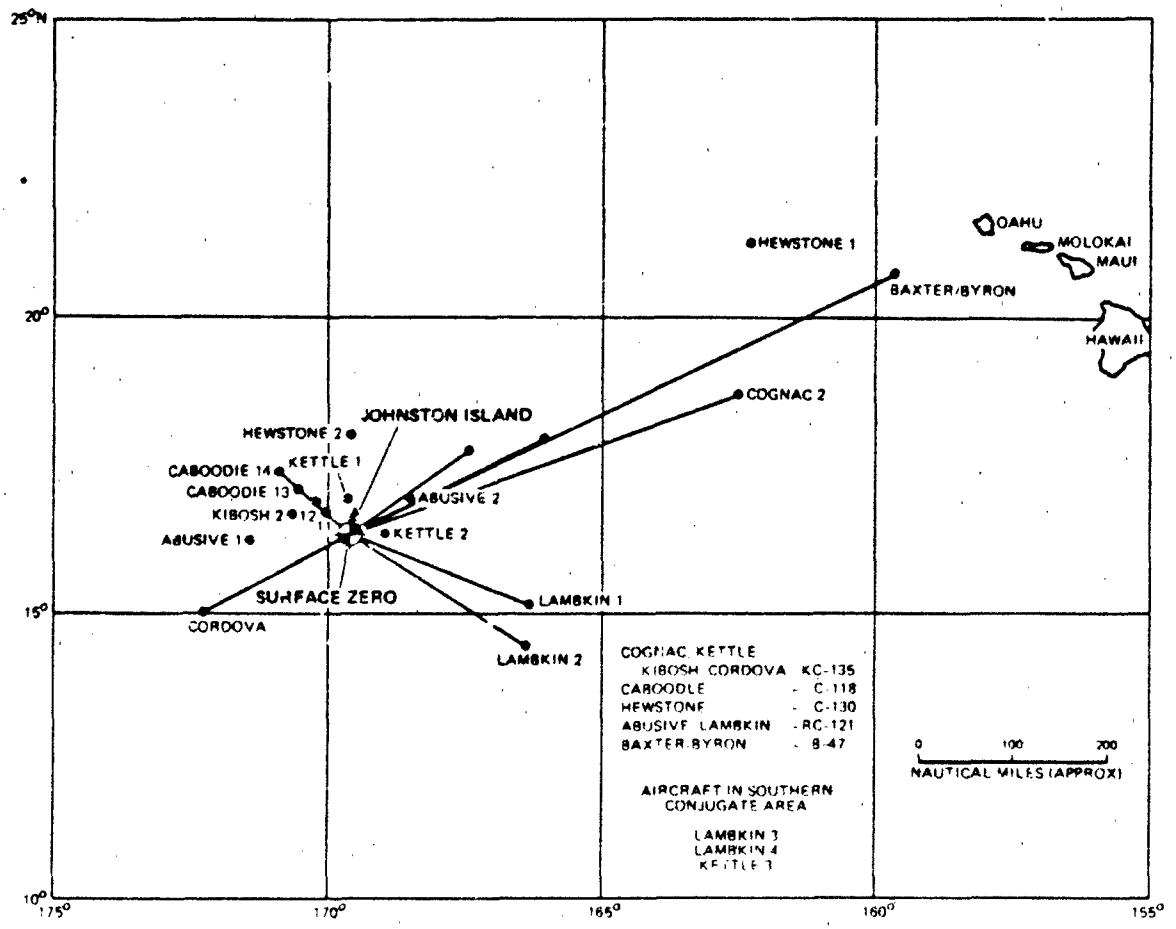


Figure 105. Aircraft array for DOMINIC, BLUEGILL Triple Prime (source: Reference C.2053, Appendix E).

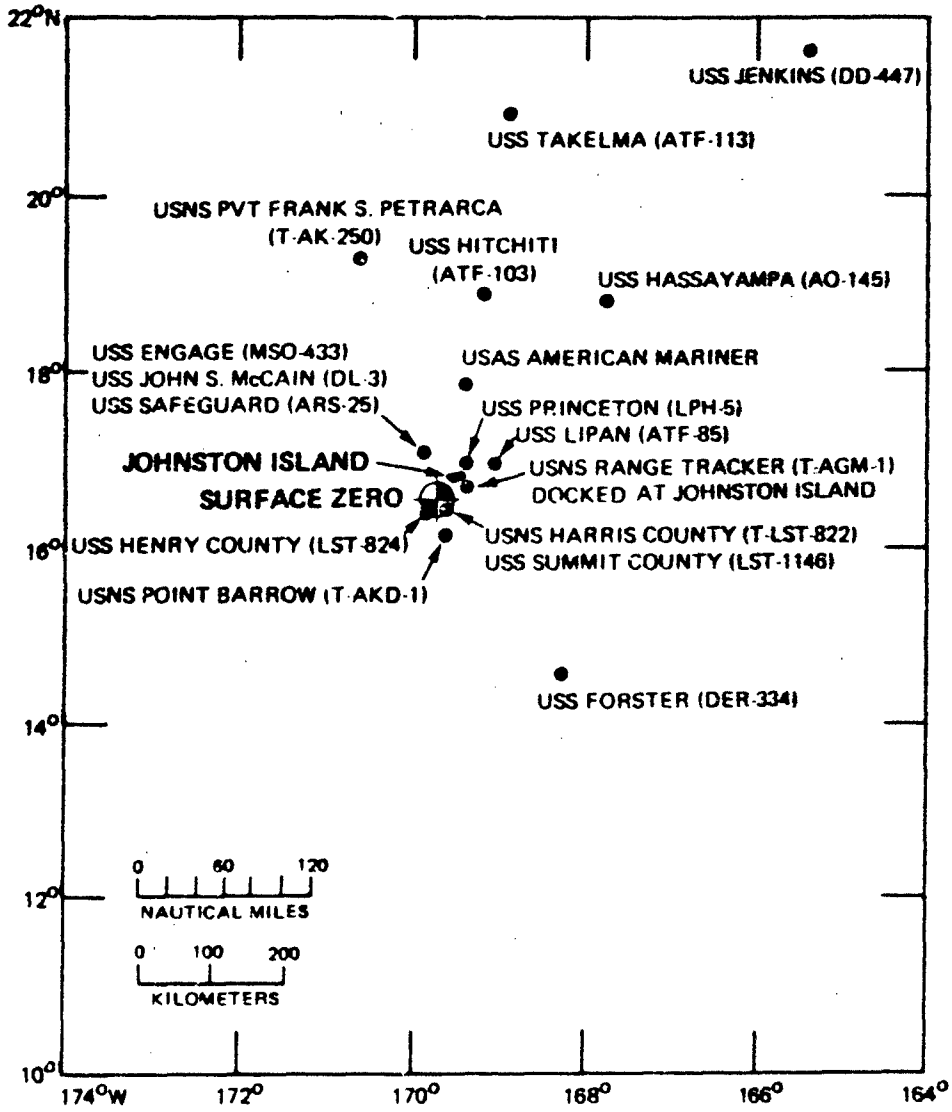


Figure 106. Ship positions, DOMINIC, BLUEGILL Triple Prime.

KINGFISH (1 November 1962, 0210)

The KINGFISH event was the fourth successful high-altitude event. A Thor missile launched the nuclear warhead and three instrument pods to the desired altitudes. Johnston Island observers saw a yellow-white, luminous circle with intense purple streamers for the first minute. Some of these streamers displayed what appeared to be a rapid twisting motion at times. A large pale-green patch appeared somewhat south of the burst and grew, becoming the dominant visible feature after 5 minutes. By H+1 the green had become dull gray, but the feature persisted for 3 hours. At Oahu a bright flash was observed and after about 10 seconds a great white ball appeared to rise slowly out of the sea and was visible for about 9 minutes.

The three pods were released on schedule prior to detonation and all three were recovered by the Navy (two by helicopter and one by ship). All pods were radioactive with the highest reading at 2 R/hr measured 8 hours after detonation (Reference C.I.L. p. C-7-3).

Twenty-nine small rockets carrying experiments were launched from Johnston Island. Two rocket nosecones were configured for sampling the nuclear cloud debris and recovery from the ocean; however, neither could be found (Reference C.I.L. p. C-7-8).

All nonessential personnel (787) were evacuated from Johnston Island to Princeton before the shot and were returned the following morning.

The aircraft array at shot time is shown in Figure 107. Other aircraft used included P2Vs (surveillance and pod recovery), WB-50s and U-2s (weather), and Marine helicopters for pod recovery. Both RC-121s that operated below the equator in the previous high-altitude shots had returned to California before this shot.

The Navy had a ten-ship array, as shown in Figure 108. These ships were positioned to obtain needed scientific data before, during, and after the detonation. As in the other high-altitude shots, the Navy had other ships in the area as well, which were used for nonscientific missions.

TIGHTROPE (3 November 1962, 2130)

A Nike-Hercules missile launched the low-yield warhead successfully. At Johnston Island, there was an intense white flash. Even with high-density goggles, the burst was too bright to view, even for a few seconds. A distinct thermal pulse was also felt on the bare skin. A yellow-orange disc was formed, which transformed itself into a purple doughnut. A glowing purple cloud was faintly visible for a few minutes.

No instrument pods were used on this event. Although experimental project participation was reduced somewhat for this event, excellent data were obtained. Seven instrumented small rockets were fired from Johnston Island in support of experiments. Another Nike-Hercules missile was launched 5 seconds before the nuclear-tipped missile, carrying a radar transmitter to the area of the nuclear detonation (Reference C.I.L., p. C-9-2).

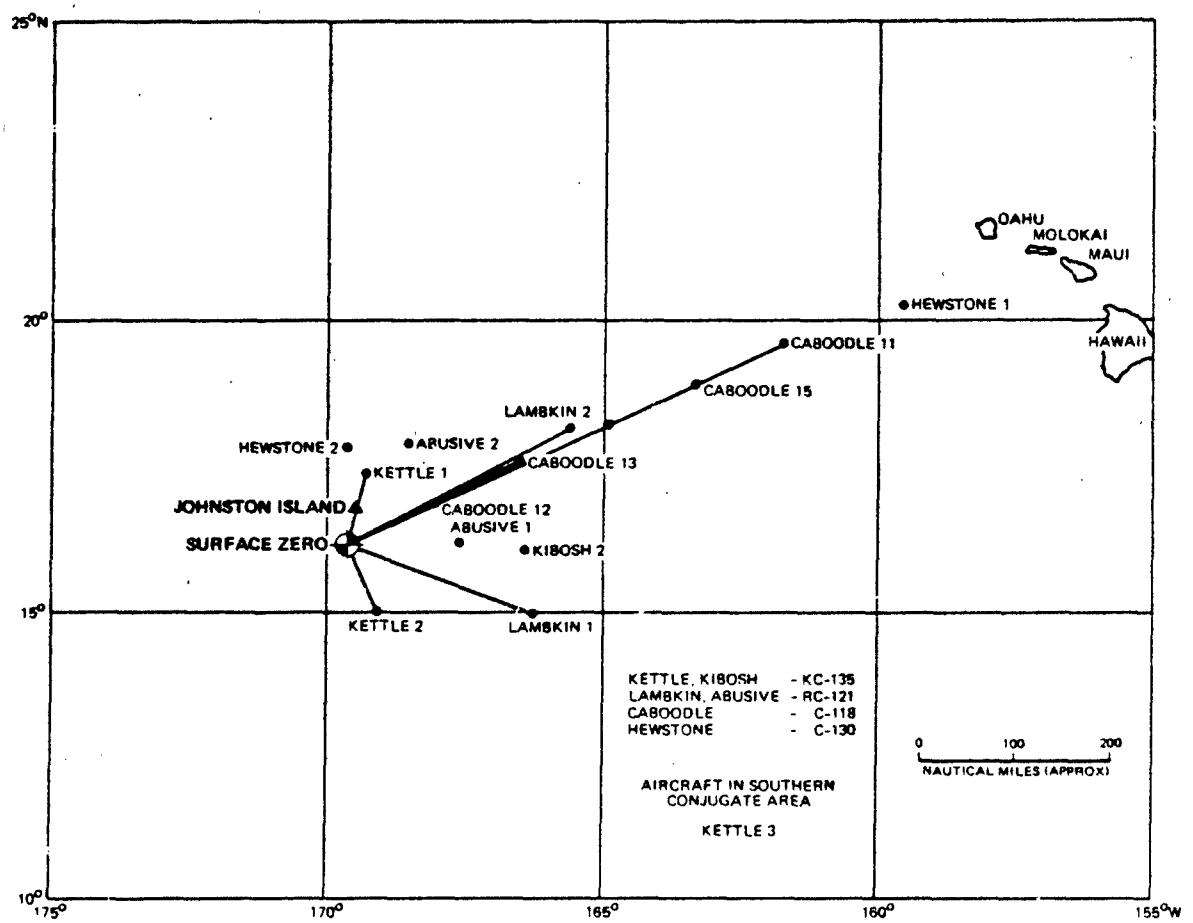


Figure 107. Aircraft array for DOMINIC, KINGFISH (source: Reference C.2053, Appendix E).

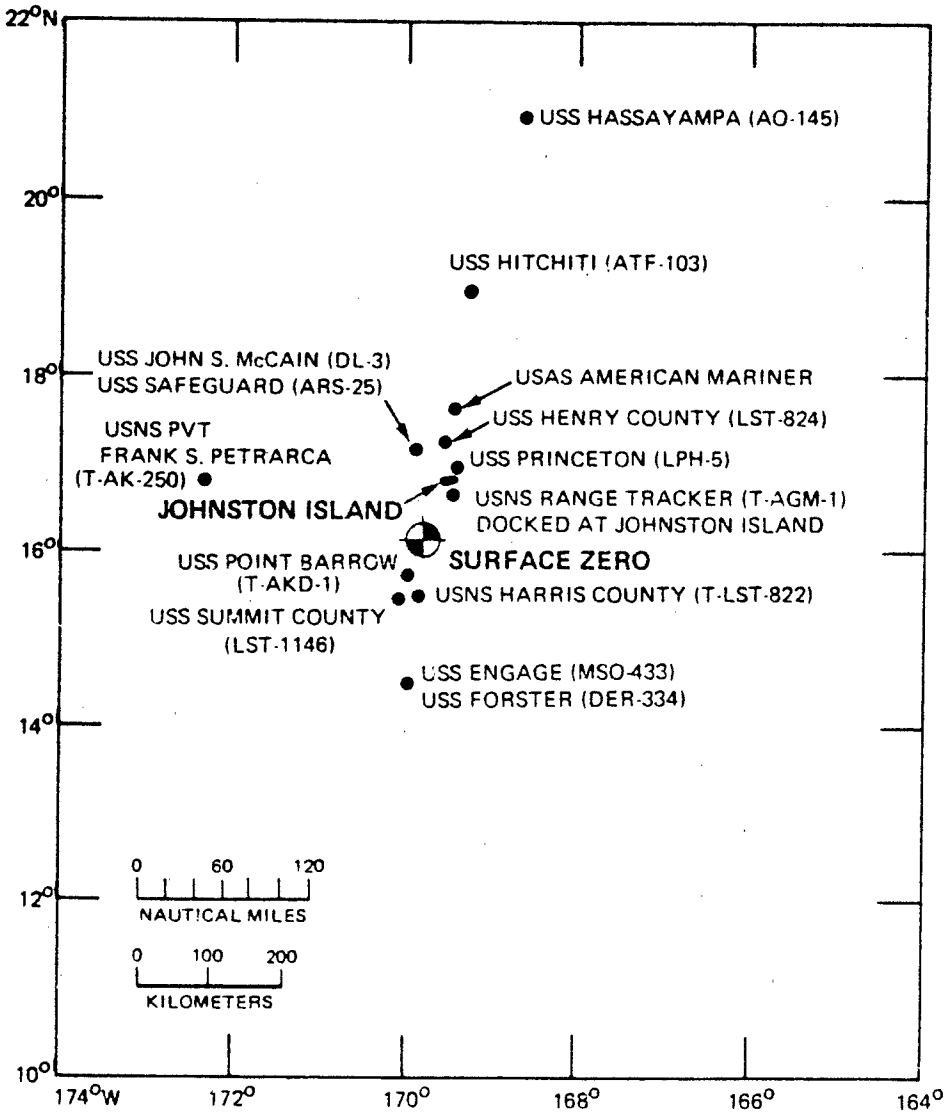


Figure 108. Ship positions, DOMINIC, KINGFISH.

Six hundred and thirty-three nonessential personnel were evacuated from Johnston Island before the detonation to Princeton; they returned to the island the following morning.

Locations of precisely positioned aircraft are shown in Figure 109. Other aircraft participating included Navy P2Vs (surveillance), two RC-121s (airborne air operations centers), two B-50s, and U-2s (weather observation).

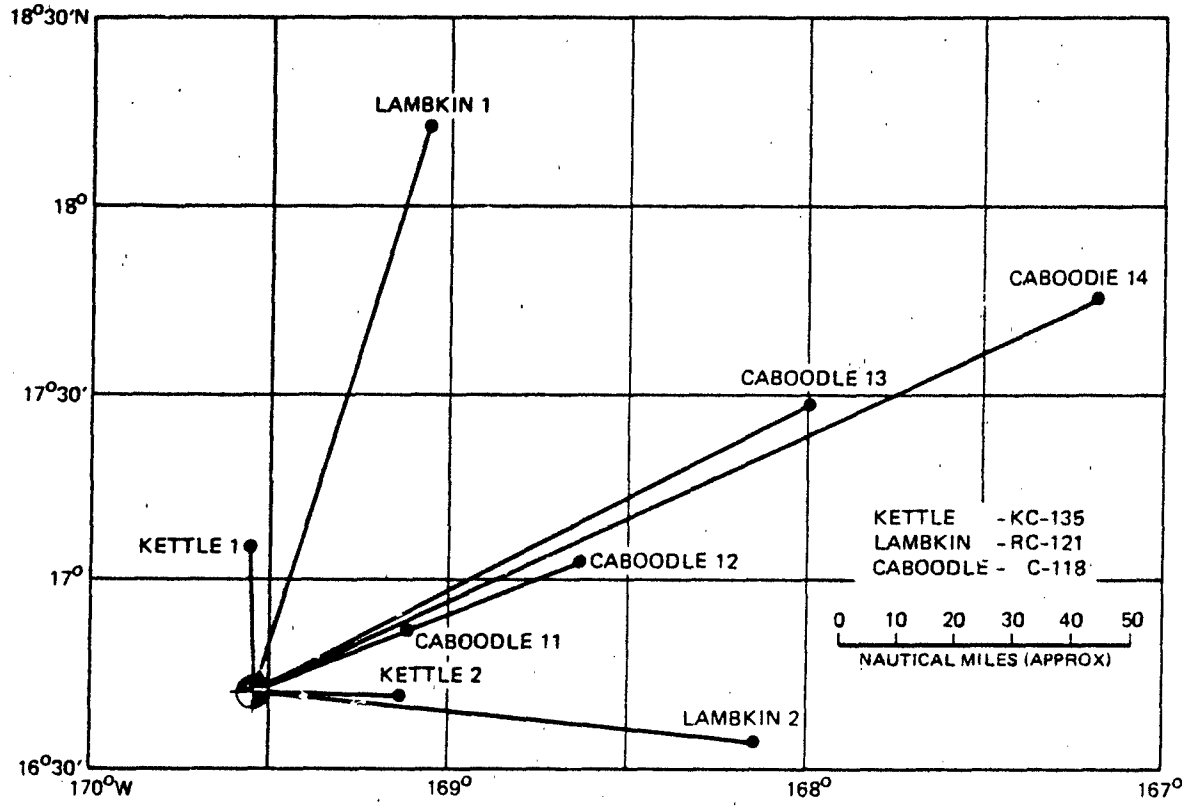


Figure 109. Aircraft array for DOMINIC, TIGHTROPE (source: Reference C.2053, Appendix E).

Figure 110 shows locations of ships that participated in TIGHTROPE. Several ships had surveillance, range safety, etc. functions in addition to those operating as scientific stations.

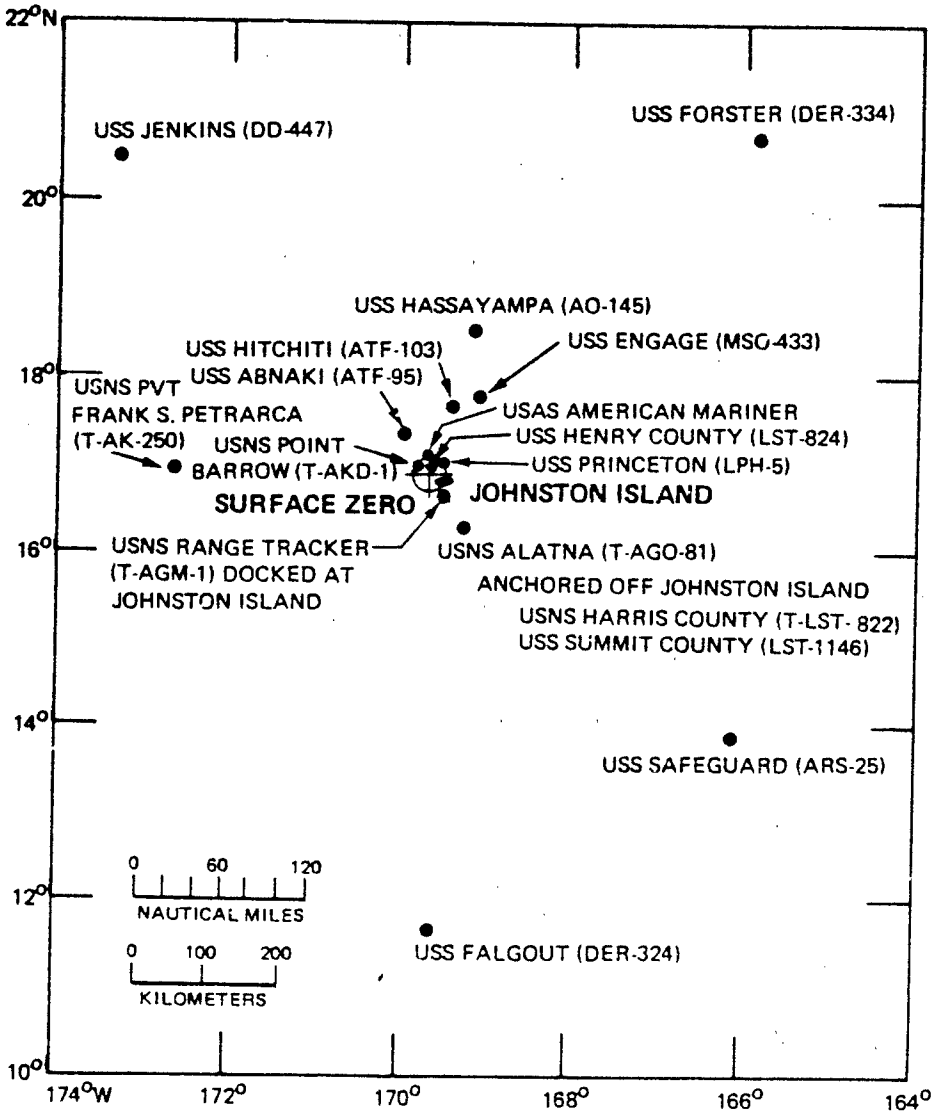


Figure 110. Ship positions, DOMINIC, TIGHTROPE.

CHAPTER 8

U.S. ARMY PARTICIPATION IN OPERATION DOMINIC

The Army was not given a specific mission, nor was it formed into an operational task group for DOMINIC as were the Air Force and Navy. The Army was well represented by personnel on the Joint Task Force 8 (JTF 8) staff and the staffs of the two island base commands at Christmas and Johnston islands. In addition, personnel from 86 Army units were represented at DOMINIC. Missions conducted by Army units included radiological safety (radsafe) functions, military police duties, Nike-Hercules missile launches, and long-line communications installation and operation for islands in the Southern Conjugate Area. Exposures for Army personnel were generally very low. Two Army units (the Chemical Corps Radiological Unit and the Chemical Corps Training Command) working in the JTF 8 Radsafe Branch, specifically with the Air Force sampler aircraft, recorded exposures that were higher than the other Army units, with a few over 3 R. These men, however, were authorized to receive up to 20 R by the JTF 8 Operations Order because they were working with sampler aircraft.

Table 23 lists all Army organizations represented at DOMINIC. The table also shows a four-digit code that was used to identify units for personnel film badge issuance and summation of readings. All codes with associated organizations are listed in Appendix B. The table is divided into two parts, the first being the units with significant* participation listed in the order of their discussion in this text. The 55 units in the second part of Table 23 contributed only 65 men; none of these had exposures greater than 0.33 R. The mean exposure for all Army personnel was 0.20 R. The numbers shown in the table are from the Consolidated List (Reference C.1.2) without the changes and corrections discussed in the text.

52nd Artillery Regiment, Fort Bliss, Texas. The unit that launched the Nike-Hercules missiles from Johnston Island was the 2nd Missile Battalion, 52nd Artillery Regiment. All personnel listed under organization codes 8255 (52nd Artillery Regiment) and 8273 (2nd Missile Battalion) are from this unit. This unit was selected by the Army Missile Command (AMC), designated Task Unit (TU) 8.1.7, to launch the Nike-Hercules missile that carried the TIGHTROPE device to its detonation altitude over Johnston Island, as well as the Nike-Hercules that carried a radar beacon on the second test. Most of the 38 personnel arrived on Johnston Island in August 1962 and departed after the TIGHTROPE shot on 3 November 1962. All exposures for persons in these two codes were less than 0.1 R.

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* Significant is used in this chapter to mean having a large contingent at DOMINIC, a mission or function that is well understood, or a radiological exposure worthy of comment.

Table 23. DOMINIC personnel exposures, U.S. Army organizations.

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
Army Units with Significant Participation											
8255	52nd Artillery Regiment, Ft. Bliss TX	15	12	3							0.082
8210	25th Aviation Company, Schofield Barracks HI	10	6	4							0.115
8257	Army Chemical Center, Edgewood Arsenal MD	16	1	14	0	1					1.325
8200	Army Chemical Corps Radiological Unit, Dugway UT	24	1	9	2	5	1	1	2	3	3.539
8201	Army Chemical Corps Training Command, Ft. McClellan AL	10	0	3	2	2	1	1	1		2.677
8275	Corps of Cadets, West Point NY	1	1								0.000
8259	901st Counter-Intelligence Corps Det, Sandia Base NM	2	0	2							0.135
8232	2nd Engineer Battalion, Ft. Belvoir MD	3	1	2							0.102
8274	65th Engineer Battalion, Schofield Barracks HI	2	0	2							0.148
8203	497th Engineer Company , Ft. Belvoir VA	9	9								0.000
8241	518th Engineer Detachment, Ft. Belvoir MD	26	9	17							0.253
8283	151st Engineer Group, Ft. Benning GA	1	0	1							0.080
8223	Army Garrison, Ft. Shafter HI	5	2	2	1						0.790
8224	Army Garrison, Schorield Barracks HI	14	9	5							0.181
8285	Army Garrison , Sandia Base NM	2	0	2							0.220
8269	Army Garrison, Ft. Belvoir VA	2	2								0.000
8226	Army Garrison, Ft. Lewis WA	1	0	1							0.210
8251	Army Garrison, Ft. Lewis WA	1	1								0.000
8266	Army Garrison, Johnston Island JI	1	1								0.000
8286	Hq Aberdeen Proving Ground MD	35	13	21	1						0.950
8250	Hq Ft. Bliss TX	11	8	1	2						0.750
8262	Hq Picatinny Arsenal NJ	9	6	3							0.065
8261	291st Military Police Company, Redstone Arsenal AL	3	2	1							0.069
8206	524th Military Police Company, Ft. Shafter HI	65	15	49	0	1					1.250
8273	2nd Missile Battalion, Ft. Bliss TX	23	21	2							0.020
8256	Army Missile Command, Redstone Arsenal AL	8	6	2							0.048
8227	White Sands Missile Range, White Sands NM	53	27	26							0.340
8253	725th Ordnance Battalion, Schofield Barracks HI	3	1	2							0.044
8258	200th Ordnance Detachment, Ft. Bliss TX	6	6								0.000
8254	Company A, School Troops, Ft. Gordon GA	7	0	7							0.268
8344	USAS American Mariner	106	65	41							0.310
8217	125th Signal Battalion, Schofield Barracks HI	29	16	13							0.327
8238	595th Signal Company, Ft. Monmouth NJ	2	0	1	0	1					1.350
8287	999th Signal Company, Naha, Okinawa	3	2	1							0.060
4582	999th Signal Company, Naha, Okinawa	1	1								0.000
8291	999th Signal Support Company, Schofield Barracks HI	1	0	0	0	0	0	1			2.281
8284	Army Signal Radio Propagation Agency, Ft. Monmouth NJ	11	2	9							0.483
8202	Army Signal Research & Development Lab, Ft. Monmouth NJ	7	4	3							0.099
8215	Strategic Army Communications Command, Ft. Schafter HI	9	8	1							0.052
8211	81st Transportation Company, Schofield Barracks HI	15	10	5							0.040
8205	Army Tripler General Hospital, Honolulu HI	11	5	6							0.110

(continued)

Table 23. DOMINIC personnel exposures, U.S. Army organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
Other Units											
8264	Army Adjutant General Center, Washington DC	1	0	1							0.050
8263	Army Adjutant General School, Ft. Ben Harrison IN	1	0	1							0.330
8280	82nd Airborne Division, Ft. Bragg NC	1	1								0.000
8292	20th Artillery Regiment, Munsan-Ni, Korea	1	1								0.000
8277	Army Artillery & Missile School, Ft. Sill OK	1	0	1							0.020
8240	Army Chaplain Board, Ft. Meade MD	1	1								0.000
8215	Army Chemical Agency, Ft. Detrick MD	2	1	1							0.021
8231	Army Data Analysis Group, Washington DC	1	0	1							0.020
8208	Army Dental Clinic, Schofield Barracks HI	1	1								0.000
8222	Military Dispersing Office, Camp Zama, Japan	2	0	2							0.355
8249	Army Engineer School, Ft. Belvoir VA	1	1								0.000
8272	Hq, Ft. Dix NJ	1	0	1							0.207
8288	Hq, Killeen Base TX	1	0	1							0.022
8248	Army Hawaii Hq, Schofield Barracks HI	2	1	1							0.056
8267	Army Japan Hq, Camp Zama, Japan	1	1								0.000
8228	Army Hospital, Ft. Ord CA	2	2								0.000
8234	General Hospital, El Paso TX	1	0	1							0.117
8233	Army Infantry Training Center, Ft. Benning GA	1	1								0.000
8209	14th Infantry Brigade, Schofield Barracks HI	1	1								0.000
8218	27th Infantry Brigade, Schofield Barracks HI	1	1								0.000
8221	Hq Company Joint Communications Activity, Ft. Ritchie MD	3	2	1							0.023
8219	Army Language School, Monterey CA	1	0	1							0.239
8220	Madigen General Hospital, Tacoma WA	1	1								0.000
8246	43rd Medical Group, Ft. Lewis WA	1	0	1							0.110
8289	Pueblo Ordnance Depot, Pueblo CO	2	0	2							0.218
8236	Army Pacific, Ft. Shafter HI	2	1	1							0.020
8242	Provost Marshal General School, Ft. Gordon GA	1	0	1							0.139
8271	3rd Reconnaissance Squadron, Schofield Barracks HI	2	1	1							0.037
8244	51st Signal Battalion, Uijongbu, Korea	1	0	1							0.065
8265	Army Signal Command Center, Ft. Bragg, SC	3	1	2							0.097
8230	Army Signal Command Center, Ft. Detrick MD	3	0	3							0.045
8270	Army Signal Command Group, Ft. Myer VA	2	0	2							0.138
4116	Army Signal Missile Support Agency, White Sands NM	1	1								0.000
8229	Army Strategic Comm Support Activity, Arlington VA	3	3								0.000
8276	Supply and Maintenance Center, Ft. Shafter HI	1	1								0.000
8278	Support Troops Hq, Ft. Monmouth NJ	1	0	1							0.245
8268	Oakland Army Terminal, Oakland CA	1	1								0.000
8281	1st Training Regiment, Ft. Jackson SC	1	0	1							0.069
8252	4th Training Regiment, Ft. Dix NJ	1	1								0.000
8260	5th Training Regiment, Ft. Dix NJ	1	1								0.000
8239	USAMS FE, Camp Fiji, Japan	4	4								0.000
8235	Walter Reed Hospital, Washington DC	1	0	1							0.050
8290	3rd Army Hq, Ft. McPherson GA	1	0	1							0.021
8247	4th Army Hq, Ft. Sam Houston TX	1	0	1							0.052
8225	6th Army Hq, Presidio CA	2	2								0.000
Total Army		628	306	293	8	10	2	3	4	2	3.539

25th Aviation Company, Schofield Barracks, Hawaii. The 25th Aviation Company was a helicopter company belonging to the 25th Infantry Division at Schofield Barracks, Hawaii. Of the 10 men badged, three were warrant officers and one was a lieutenant, which strongly suggests that these men were helicopter pilots. However, there is no available information that any Army helicopters were at Johnston Island. Nine of the ten persons were stationed on Johnston Island from August through the last shot in November. The remaining man, a private first class whose specific duties are also unknown, was stationed at Christmas Island from April through July. The highest exposure recorded for the ten was 0.115 R.

Army Chemical Center, Edgewood Arsenal, Maryland. This organization had 16 men badged, all on Johnston Island. The 5x8 cards of eight of these indicated that they were assigned to the Nuclear Defense Laboratory (NDL) at the Army Chemical Center. NDL managed and executed Projects 2.1, 2.2, 2.3, and SWORDFISH Project 2.1 (see Chapter 3 for a discussion on these projects). It is probable that the other eight also worked on these same projects because their 5x8 cards were marked "TU 8.1.3," which is synonymous with DOD experimental projects. Most of the badges from this unit showed some exposure but only one was greater than 0.5 R, that being 1.325 R -- all accumulated on one badge worn from May through November by a man working on the three Johnston Island projects. NDL also had three enlisted men (not badged) working at the Radiological Laboratory in Hawaii.

Army Chemical Corps Radiological Unit, Dugway, Utah. This unit had 24 men badged during DOMINIC. All but five worked with Air Force personnel monitoring and decontaminating the B-57 sampler aircraft, and they may also have been involved with sample removal. The remaining five men worked in the JTF 8 Radsafe Branch performing monitoring and instrument repair duties. Duty stations included Christmas Island, Johnston Island and NAS Barbers Point on Oahu. Some men moved from Christmas Island to NAS Barbers Point after the last shot at Christmas Island in July. Most of these men had a total of three or more badges during the entire operation, usually with readings between 0.1 and 1 R for each badge. One man's total exposure was incorrectly computed on his 5x8 card; it should have been 3.384 R instead of 2.825 R. Overall, exposures were relatively high for this unit because of their work with contaminated aircraft. Three exposures were between 3 and 4 R. Nine other exposures were between 1 and 3 R.

Army Chemical Corps Training Command, Fort McClellan, Alabama. Ten men of this unit were badged during DOMINIC. All worked with Air Force personnel in monitoring and decontaminating B-57 sampler aircraft. They may also have been involved with sample removal and packaging for shipment. Eight were stationed at Christmas Island and the other two were stationed at NAS Barbers Point. Two of the eight at Christmas Island moved in July, one to Johnston Island and one to NAS Barbers Point. Most had several badges during their stay in the test area. As expected, exposures were relatively high. Five had exposures over 1 R, two of which were between 2 and 3 R; the highest exposure recorded was 2.677 R.

U.S. Corps of Cadets, West Point. One individual, a cadet at West Point, spent 2 weeks at Christmas Island in June 1962. He was the son of Commander, JTF 8, and his badge recorded no exposure.

901st Counter-Intelligence Corps Detachment, Sandia Base, New Mexico. Although there were only two men badged from the 902nd Combat Intelligence Corps, six to eleven worked in intelligence and counterintelligence for Hq JTF 8 during DOMINIC. Two were assigned to Christmas Island, two to Johnston Island, and two to Oahu, in addition to five to eight in the J-2 section of JTF 8 (Reference C.1.A, p. K-A-2). Units providing these other intelligence personnel are unknown. Exposures for the two badged with this unit, who were on Johnston Island, were less than 0.2 R.

2nd Engineer Battalion, Ft. Belvoir, Virginia. Three men were badged; all were on Johnston Island from August to November. These men probably assisted the 518th Engineer Detachment, which operated and maintained the liquid-oxygen plant.

65th Engineer Battalion, Schofield Barracks, Hawaii. Two men were badged; both were on Christmas Island from May to July, probably assisting the 497th Engineer Company in operating and maintaining the petroleum, oil, and lubricant (POL) pipelines.

497th Engineer Company, Ft. Belvoir, Virginia. Nine men were badged, most of whom operated and maintained about 30 miles (50 km) of POL pipeline on Christmas Island. One person, whose duties are unknown, was on Johnston Island from September to December.

518th Engineer Detachment, Ft. Belvoir, Virginia. This detachment operated and maintained the liquid-oxygen plant on Johnston Island, which supplied fuel to the Thor missile. Most of the 26 men badged arrived in May and remained through the last shot in November.

151st Engineer Group, Ft. Benning, Georgia. One enlisted man was badged. He was stationed at Christmas Island from April to July, probably assisting the 497th Engineer Company in operating and maintaining the POL pipelines.

The highest exposure among these five engineer units was 0.253 R by a man who helped to operate and maintain the liquid-oxygen plant at Johnston Island from May to November.

Army Garrison, Fort Shafter, Hawaii. Five men were badged under this organization. A captain from the 6th Explosive Ordnance Disposal Detachment at Ft. Shafter, was on Johnston Island from August through September, the period during which the Thor launch area was being decontaminated and rebuilt. The other four performed separate duties with a variety of organizations, one sergeant working with the Navy for 6 months. The highest exposure recorded was 0.79 R; this man worked on Johnston Island from May through the last shot in November.

Army Garrison, Schofield Barracks, Hawaii. This organization had 14 men badged. It was a conglomeration of post support personnel and is not similar to a normal Army unit. Two of the fourteen were actually from the 25th Infantry Division and were listed with this organization erroneously. Some of these men worked on Christmas Island and some on Johnston Island. One worked in the dispensary as an aide, one worked for CJTF 8 on Christmas Island, and

one was a visitor to Christmas Island for 2 days. The highest exposure recorded was 0.181 R.

Army Garrisons -- Other Locations. In addition to the garrisons at Ft. Shafter and Schofield Barracks, Hawaii, there were three other posts that supplied personnel: Ft. Lewis, Ft. Belvoir, and Sandia Base. The Army garrison, Johnston Island, is also shown as sending one person; however, there were no Army personnel actually assigned to the island in 1962. This individual listed no home organization on his 5x8 card and entered Johnston Island as his home station instead of his duty station. These men performed a variety of duties, some at Christmas Island and some at Johnston Island. The Ft. Lewis garrison was assigned two organization codes. All badges except one recorded no exposure; the exception recorded 0.21 R.

Headquarters, Aberdeen Proving Ground, Maryland. All but five men from this unit were assigned to Ballistic Research Laboratories (BRL), which is located at Aberdeen. There are four duplicate names on the Consolidated List, making the total 31 instead of 35. BRL was active in the DOD experimental program on Projects 1.1, 6.2, and 6.3, as described in Chapter 3. All were on Johnston Island, most arriving in May and remaining through the last shot in November. They were probably not on Johnston Island during the August through September pause in operations. The highest exposure received was 0.95 R by a man who arrived in June and departed in November.

Headquarters, Fort Bliss, Texas. This unit had 11 persons badged; all on Johnston Island. Since the 2nd Missile Battalion, 52nd Artillery Regiment, which launched the Nike-Hercules missiles at Johnston Island, was from Ft. Bliss, this contingent was probably supporting the missile unit. The highest exposure received was 0.75 R.

Headquarters, Picatinny Arsenal. This group had nine men badged, all on Johnston Island. They worked on the TIGHTROPE nuclear warhead so that it would function in the Nike-Hercules missile. Most were on Johnston Island from September through the last shot in November, although one left in October. Badge readings were less than 0.1 R.

291st Military Police Company, Redstone Arsenal, Alabama. Although JTF 8 records indicate that three persons were badged from this unit, the 5x8 cards show that only one was from the 291st Military Police Company. The other two were from the Army garrison at Ft. Campbell, Kentucky, and the Army Missile Command. All three were on Johnston Island; all exposures were less than 0.1 R.

524th Military Police Company, Fort Shafter, Hawaii. This unit had 66 men badged (1 was listed under the 3638th Flight Training Squadron, code 4106). Some were at Christmas Island and some at Johnston Island. At both islands they formed the island base command Military Police Detachment. They patrolled the islands and guarded specified facilities such as the liquid-oxygen plant and the Master Control Bunker at Johnston Island (Reference C.1.A, p. K-B-12). Only one person in this unit received more than 0.5 R, recording 1.25 R while on Johnston Island from May through November. As a military policeman he probably remained on Johnston Island during the August through September operational pause.

2nd Missile Battalion, Ft. Bliss, Texas. See 52nd Artillery Regiment.

Army Missile Command (AMC), Redstone Arsenal, Alabama. The AMC contingent was designated TU 8.1.7 and was responsible for obtaining, shipping, checking out, and launching the Nike-Hercules missiles for the TIGHTROPE event. It designated the 2nd Missile Battalion 52nd Artillery Regiment from Ft. Bliss, Texas, to accomplish this; however, eight men from AMC managed the program at Johnston Island. Their exposures were less than 0.1 R. The highest exposure was 0.048 R.

White Sands Missile Range (WSMR), New Mexico. The Consolidated List shows 53 men badged from WSMR; however, one person listed was actually from Ft. Myer, Virginia, and one person was listed twice, so the total should be 51. Most of them were assigned to the Signal Missile Support Agency (SMSA) at WSMR. However, three were from the Electronics Research and Development Activity (ERDA), which was responsible for Project 6.1 (see Chapter 3). There were also two men from WEC, WSMR (probably Western Electric Corporation), and one from Bell Telephone Laboratories, WSMR. Fourteen of the fifty-one were stationed on Christmas Island where SMSA was fielding Project 7.3, and the rest were on Johnston Island. Periods of time in the test area ranged from a few days to 6 months. The one person listed in Table 23 under U.S. Army Signal Missile Support Agency (organization code 4116) should be discounted as he is included among the 51 people listed herein. The highest exposure received by these 51 was 0.34 R.

725th Ordnance Battalion, Schofield Barracks, Hawaii. This unit, part of the 25th Infantry Division at Schofield Barracks, Hawaii, had three men badged, all on Christmas Island from May to July 1962. They were probably maintenance or supply personnel taking care of equipment brought over by other elements of the 25th Infantry Division. All exposures were less than 0.1 R.

200th Ordnance Detachment, Fort Bliss, Texas. This unit was the missile support unit for the 2nd Missile Battalion, 52nd Artillery Regiment (Nike-Hercules), and had six men badged, all on Johnston Island. They supported the missile motor section, missile guidance section, launcher, and Battery Control Trailer -- all part of the Nike Firing Battery. All six badges recorded no exposure.

Company A, School Troops, Fort Gordon, Georgia. Seven men from this organization arrived and departed Christmas Island together. They were on the island from April to July. Although their specific duties are not recorded, they worked for the JTF 8 staff.

USAS American Mariner. This ship was operated for the Army by Mathiasen Tanker Industries, Inc., Philadelphia, Pennsylvania. The Army Missile Command used this ship, designated the DAMP (Down Range Anti-Missile Measurement Program) ship, as an instrumentation platform for Project 6.13. Other experiments also used the ship for some of their projects, notably Projects 6.8 and 6.9. Employees from RCA and Barnes Engineering were on board the ship for extended periods during the high-altitude tests. Their exposure data are discussed in Chapter 11. The 106 civilian crewmembers for American Mariner are shown in Table 23. The exposures they received were relatively low; 65 recorded no exposure and 41 received between 0.001 and 0.31 R.

125th Signal Battalion, Schofield Barracks, Hawaii. This unit was part of the 25th Infantry Division at Schofield Barracks, Hawaii. There were only 29 men badged from this unit, but many more were involved in the unit's mission, which established and maintained the long lines of communication for DOMINIC. The men operated communications equipment on several islands throughout the Southern Conjugate Area, French Frigate Shoals, Christmas Island, and Johnston Island. The highest exposure recorded was 0.327 R.

595th Signal Company, Fort Monmouth, New Jersey. This unit only had two persons but one received 1.35 R, among the higher Army DOMINIC exposures. He was on Christmas Island from April to July and then moved to Johnston Island, where he stayed until after the last shot in November. His specific duties are not known. The other badged person was on Johnston Island from May through the last shot in November.

999th Signal Company, Naha, Okinawa, and Schofield Barracks, Hawaii. This unit was given three different organization codes, one by mistake and one because one sergeant indicated that he was from Schofield Barracks, Hawaii, instead of Okinawa. This same individual also received an unusually high exposure of 2.281 R while he was on Johnston Island. He worked for the Weapons Effects Test Group, Field Command, Defense Atomic Support Agency, on Johnston Island from May through November but almost all his exposure was received from September to November. Exposures for the four others badged with this unit were less than 0.1 R.

Army Signal Radio Propagation Agency (SRPA), Fort Monmouth, New Jersey. Eleven men were badged from this agency; however, there were two additional personnel from this agency in the test area. They were mistakenly placed in the records with the Army Signal Research and Development Laboratory (SRDL), which is also at Ft. Monmouth. SRPA was responsible for managing and fielding Project 6.5d, which involved a contingent of men at Kwajalein as well (see Chapter 3). SRPA also provided an Army Radio Frequency and Field Intensity Team to the JTF 8 Frequency Interference Control Center. Working with Douglas Aircraft Company and Sandia Corporation, the men conducted a comprehensive survey of all RF fields on Johnston Island. All badged personnel were on Johnston Island, some from May through the last shot and others for shorter periods. Exposures were average for location and duration on the island. The highest exposure recorded was 0.483 R.

Army Signal Research and Development Laboratory (SRDL), Fort Monmouth, New Jersey. This unit is credited with seven men in the Consolidated List; however, two of these belonged to SRPA (above) and one other person was listed twice by mistake. A fourth man's 5x8 card shows only that he was from Ft. Monmouth and that he spent 1 day in the test area. The remaining three men were from SRDL. Two were at Johnston Island from May to September and one was at Johnston Island from June to July. SRDL was responsible for managing Projects 6.5e and 6.11. Most of the Project 6.5e activity was on the island of Hawaii and SRDL's role in Project 6.11 was as manager only, perhaps explaining why only three from SRDL were badged. Exposures for all seven were less than 0.1 R, the highest being 0.099 R.

Strategic Army Communications Command (STARCOM), Fort Shafter, Hawaii. Nine men from this command were badged and all were on Christmas Island. Although its specific duties are not known, STARCOM was usually responsible for long lines of communication, so these men may well have worked with the 125th Signal Company in establishing lines of communication for the many islands used during DOMINIC. Badge readings were less than 0.1 R.

81st Transportation Company, Schofield Barracks, Hawaii. This unit was a non-divisional light helicopter company that supported the 25th Infantry Division at Schofield Barracks, Hawaii. Five of the fifteen men badged were officers or warrant officers, perhaps an indication that they were helicopter pilots. If so, they may have been assisting the Marines in pod recovery or personnel evacuation since all 15 men served on Johnston Island. Exposures were less than 0.1 R.

Army Tripler General Hospital, Honolulu, Hawaii. This hospital had 11 persons badged during DOMINIC. Several other hospitals and medical organizations had a total of seven additional persons badged. These medical and dental personnel were assigned either to Christmas or Johnston island, with some moving to Johnston from Christmas in July when Christmas Island closed. One man from Walter Reed Hospital was a nuclear medicine specialist and was assigned to the Johnston Island Base Command staff. These medical specialists supplemented the civilian medical staff under contract to Holmes & Narver at both locations. The highest exposure recorded for the 11 men identified was 0.117 R.

CHAPTER 9

U.S. NAVY PARTICIPATION IN DOMINIC

Participation of Navy organizations was not limited to formal naval task units during DOMINIC. Navy representatives were also found in various scientific units. In addition to the Navy's Joint Task Group 8.3 (JTG 8.3), DOMINIC had other task groups with dominant Navy involvement and manning. Specifically, these were JTG 8.8 (FRIGATE BIRD) and JTG 8.9 (SWORDFISH). Both FRIGATE BIRD and SWORDFISH were Navy-sponsored events and are covered in earlier chapters. JTG 8.3, JTG 8.8, and JTG 8.9 all involved extensive use of Navy equipment, personnel, and expertise. General Navy responsibilities included participation in scientific projects such as laying deep-sea moors and instrumenting and positioning target rafts, air and surface surveillance of the danger area, providing scientific ship stations, general logistic support, and providing evacuation ships and helicopters.

The potential for radiation exposure in these activities was like that for most other DOMINIC operations -- low. There were several well-defined exceptions, however. These exceptional activities were several directly involved in support of the scientific program.

The first was the collection of samples of the device debris from the underwater shot, SWORDFISH. This required USS Sioux (ATF-75) to enter the radioactive pool of water created by the explosion as soon as possible after the burst. This operation is described in Chapter 6. Exposures experienced were higher than those of an ordinary DOMINIC operation, but this was expected. The ship was stripped to a skeleton crew to minimize the possible collective exposure, personnel were clothed in a way to aid in decontamination, and self-reading pocket dosimeters were carried so that the participants and CJTG 8.3 knew approximately what exposure had already been accrued at any time. There appear to have been some problems in the recording of the exposures (see Chapters 6 and 13), but actual exposures appear to be in line with the activities.

The second Navy activity with higher than usual potential for radiation exposure was pod recovery during FISHBOWL tests at Johnston Island. In this operation, large objects that had been exposed to the nuclear burst at relatively short ranges in the thin upper atmosphere or that had been at extremely close range to the destruction of a nuclear weapon due to mission abort had to be found, picked out of the water, and returned to Johnston Island. Pods could have been activated by neutrons or contaminated by device debris or unfissioned device material. In all cases, care in handling was necessary and was apparently exercised. The crew of the unit that took part in all the pod recoveries, USS John S. McCain (DL-3), did have generally higher exposures recorded than other ships. But even with certain irregularities that are apparent in the ways McCain exposures were recorded (see Chapter 13), these exposures appear to be appropriate with the activity.

The third exceptional activity with a potential for higher exposures was servicing airdrop target rafts. This did not turn out to be a problem, however, as the highest reading of any target raft was 0.75 R/hr, the next highest was 0.04 R/hr, and the next highest was about 0.00003 R/hr (essentially normal background). The radioactive rafts were apparently sunk rather than being decontaminated and salvaged.

There were, however, cases of the opposite character, where the Consolidated List (Reference C.1.2) shows exposures when there is no basis in the operational history. For example, USS Loyalty (MSO-457) and USS Inflict (MSO-456) were involved in JTG 8.3 activities in conducting the Project 7.1 experiment. At all times, however, the ships were off the coast of Kauai, Hawaii, 800 to 1,100 nmi (1,483 to 2,039 km) from the test area. They were not involved in activities in which personnel exposure to radiation was an element. In spite of this, both Inflict and Loyalty had badged crewmembers with exposures significantly above background. One man aboard Inflict had an exposure of 0.702 R. These exposures are neither understandable nor explainable by the JTG 8.3 narrative in the Final Report, weapon test documents, or log activities for the ships.

A similar instance was USNS Point Barrow (T-AKD-1), which served as a communications and instrumentation ship. It was at Johnston Island for most of the October and November FISHBOWL operations. Activity at Johnston Island was primarily connected with high-altitude tests, from which there was no fallout. There were airdrops near Johnston Island, but these were detonated high enough so that no local fallout was formed. Nevertheless, one individual on Point Barrow received an exposure of 2.980 R. Seven personnel in all had exposures between 2.50 and 3.00 R. Well over two-thirds of the personnel aboard the ship had exposure in excess of 1.00 R. Again the exposures are not in keeping with the ship's known assigned duties.

A Joint Task Force 8 (JTF 8) letter of 26 February 1963 (Reference C.1.3) stated that near the end of the operation (when certain film lots were being processed) it was observed that higher-than-expected exposure readings were being obtained. An immediate check of the rosters revealed that individuals who had worn the badges could hardly have received such exposures, since they had not participated in any operation that 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 characteristic of that 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 water damage. Thus, a minor amount of deterioration in the film packet was sufficient to produce a greater film emulsion fog resulting in an erroneous radiation exposure indication by the film.

A 1980 evaluation (Reference D.8) was made of 1,349 DOMINIC film badges. This included units with suspect exposures and showed that 45 percent of the badges exhibited one or more types of damage related to light, heat, and age effects. Ninety percent of the observed damage was moisture associated.

Ninety-eight percent of the films with exposures greater than 0.4 R were damaged. In the absence of a documented radiological exposure, and on the basis of the extremely high correlation between film damage and elevated reading, it was suggested that film damage may have been responsible for elevated exposure readings on ships with suspect exposures. It also appears likely that film damage resulted in small increases to the exposures (or readings) recorded for the majority of the DOMINIC population, thereby resulting in slight overestimations of actual exposures received. Therefore, personnel with exposures greater than 0.4 R have a high probability that environmental damage to the film badge may have been responsible for some part of the recorded exposure.

A total of 16 ships had film badge readings that were suspect:

USS Chickasaw (ATF-83)	USS Loyalty (MSO-457)
USS Falgout (DER-324)	USS Newell (DER-322)
USS Fort Marion (LSD-22)	USS Oak Hill (LSD-7)
USS Fortify (MSO-446)	USS O'Bannon (DDE-450)
USS Inflict (MSO-456)	USNS Point Barrow (T-AKD-1)
USS Impervious (MSO-449)	USS Takelma (ATF-113)
USS Walker (DDE-517)	USS Taylor (DDE-468)
USS Lansing (DER-388)	USS Tuscumbia (YTB-762)

However, in this report, the Consolidated List badge readings have been used with few exceptions to construct the tables that summarize the exposures, notwithstanding the fact that these recorded exposures are, in some cases, evidently greater than actually received.

While the exposure data for Inflict, Loyalty, Point Barrow, and other suspect ships seems unusually high, the opposite is true of Sioux. The JTG 8.3 Final Report (Reference C.3.1) cites one Sioux crewmember as having received an exposure of 5.4 R. However, the Consolidated List shows a different story of the Sioux's exposure. No crewmember is reported with an exposure in excess of 3.00 R, the operation's designated Maximum Permissible Exposure (MPE). When the 5x8 cards, the original source from which the Consolidated List was prepared, are compared to the final computer-prepared Consolidated List, differences appear. A few low exposures were raised, and a small number of high exposures were lowered, among them a few Sioux crewmembers. As a result of a reevaluation of this small group of film badges, discussed in Chapter 13, several Sioux crewmembers show higher exposures than entered in the Consolidated List.

The remainder of this chapter is a discussion of the Navy units identified as having participated in or having representative personnel that participated in DOMINIC. These units have been identified in various test documentation, especially the 138 units whose personnel were represented on the Consolidated List of Exposures.

The order of presentation is, first, those naval units whose personnel were badged as members of the JTF 8 command structure. Then follow Navy laboratory

and research management organizations, Navy ship units, Navy air units, and finally a group of other Navy support groups and organizations. The information presented is a short statement of what is known concerning that unit's participation. Table 24 presents a summarization of the unit exposures in the same order as the text. The mean exposure for all Navy personnel was 0.176 R. Six ships that are discussed in the narrative sections that follow do not appear in Table 24: USS Deliver (ARS-23), USS Ethan Allen (SSBN-608), USS Jenkins (DD-447), USS Point Defiance (LSD-31), USS Sea Fox (SS-402), and USS Ute (ATF-76). Two of these ships, Jenkins and Ute, are in the Consolidated List with indications that no badges were issued on either ship. The remaining four ships are not in the Consolidated List. However, as the narratives indicate, none of these six ships are suspected to have been exposed to radiation from DOMINIC. There was no need for crewmembers to have been badged.

JOINT TASK FORCE 8 ORGANIZATIONS

Commander Joint Task Group 8.3 Headquarters

During the compressed 4-month planning period, January to April 1962, the JTG 8.3 staff grew from 15 officers and 17 enlisted men to a total of 20 officers and 109 enlisted men. CJTG 8.3's duties were operational control of assigned ships and aircraft, surveillance of the specified danger areas, providing ships to serve as instrumentation platforms, logistics support, the recovery of scientific instrumentation from the sea, and providing moored target rafts. By early January the major portion of CTG 8.3 staff had reported for duty.

Task Unit 8.3.9 (Special Operations Unit)

At maximum strength the task unit consisted of ten officers and 331 enlisted men. The staff of Task Unit (TU) 8.3.9 (at Pearl Harbor) consisted of 5 officers and 20 enlisted men; the Christmas Island Boat Element (8.3.9.7) was assigned a maximum of one officer and 62 enlisted men. Following a major shift from the planned open sea test to Christmas Island, enlisted requirements were reduced and approximately 100 enlisted men were returned to Commander in Chief, Pacific Fleet (CINCPAC) for reassignment. In addition to its boat pool work, CTU 8.3.9 (at Pearl Harbor) was a major unit in JTG 8.3 supply chain. Commander Task Element (CTE) 8.3.9.7 was responsible for loading a YC (lighter) with fuel and providing a petroleum-oil-lubricants (POL) boat loading facility. CTE 8.3.9.7 also assisted in Christmas Island evacuation operations. The staff of TU 8.3.9 had 24 badged members; TE 8.3.9.7 had 94 badged; TE 8.3.9.6 (Johnston Island Boat Element) had 55 badged.

NAVY LABORATORY AND RESEARCH ORGANIZATIONS

Bureau of Docks and Yards, Washington, D.C. There was one badged individual. His assignment and participation are unknown.

Fleet Weather Central, Pearl Harbor, Hawaii. Four personnel were badged.

Navy Hydrographic Office. Two individuals were badged. The Hydrographic Office in Washington was involved in analysis of underwater sound detection for the Polaris FRIGATE BIRD event. Hydrographic Office personnel were also involved in Hq JTG 8 Hazards Evaluation Branch.

Table 24. DOMINIC personnel exposures, U.S. Navy organizations.

Org Code	Organization and Home Station	Total Badged	Exposure Range (R) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	High (R)
Joint Task Force 8 Organizations											
8300	Hq Joint Task Group 8.3	204	69	132	2	1					1.050
8362	Task Unit 8.3.9	24	18	5	0	1					1.230
8347	Task Element 3.3.9.6	55	15	31	6	1	1	1			2.270
8304	Task Element 8.3.9.7	94	10	82	2						0.533
Navy Scientific Organizations											
3524	Bureau of Yards and Docks, Washington DC	1	0	1							0.028
3519	Fleet Weather Central, Pearl Harbor HI	4	2	2							0.104
3525	Navy Hydrographic Office, Washington DC	2	1	1							0.038
3535	Naval Material Laboratory, Brooklyn NY	1	1								0.000
3537	Navy Administrative Unit, Sandia Base NM	6	2	4							0.106
3541	Naval Air Development Center, Johnsville PA	1	1								0.000
3526	Commander Pacific Missile Range, Pt. Mugu CA	1	1								0.000
3505	Pacific Missile Range, Pt. Mugu CA	81	56	25							0.215
3540	Naval Ordnance Laboratory, Silver Springs MD	1	1								0.000
8329	Naval Ordnance Laboratory, Silver Springs MD	23	2	19	2						0.608
3538	Naval Radiological Defense Laboratory, San Francisco CA	1	1								0.000
8330	Naval Radiological Defense Laboratory, San Francisco CA	16	1	12	0	0	1	0	1	1	4.100
Navy Ships											
8393	USS Abnaki (ATF-95)	71	8	60	1	0	1	1			2.500
8333	USS Agerholm (DD-826)	263	164	99							0.270
8327	USNS Alatna (T-AOG-81)	53	6	3	11	26	7				1.660
8331	USS Richard B. Anderson (DD-786)	169	148	21							0.094
8315	USS Arikara (ATF-98)	83	30	53							0.330
8323	USS Bausell (DD-845)	220	180	40							0.041
8340	USS Brush (DD-745)	211	167	44							0.044
8309	USS Cabildo (LSD-16)	262	94	168							0.317
8336	USS Carbonero (SS-337)	85	78	7							0.021
8342	USS Chemung (AO-30)	223	5	218							0.288
8372	USS Chickasaw (ATF-83)	68	1	67							0.327
8374	USS Chipola (AO-63)	244	23	211	6	2	1	1			2.070
8305	USS Conserver (ARS-39)	110	85	25							0.122
3546	USS Constellation (CV-64)	3	0	3							0.065
8321	USS Cree (ATF-84)	75	36	39							0.065

(continued)

Table 24. DOMINIC personnel exposures, U.S. Navy organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)							High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
Navy Ships (continued)											
8384	USS Engage (MSO-433)	62	0	62							0.260
8371	USS Falgout (DER-324)	273	31	241	1						0.825
8348	USS Finch (DER-328)	174	1	173							0.135
8352	USS Forster (DER-334)	235	2	222	10	1					1.305
8343	USS Fort Marion (LSD-22)	195	9	185	1						0.636
8385	USS Fortify (MSO-446)	73	0	73							0.155
3547	USS Frontier (AD-25)	1	1								0.000
8335	USS Gannet (MSC-290)	39	39								0.000
8356	USS Grapple (ARS-7)	90	19	71							0.358
8396	USS Gurke (DD-783)	249	5	234	5	4	0	1			2.260
8380	USNS Harris County (T-LST-822)	85	4	75	6						0.990
8345	USS Hassayampa (AO-145)	353	136	217							0.180
8387	USS Henry County (LST-824)	91	0	91							0.352
8379	USS Hitchiti (ATF-103)	57	2	55							0.168
8332	USS Hopewell (DD-681)	236	179	57							0.267
3503	USS Hornet (CV-12)	1	0	1							0.021
8383	USS Impervious (MSO-499)	68	0	68							0.145
3002	USS Inflict (MSO-456)	80	6	72	2						0.702
8337	USS Iwo Jima (LPH-2)	585	283	302							0.265
8328	USS Jerome County (LST-848)	102	13	86	2	1					1.120
8378	USS Lansing (DER-388)	150	0	147	0	0	0	3			2.500
8363	USS Lipan (ATF-85)	134	10	123	0	1					1.270
8357	USS Loyalty (MSO-457)	67	3	64							0.394
8339	USS Maddox (DD-731)	219	132	87							0.052
8310	USS Marshall (DD-676)	239	15	224							0.448
8358	USS Mataco (ATF-86)	66	61	5							0.080
8366	USS John S. McCain (DL-3)	485	267	202	4	2	0	8	2		2.602
8369	USS Medregal (SS-480)	85	85								0.000
8313	USS Moctobi (ATF-105)	65	65								0.000
8319	USS Molala (ATF-106)	66	17	49							0.035
8355	USS Monticello (LSD-35)	312	48	264							0.308
8338	USS Samuel N. Moore (DD-747)	235	228	7							0.033
8307	USS Munsee (ATF-107)	73	22	51							0.141
8370	USS Newell (DER-322)	183	47	136							0.381
8314	USS Norton Sound (AVM-1)	335	334	1							0.038
8359	USS Oak Hill (LSD-7)	251	15	235	1						0.625

(continued)

Table 24. DOMINIC personnel exposures, U.S. Navy organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
Navy Ships (continued)											
8360	USS O'Bannon (DDE-450)	451	52	396	1	1	0	1			2.500
8326	USS Page County (LST-1076)	111	41	70							0.156
8303	USNS Pvt. Frank S. Petrarca (T-AK-250)	80	37	42	1						0.982
8382	USNS Point Barrow (T-AKD-1)	89	0	13	3	33	24	9	7		2.980
8325	USS Polk County (LST-1084)	103	93	10							0.130
3534	USS Halsey Powell (DD-686)	1	1								0.000
8306	USS Halsey Powell (DD-686)	261	13	247	1						0.551
8311	USS Ponchatoula (AO-148)	277	277								0.000
8341	USS Preston (DDE-795)	200	186	14							0.118
8375	USS Princeton (LPH-5) (includes 101 USMC)	1,175	307	332	3	0	1	31	1		2.870
8394	USNS Range Tracker (T-AGM-1)	70	14	55	1						0.810
8318	USS Razorback (SS-394)	86	56	30							0.047
8350	USS Reclaimer (ARS-42)	80	7	73							0.358
8373	USS Rowan (DD-782)	243	47	196							0.231
8381	USS Safeguard (ARS-25)	86	0	85	0	1					1.250
8317	USS Sioux (ATF-75)	98	34	54	3	0	1	1	2	3	4.150
8354	USS Snohomish County (LST-1126)	99	12	87							0.444
8353	USS Southerland (DDR-743)	263	34	225	3	1					1.110
8376	USS Summit County (LST-1146)	121	0	121							0.430
8319	USS Yakelma (ATF-113)	90	55	35							0.102
8358	USS Tawakoni (ATF-114)	63	63								0.000
8386	USS Taylor (DD-468)	290	1	45	82	64	49	33	16		2.980
3351	USS Tolovana (AO-64)	216	8	207	0	1					1.060
3009	USS Tunny (SSG-282)	1	1								0.000
8392	USS Tuscumbia (YTB-762)	9	0	9							0.190
8391	USS Walker (DDE-517)	92	68	22	0	0	0	2			2.500
8316	USS Yorktown (CVS-10) (includes 37 USMC)	2,347	2,264	83							0.207
Naval Air Units											
8361	Commander Fleet Air Wing 2	35	27	8							0.122
8367	Airborne Early Warning Barrier Squadron	62	53	9							0.030
3520	Attack Squadron 215 (VA-215), Moffett Field CA	1	0	1							0.235
8320	Heavy Photo Sq 62 (VAP-62), Det 35 (includes 1 Marine)	28	23	5							0.027
8395	Patrol Squadron 6 (VP-6)	4	4								0.000
8390	Patrol Squadron 9 (VP-9)	305	46	257	0	0	0	2			2.020
8365	Patrol Squadron 28 (VP-28)	142	31	111							0.176

(continued)

Table 24. DOMINIC personnel exposures, U.S. Navy organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
	Naval Air Units (continued)										
8322	Patrol Squadron 46 (VP-46), San Diego CA	14	4	10							0.041
8312	Patrol Squadron 872 (VP-872)	249	237	11	1						0.506
3007	Transport Squadron 3 (VR-3), McGuire AFB NJ	49	15	33	1						0.571
3531	Naval Air Station, Norfolk VA	2	1	1							0.100
3528	Naval Air Station, Sanford FL	1	0	1							0.080
	Other Naval Organizations										
3549	Navy Ammunition Depot, Lualui HI	1	1								0.000
3511	Amphibious Unit, Coronado CA	1	0	1							0.264
8308	Amphibious Construction Battalion 1	21	8	13							0.109
8301	Amphibious Construction Battalion 1, Detachment Zulu	29	11	18							0.235
3521	Chief of Naval Operations, Code 28	2	2								0.000
3507	Communication Station, San Diego CA	2	2								0.000
3512	Communication Station, Kodiak AK	1	1								0.000
3529	Communication Station, Pearl Harbor HI	2	1	1							0.040
3545	Communication Station, Wahiawa HI	1	1								0.000
3522	Commander Destroyer Squadron 5	1	1								0.000
3524	Commander Destroyer Squadron 7	8	1	7							0.259
3523	Explosive Ordnance Disposal Unit 1 (EODU-1)	14	13	1							0.020
3517	Navy Hospital, Bethesda MD	2	1	1							0.025
3551	Mine Division 113, Long Beach CA	1	0	1							0.065
3527	Nuclear Weapon Training Center, Norfolk VA	1	1								0.000
3509	Commander in Chief, Pacific Fleet	7	2	4	1						0.520
3532	Naval Security Station, Washington DC	1	0	1							0.134
3530	Naval Supply Center, Pearl Harbor HI	1	1								0.000
3510	Commander Service Forces Pacific	2	1	1							0.030
8202	Utility Landing Craft, Division 13, Detachment 8	42	9	32	1						0.520
3533	Advanced Submarine Base, Pearl Harbor HI	3	1	2							0.150
3536	Clarksville Base TN	2	0	2							0.126
3539	Naval Unit, Lake Mead NV	1	0	1							0.081
3543	Naval Station, Long Beach CA	1	1								0.000
3548	Naval Station, Pearl Harbor HI	2	2								0.000
3514	14th Naval District, Pearl Harbor HI	1	1								0.000
3516	14th Naval District, Pearl Harbor HI	1	1								0.000
	Total (includes 294 USMC on Princeton and Yorktown)	16,714	7,460	8,736	164	141	86	94	29	4	4.150

Navy Material Laboratory (NML), New York Naval Shipyard, Brooklyn, New York. NML provided the basic thermal exposure measurements for Project 4.1, which was based in aircraft operating from Hickam AFB on shots at Christmas and Johnston islands. One man from NML provided analytical assistance to SWORDFISH Project 1.3B, but this clearly involved no onsite activity. A second man from NML had his exposure listed as from an "unidentifiable" unit in the Consolidated List.

Navy Administrative Unit, Sandia Base, New Mexico. Six individuals were badged with this unit, which provided administrative support for Navy scientific personnel stationed at LASL.

Naval Radiological Defense Laboratory (NRDL), San Francisco, California. Trained personnel assisted the CJTG 8.3 Staff Radsafe Officer for SWORDFISH. NRDL also conducted SWORDFISH Projects 2.1 (Base Surge Radiation) and 2.2 (Radioactive Pool Airborne Monitoring). In these activities NRDL personnel accrued the highest exposures of any Navy personnel.

Naval Ordnance Laboratory (NOL), White Oak, Maryland. The laboratory conducted SWORDFISH Projects 1.1 (Underwater Pressures) and 1.2 (Surface Phenomena). NOL was assigned the responsibility for coordinating the technical photography of the SWORDFISH test event.

Pacific Missile Range (PMR). This unit provided range safety tracking for the Johnston Island operations. PMR operated USNS Range Tracker (T-AGM-1), which was docked at Johnston Island throughout DOMINIC, as well as portable equipment at French Frigate Shoals. PMR also provided communications facilities at Kauai for CTU 8.3.2 (Land Based Naval Units, Kauai). His staff also devised and installed a range safety missile tracking system on USS Norton Sound (AVM-1). Commander Pacific Missile Range with CINCPAC, Norton Sound, and Long Beach Naval Shipyard also installed a special underwater and radio communications/crypto installation in Norton Sound.

NAVY SHIPS

The summary of activities provided in this section is taken for the most part from ships' deck logs. The figures given for each ship's normal complement have been taken from the Dictionary of American Naval Fighting Ships. Actual manning levels varied from week to week depending upon transfers, emergency leave and other routine personnel action.

USS Abnaki (ATF-95)

This fleet ocean tug had a normal complement of 85. It was at Johnston Island for rollup of the October through November operations. For TIGHTROPE (Johnston Island, 3 November, 2130), the only shot it was present for, Abnaki was underway from Pearl Harbor, and at 2130 observed nuclear detonation, about 30 nmi (56 km) north of detonation.

USS Agerholm (DD-826)

A destroyer with a normal complement of 355, Agerholm participated only in shot SWORDFISH as the ASROC firing ship. It arrived in the operating area on 8 May and departed 12 May. For shot SWORDFISH (370 nmi [685 km] off coast of San Diego, 11 May, 1300), Agerholm steamed in company with JTG 8.9.3, composed of USS Monticello (LSD-35), USS Richard B. Anderson (DD-786), USS Bausell (DD-845), USS Hopewell (DD-681), USS Razorback (SS-394), Sioux, USS Cree (ATF-84), and USS Molala (ATF-106). At 0845 observers were transferred from Monticello and at 1058 CJTG 8.9 arrived by helicopter and broke his flag. At H-hour the ship launched the ASROC at a 299° bearing, 4,313 yards (3.9 km) from the target barge. Agerholm reported shock damage to its air search radar and gun fire control computer. At 1447 CTG 8.9.3 departed ship and transferred to Monticello.

USNS Alatna (T-AOG-81)

Alatna was a Military Sea Transportation Service (MSTS) oiler with a normal complement of 124 and provided bulk fuel to Johnston Island. It departed Johnston Island on 4 November. Operational activities for shots that it participated in are summarized below.

- ARKANSAS (Christmas Island, 2 May, 0902). Moored at Christmas Island, about 28 nmi (52 km) from surface zero. At 1000 third mate made tests for fallout with Geiger counter. Results were negative. At 1342 underway for Johnston Island.
- QUESTA (Christmas Island, 4 May, 1005). Steaming en route from Christmas to Johnston Island, approximately 600 nmi (1,112 km) from Christmas Island.
- CHETCO (Christmas Island, 19 May, 0637). Moored at Christmas Island about 20 nmi (37 km) northwest of surface zero. At 0753 vessel monitored for radioactive fallout each hour by deck officer and seaman of the watch using AN/PDR-27.
- CHAMA (Johnston Island, 18 October, 0601). Steaming from Enewetak to Johnston Island, approximately 280 nmi (519 km) north-northwest of detonation. Flash of light from detonation lit up entire sky and eastern horizon, witnessed by first officer.
- CHECKMATE (Johnston Island, 19 October, 2230). Anchored off Johnston Island about 40 nmi (74 km) north of detonation. At 2230 all personnel were under cover and wore dark glasses. Vessel was monitored for fallout with AN/PDR-27 radiac set and was checked hourly. Crew wearing film badges were monitored hourly the next day and had negative readings.
- KINGFISH (Johnston Island, 1 November, 0210). At 0200 ship stopped its engines at latitude 8°53'N; longitude 162°50'W, approximately 660 nmi (1,223 km) south-southeast of detonation.

- TIGHTROPE (Johnston Island, 3 November, 2130). At 2123 personnel faced forward in vessel with eyes closed and head down. The ship was approximately 40 nmi (74 km) south-southeast of surface zero. At 2134 permission was given to uncover eyes and open up vessel.

USS Ethan Allen (SSBN-608)

Nuclear-powered fleet ballistic missile submarine with a complement of 138. Participated only in shot FRIGATE BIRD as the Missile Submarine Unit (TU 8.8.3). It was the missile launching submarine. Arrived operating area 2 May and conducted rehearsals through 6 May. Departed the operating area 2200 on shot day. For FRIGATE BIRD (Christmas Island, 6 May, 1430), Ethan Allen submerged after conducting destruct checks. Firing was delayed several times for technical reasons. At 1417:49 Ethan Allen fired the missile, on a flight azimuth of 243°, range of 1,020 nmi (1,890 km). The crew was not badged for DOMINIC and the ship does not appear in the Consolidated List. It was not exposed to any DOMINIC radiation.

USS Richard B. Anderson (DD-786)

Destroyer with a normal complement of 336. Participated only in shot SWORDFISH as the secondary (back-up) firing ship for the ASROC weapon. It also provided radar range and bearing inputs and participated in Project 3.1 (Ship Response). For shot SWORDFISH (370 nmi [685 km] off San Diego, 11 May, 1300), Anderson was steaming 4,222 yards (3.9 km), bearing 325°T from surface zero. Ship reported shock wave and reported minor damage. At 2139 departed for San Diego.

USS Arikara (ATF-98)

Fleet ocean tug with a normal complement of 85, participated in Tigerfish, SWORDFISH, and STARFISH pod recoveries. Departed Johnston Island on 26 July. Operational activities for each shot that it participated in are summarized below.

- SWORDFISH (370 nmi [685 km] off coast of San Diego, 11 May, 1300). Steaming in vicinity of 18°30'N, 157°38'W, approximately 1,900 nmi (about 3,520 km) from detonation.
- STARFISH Prime (Johnston Island, 8 July, 2300). At 1605 underway in company with McCain. Observed nuclear detonation at 2300. The next day the ship was underway for pod recovery operations, which were completed by 0258, and pods were transferred to LCM-10. Ship about 40 nmi (74 km) from detonation with USS Grapple (ARS-7) and Sioux.

USS Bausell (DD-845)

A destroyer with a normal complement of 367, participated only in shot SWORDFISH as part of the Towed Target Array Group as an unmanned destroyer.

For SWORDFISH (370 nmi [685 km] off coast of San Diego, 11 May, 1300), the ship was towed by Molala in the target and array group. All except a small securing detail abandoned ship before the detonation. The securing detail completed their tasks, energized the water washdown system, and also abandoned ship about 2 hours before shot time. Bausell, without its crew, was towed by Molala and positioned 2,200 yards (2 km) upwind from surface zero with water washdown system running at H-hour. The ship was not enveloped by the base surge, which approached within 250 yards (about 230 meters) of its fantail. Maximum radiation intensities of 44 R/hr, but a total accumulated exposure of only 2 R was recorded on its fantail (Reference C.3.1, pp. H-17 and H-18; Reference C.2004, p. 6). At other locations, recorders indicated much lower readings and gamma intensities below deck were less than one-tenth of those topside. At 1440 the securing detail and decontamination team remanned the ship and reported no contamination. By 1540 all personnel reboarded the ship and the tow line from Molala was disconnected. Naval Ordnance Laboratory personnel completed recovery of instruments by 2040. The ship departed for San Diego the next day, arriving in the afternoon.

USS Brush (DD-745)

A destroyer with a normal complement of 211 participated in FRIGATE BIRD and SWORDFISH as part of the surveillance unit centered around USS Yorktown (CVS-10). Operational activities for the two shots are summarized below.

- FRIGATE BIRD (Christmas Island, 6 May, 1430). Underway as part of a surveillance unit composed of Yorktown, Norton Sound, Destroyer Division 232, and USS Maddox (DD-731); USS Preston (DD-795) later joined the formation. At H-hour Brush was approximately 2,000 yards (1.8 km), bearing 260°T, from the submerged Ethan Allen when it launched the Polaris missile. Ethan Allen was approximately 1,020 nmi (about 1,890 km) from the FRIGATE BIRD detonation. Six hours after the detonation Brush, Maddox, and Preston were detached and proceeded to SWORDFISH operational area.
- SWORDFISH (370 nmi [685 km] off coast of San Diego, 11 May, 1300). Underway as part of TU 8.9.4 composed of Yorktown and Destroyer Division 232 while conducting surveillance in assigned area. At H-hour Brush was approximately 8,100 yards (7.4 km) from surface zero, bearing 206°T. Approximately 1-1/2 hours later the ship departed station 8,000 yards (7.3 km) from Bausell, bearing 215°T, and proceeded on an independent exercise. Later the ship joined a formation with Maddox, Moore, and Preston departing for Long Beach, arriving the next day.

USS Cabildo (LSD-16)

Dock landing ship with a normal complement of 326 was assigned to transport rafts from Christmas Island to moorings in target areas south of the island. The ship also provided evacuation of Gilbertese workers. Operational activities for each shot the ship participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Steaming in target area. At 0645 observed nuclear detonation at site GZ-10, experienced the shock wave at 0648 and large cloud rising on bearing 145° about 30 nmi (56 km). An hour after the shot, the ship returned to Christmas Island anchorage.
- AZTEC (Christmas Island, 27 April, 0702). Steaming independently while conducting target raft operations off Christmas Island. Observed nuclear blast, bearing 145°, distance 27 nmi (50 km), and experienced shock wave 3 minutes later. By 0749 the ship was anchored off Christmas Island.
- ARKANSAS (Christmas Island, 2 May, 0902). Anchored at Christmas Island about 30 nmi (56 km) from surface zero. Observed large mushroom-shaped cloud rising on bearing of 150°T, 3 minutes later the shock wave hit the ship.
- QUESTA (Christmas Island, 4 May 1005). Anchored off Christmas Island in London Roads. At 1005 observed nuclear blast, about 28 nmi (52 km) from ship.
- YUKON (Christmas Island, 8 May, 0901). Anchored London Roads, Christmas Island, about 23 nmi (43 km) from surface zero. At 0800 island natives boarded the ship. At 0901, observed nuclear detonation; 2 minutes later experienced the shock wave.
- MESILLA (Christmas Island, 9 May, 0801). Anchored 1,000 yards (914 meters) off Bridges Point, Christmas Island. At 0801 observed atomic burst about 23 nmi (43 km) from ship; 2 minutes later the shock wave hit the ship.
- MUSKEGON (Christmas Island, 11 May, 0637). Anchored at London Roads, Christmas Island. Native islanders totalling 205 boarded the ship. At 0637 observed the detonation about 23 nmi (43 km) from ship; at 0640 the shock wave engulfed the ship.
- ENCINO (Christmas Island, 12 May, 0803). Anchored bearing 291°T from Bridges Point Light, Christmas Island. At 0553 native islanders boarded the ship. At 0803 observed the detonation, bearing 150° about 25 nmi (46 km) from ship. The shock wave hit the ship at 0806.
- SWANEE (Christmas Island, 14 May, 0622). Anchored at London Roads, Christmas Island. Native islanders boarded the ship 13 May at 2322. At 0622 viewed nuclear detonation about 23 nmi (43 km) from ship; at 0627 experienced shock wave. Commenced monitoring ship with radiac instruments.
- CHETCO (Christmas Island, 19 May, 0637). Anchored at Christmas Island. At 2320 on 18 May, 160 islanders boarded the ship. Observed the detonation at 0637 about 23 nmi (43 km) from ship; 1 minute later experienced the shock waves.

Cabildo (continued)

- TANANA (Christmas Island, 25 May, 0709). Anchored at London Roads, Christmas Island. At 2315 on 24 May, 190 islanders boarded the ship. Observed the detonation about 23 nmi (43 km) from the ship at 0709. By 0845 the native islanders departed, and the ship was underway.

- NAMBE (Christmas Island, 27 May, 0803). Anchored at London Roads, Christmas Island. At 0613 islanders boarded the ship. Observed the detonation about 23 nmi (43 km) from ship at 0803 and shock wave at 0805. At 0921 native islanders departed; the ship got underway to the local operations area by 0956.

- ALMA (Christmas Island, 8 June, 0803). Anchored off Christmas Island. At 0548, 124 native islanders boarded the ship. Observed detonation about 28 nmi (52 km) from the ship at 0803; experienced shock wave at 0805. The Gilbertese departed at 0928. Ship was underway for local operations by 1035.

- TRUCKEE (Christmas Island, 9 June, 0637). Anchored at Christmas Island. On 8 June at 2227, 170 islanders boarded the ship. Observed the detonation about 23 nmi (43 km) from the ship at 0637; 2 minutes later the shock wave engulfed the ship. The islanders departed at 0750. Ship got underway for local operations by 0952.

- YESO (Christmas Island, 10 June, 0701). Anchored off Christmas Island. On 9 June at 2350, 237 islanders boarded the ship. Observed the detonation at 0701, about 30 nmi (56 km) from ship bearing 163°T. The shock wave passed the ship at 0704. At 0842 the islanders departed, and the ship got underway for local operations area by 1208.

- HARLEM (Christmas Island, 12 June, 0637). Anchored at London Roads, Christmas Island. On 11 June at 2225, 155 islanders boarded the ship. Observed the detonation at 0637 about 30 nmi (56 km) from ship and experienced the shock wave at 0640. By 0806 the islanders departed, and the ship got underway for local operations by 0922.

- RINCONADA (Christmas Island, 15 June, 0701). Anchored in London Roads, Christmas Island. On 14 June at 2218, 148 natives boarded the ship. Atomic blast occurred at 0701 about 30 nmi (56 km) from ship. The islanders departed at 0809. Ship got underway at 0925 for local operations.

- DULCE (Christmas Island, 17 June, 0701). Anchored off Bridges Point, Christmas Island. On 16 June at 2218, 148 Gilbertese boarded the ship. Detonation occurred at 0701 about 23 nmi (43 km) from ship, and the shock wave engulfed the ship 1 minute later. By 0752 Gilbertese departed and the ship got underway for local operations by 0920.

- PETIT (Christmas Island, 19 June, 0601). Anchored off Bridges Point, Christmas Island. On 18 June at 2227, 123 islanders boarded the ship. Observed the detonation at 0601 about 30 nmi (56 km) from

ship and felt the shock wave 2 minutes later. By 0715 islanders departed. Ship got underway for local operations by 0825.

- OTOWI (Christmas Island, 22 June, 0701). Anchored off Bridges Point, Christmas Island. At 0523, 72 islanders boarded the ship. Observed detonation about 23 nmi (43 km) from ship at 0701 and felt the shock wave 2 minutes later. The islanders departed at 0755. Ship got underway to local operations by 0938.
- BIGHORN (Christmas Island, 27 June, 0619). Anchored at London Roads, Christmas Island. On 26 June at 2315, 138 islanders boarded the ship. The detonation occurred about 37 nmi (69 km) from ship. The islanders departed by 0744. Ship got underway for local operations by 0915.
- STARFISH Prime (Johnston Island, 8 July, 2300). At 2127 the ship was underway from Fanning Island to Christmas Island. Observed explosion of nuclear device 315°, 900 nmi (1,668 km) at Johnston Island.
- SUNSET (Christmas Island, 10 July, 0732). Anchored 1,000 yards (914 meters) off Bridges Point, Christmas Island. Observed detonation 180°, 30 nmi (56 km) from ship. Three minutes later shock wave hit ship. Underway for replenishment from USS Tolovana (AO-64) by 0856.
- PAMLICO (Christmas Island, 11 July, 0637). Steaming en route from Christmas Island to Malden Island. At 0637 observed nuclear detonation, 20°, 130 nmi (241 km).

USS Carbonero (SS-337)

Submarine, normal complement 66. Participated only in FRIGATE BIRD as TU 8.3.5, FRIGATE BIRD Test Unit. The boat was responsible for obtaining weapon detonation information and periscope-fireball and cloud-formation photography (Figure 76), bhangmeter observations of nuclear burst, assisting in surveillance of impact area, and reporting weather observations. For FRIGATE BIRD (Christmas Island, 6 May, 1430), Carbonero's planned position was 26 nmi (46 km) from the estimated burst point; however, no position data for shot time are available. Technical observers, photographers, equipment, and film were transferred to USS Southerland (DDR-743) for return to Christmas Island after obtaining photographic and instrument readings. Boat arrived at Pearl Harbor 10 May.

USS Chemung (AO-30)

Oiler with a normal complement of 304. Involved primarily in the June through July operations at Johnston Island, providing oil and lubricants and engaged in underway replenishments. Ship's locations at shot times are summarized below.

- AZTEC (Christmas Island, 27 April, 0702). Ship was approximately 540 nmi (about 1,000 km) east-northeast of Johnston Island.
- ARKANSAS (Christmas Island, 2 May 0902). Underway for assigned station. Ship was approximately 30 nmi (56 km) northwest of Johnston Island.
- QUESTA (Christmas Island, 4 May, 1005). En route to Pearl Harbor, approximately 45 nmi (83 km) southwest of Oahu, Hawaii.
- TANANA (Christmas Island, 25 May, 0709). En route to Johnston Island, approximately 20 nmi (37 km) southeast of island.
- NAMBE (Christmas Island, 27 May, 0803). Approximately 30 nmi (56 km) southwest of Johnston Island.
- RINCONADA (Christmas Island, 15 June, 0701). Steaming en route to rendezvous with Jenkins, approximately 330 nmi (611 km) north-northeast of Johnston Island.
- DULCE (Christmas Island, 17 June, 0701). Steaming 215 nmi (398 km) southeast of Johnston Island.

USS Chickasaw (ATF-83)

Fleet ocean-going tug with a normal complement of 85. Element of Recovery Unit (TG 8.3.6.3). Arrived Johnston Island on 22 July and departed 26 July. Exposures are summarized in Table 24. For shot BLUEGILL Prime (Johnston Island, 25 July, abort), the only shot it was present for, Chickasaw was underway at 1610 for station, approximately 90 nmi (167 km) from detonation. When missile was detonated, ship was about 20 nmi (37 km) from Johnston Island.

USS Chipola (AO-63)

Oiler with normal complement of 304. Provided logistic support to TU 8.3.7 and TU 8.3.6, and underway replenishment, fuel, provisions, and fresh and frozen foods. Operational activities for each shot that it participated in are summarized below.

- YUKON (Christmas Island, 8 May, 0901). Steaming independently en route from Pearl Harbor to Christmas Island. The ship was approximately 110 nmi (204 km) north of surface zero at the time of detonation.
- MESILLA (Christmas Island, 9 May, 0801). Anchored off London Roads, Christmas Island. At 0801 observed detonation, bearing 150°, distance 23 nmi (43 km).
- MUSKEGON (Christmas Island, 11 May, 0637). Anchored off London Roads, Christmas Island, about 23 nmi (43 km) from detonation.
- ENCINO (Christmas Island, 12 May, 0803). Steaming independently en route to Christmas Island from local operating area. The ship was approximately 114 nmi (211 km) south of Christmas Island at the time of detonation.

- SWANEE (Christmas Island, 14 May, 0622). Anchored off London Roads. At 0622 viewed atomic burst, bearing 140°, distance 23 nmi (43 km).
- CHETCO (Christmas Island, 19 May, 0637). Anchored off London Roads, Christmas Island. At 0637 viewed atomic burst, bearing 150°, distance 23 nmi (43 km).
- TANANA (Christmas Island, 25 May, 0709). Steaming independently en route from Christmas Island to rendezvous with USS Rowan (DD-782). At time of detonation, the ship was approximately 240 nmi (445 km) south-southwest of Christmas Island.
- NAMBE (Christmas Island, 27 May, 0803). Anchored off London Roads, Christmas Island. Viewed the airburst, bearing 15.5°, distance 23 nmi (43 km).
- ALMA (Christmas Island, 8 June, 0803). Steaming independently to Pearl Harbor. At time of detonation the ship was approximately 330 nmi (611 km) north-northeast of Christmas Island.
- TRUCKEE (Christmas Island, 9 June, 0637). Steaming independently to Pearl Harbor. At time of detonation the ship was approximately 600 nmi (1,112 km) north of Christmas Island.
- YESO (Christmas Island, 10 June, 0701). Steaming independently to Pearl Harbor. At time of detonation the ship was approximately 876 nmi (1,622 km) north of Christmas Island.
- STARFISH Prime (Johnston Island, 8 July, 2300). Steaming en route to Johnston Island from Pearl Harbor. At 2300 the ship reported viewing the atomic burst. At shot time the ship was approximately 120 nmi (222 km) south of the detonation.

USS Conserver (ARS-39)

Salvage ship with a normal complement of 120. Participated in Christmas Island operations as a unit of TE 8.3.7 and in Kauai area for Johnston Island shots as rocket recovery unit. Operational activities for each shot that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Anchored off Christmas Island. The ship's washdown system was rigged at 0615, at 0646 the crew observed detonation, bearing 135°T, distance 23 nmi (43 km). The ship was monitored for radiation and only negative readings were recorded.
- AZTEC (Christmas Island, 27 April, 0702). Anchored off Christmas Island, about 23 nmi (43 km) from detonation. Washdown system was rigged at 0545. The washdown system was again rigged on 29 April.
- ARKANSAS (Christmas Island, 2 May, 0902). Moored off Christmas Island, about 28 nmi (52 km) from detonation.

- QUESTA (Christmas Island, 4 May, 1005). Moored off Christmas Island, about 28 nmi (52 km) from detonation.
- YUKON (Christmas Island, 8 May, 0901). Moored off Christmas Island, about 23 nmi (43 km) from detonation.
- MESILLA (Christmas Island, 9 May, 0801). Moored off Christmas Island, about 23 nmi (43 km) from detonation.
- MUSKEGON (Christmas Island, 11 May, 0637). Steaming independently en route from Christmas Island to Malden Island. At shot time the ship was approximately 190 nmi (352 km) north-northeast of Christmas Island.
- ENCINO (Christmas Island, 12 May, 0803). Steaming independently en route from Malden Island to Christmas Island. At shot time the ship was approximately 270 nmi (500 km) south-southeast of Christmas Island.
- SWANEE (Christmas Island, 14 May, 0622). Moored off Christmas Island, about 23 nmi (43 km) from detonation.
- CHETCO (Christmas Island, 19 May, 0637). Steaming en route from Christmas Island to Pearl Harbor with aircraft transportation lighter YCV-1412 in tow. At shot time the ship was approximately 1,110 nmi (2,057 km) north of surface zero.
- BLUESTONE (Christmas Island, 30 June, 0621). Steaming independently in Kauai, Hawaii hazard area.
- STARFISH Prime (Christmas Island, 8 July, 2300). Steaming independently in Kauai hazard area. On 9 July sighted nosecone and recovered it.
- SUNSET (Christmas Island, 10 July, 0732). Steaming independently in Kauai hazard area.
- PAMLICO (Christmas Island, 11 July, 0637). Steaming independently in Kauai hazard area.

USS Constellation (CV-64)

This ship was not assigned to JTF 8 and was not a participant. It operated either in the Atlantic or near California during the shots. However, three personnel were badged according to the Consolidated List with a 0.055 mean reading. They may have been assigned to JTF 8 for temporary additional duty.

USS Cree (ATF-84)

Fleet ocean tug with a normal complement of 85. Participated only in shot SWORDFISH, Project Vela. Steaming independently in SWORDFISH operating area, approximately 95 nmi (176 km) east of the detonation site at shot time. Departed SWORDFISH operating area 5 hours after the detonation. Exposures are summarized in Table 24.

USS Deliver (ARS-23)

Salvage ship with normal complement of 120. Did not participate in any of the DOMINIC events. Provided logistic support for the Johnston Island operation from January through March 1962. Exposure data are not available.

USS Engage (MSO-433)

Ocean minesweeper with a normal complement of 74. Participated in pod and nosecone recovery operations as well as in TU 8.3.6 (Johnston Island Operations Unit). Arrived Johnston Island 11 October. Departed Johnston Island on 3 November. Operational activities for each shot that the ship participated in are summarized below.

- CHAMA (Johnston Island, 18 October, 0601). Anchored off Johnston Island, about 130 nmi (241 km) from detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Underway at 1448 rendezvousing at 2009 with McCain and USS Safeguard (ARS-25). The ship was approximately 40 nmi (74 km) north of detonation site.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Steaming on assigned station, off Johnston Island, approximately 35 nmi (65 km) north of detonation.
- CALAMITY (Johnston Island, 27 October, 0546). Anchored off Johnston Island about 140 nmi (259 km) from CALAMITY shot site.
- HOUSATONIC (Johnston Island, 30 October, 0602). Anchored off Johnston Island about 240 nmi (445 km) from HOUSATONIC shot site.
- KINGFISH (Johnston Island, 1 November, 0210). On 31 October at 1600 proceeding to position 130 nmi (241 km), bearing 200°T from Johnston Island to join USS Forster (DER-334). At 0210 observed nuclear test explosion about 100 nmi (185 km) north.
- TIGHTROPE (Johnston Island, 3 November, 2130). At 1123 steaming en route to Pearl Harbor with gasoline barge YOGN-115 in tow. At 2130 witnessed nuclear detonation approximately 60 nmi (111 km) south-southeast.

USS Falgout (DER-324)

Radar picket escort with a normal complement of 186. Element of Area One Operations Unit (TU 8.3.7). Decontaminated ship after shot BUMPING. For all Christmas Island and June and July Johnston Island shots, the ship was underway from Pearl Harbor or at weather station Alpha some 570 nmi (1,056 km) north-northeast of the Christmas Island airdrops and 1,155 nmi (2,140 km) south-southeast of Johnston Island. Activities for the fall Johnston Island shots are summarized below from the deck log.

- ANDROSCOGGIN (Johnston Island, 2 October, 0617). Operating on special surveillance station. The ship was approximately 165 nmi (306 km) south-southwest of the detonation.

- BUMPING (Johnston Island, 6 October, 0552). Operating on special surveillance station. The ship was approximately 390 nmi (723 km) south-southwest from the detonation. The log then states, "1837 [hrs] changed course to 210. Radiation of alfa [sic] particles 0.4 CPM on M scale of alfa meter. 1847 changed course to 030. 1906 activated water washdown system. . . . 1925 secured water washdown system. 1926 the ship was decontaminated. Alfa radiation normal." Considering the great distance from the detonation point, any connection between this incident and the BUMPING test is extremely unlikely.
- CHAMA (Johnston Island, 18 October, 0601). En route from Johnston Island to special surveillance station. The ship was approximately 280 nmi (519 km) north-northwest of the detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Underway en route to special surveillance station from Johnston Island. The ship was approximately 340 nmi (630 km) north-northwest of the detonation.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Underway in special surveillance station. The ship was approximately 450 nmi (834 km) south of the detonation.
- CALAMITY (Johnston Island, 27 October, 0546). Underway en route to special surveillance station. The ship was approximately 90 nmi (167 km) south of the detonation.
- HOUSATONIC (Johnston Island, 30 October, 0602). Operating in special surveillance station. The ship was approximately 240 nmi (445 km) south-southeast of the detonation.
- KINGFISH (Johnston Island, 1 November, 0210). Underway operating in special surveillance station. The ship was approximately 500 nmi (927 km) south of the detonation.
- TIGHTROPE (Johnston Island, 3 November, 2130). Underway operating on special surveillance station. The ship was approximately 315 nmi (584 km) south of the detonation.

USS Finch (DER-328)

Radar picket escort with a normal complement of 186. Conducted air and surface surveillance. Operational activities for each shot that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Steaming on Station Alfa-2. The ship was approximately 250 nmi (482 km) north-northeast of the detonation.
- AZTEC (Christmas Island, 27 April, 0702). Steaming independently on Station Alfa-2.
- TANANA (Christmas Island, 25 May, 0709). Steaming independently on Station Alfa-2.

- NAMBE (Christmas Island, 27 May, 0803). Steaming independently on Station Alfa-2.
- DULCE (Christmas Island, 17 June, 0701). Steaming independently from Papeete, Tahiti, to Christmas Island. At 0701 reported viewing nuclear detonation, bearing 320°, distance 30 nmi (56 km); however, the ship was approximately 120 nmi (222 km) south of the detonation.
- STARFISH Prime (Johnston Island, 8 July, 2300). Steaming independently en route from Station Alfa-2 to 11°20'N, 168°15'W. The ship was approximately 320 nmi (593 km) south of the detonation.
- SUNSET (Christmas Island, 10 July, 0732). Steaming independently en route from Johnston Island test area to Station Alfa-2. The ship was approximately 690 nmi (1,279 km) north-northwest of the detonation.
- PAMLICO (Christmas Island, 11 July, 0637). Steaming en route to Station Alfa-2. The ship was approximately 225 nmi (417 km) north-northwest of the detonation.

USS Forster (DER-334)

Radar picket escort with a normal complement of 186. Participated in Johnston Island operations during October and November as target-raft tending ship and in Christmas Island operations as a navigational aid and search and rescue ship. Activities for the shots it participated in are summarized below.

- ARKANSAS (Christmas Island, 27 April, 0702). Patrolling assigned SAR station, 230 nmi (426 km) north.
- QUESTA (Christmas Island, 4 May, 1005). Patrolling assigned SAR station, 265 nmi (491 km) north.
- YUKON (Christmas Island, 8 May, 0901). Patrolling assigned SAR station, 235 nmi (436 km) north of surface zero.
- MESILLA (Christmas Island, 9 May, 0801). Patrolling assigned SAR station, 220 nmi (408 km) north of surface zero.
- MUSKEGON (Christmas Island, 11 May, 0637). Patrolling assigned SAR station, 220 nmi (408 km) north of surface zero.
- ENCINO (Christmas Island, 12 May, 0803). Patrolling assigned SAR station, 235 nmi (436 km) north of surface zero.
- SWANEE (Christmas Island, 14 May, 0[illegible]). Patrolling assigned SAR station, 225 nmi (417 km) north of surface zero.
- CHETCO (Christmas Island, 19 May, 0637). Patrolling assigned SAR station, 230 nmi (426 km) north of surface zero.
- YESO (Christmas Island, 10 June, 0701). En route Pearl Harbor to assigned SAR station, 230 nmi (426 km) north of surface zero.

- HARLEM (Christmas Island, 12 June, 0637). Patrolling assigned SAR station, 220 nmi (408 km) north-northwest of surface zero.
- BIGHORN (Christmas Island, 27 June, 0619). Patrolling assigned SAR station, 250 nmi (463 km) north of surface zero.
- STARFISH Prime (Johnston Island, 8 July, 2300). En route from assigned SAR station (Johnston Island) to rendezvous with Finch, 320 nmi (593 km) south-southeast of surface zero.
- ANDROSCOGGIN (Johnston Island, 2 October, 0617). 50 nmi (93 km) east of surface zero.
- BUMPING (Johnston Island, 6 October, 0552). 35 nmi (65 km) northwest of detonation.
- CHAMA (Johnston Island, 18 October, 0601). 30 nmi (56 km) east of detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). 170 nmi (315 km) southeast of detonation.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2339). 130 nmi (241 km) southwest of detonation.
- CALAMITY (Johnston Island, 27 October, 0546). 31 nmi (57 km) west of detonation. At 0546 observed nuclear detonation, bearing 90°.
- HOUSATONIC (Johnston Island, 30 October, 0601). Observed nuclear detonation, bearing 245°, distance 50 nmi (93 km).
- KINGFISH (Johnston Island, 1 November, 0210). At 100 nmi (185 km) southwest conducting a search for instrumented rocket nosecones. Observed nuclear detonation.
- TIGHTROPE (Johnston Island, 3 November, 2130). 320 nmi (593 km) northeast of detonation. Observed the detonation, bearing 225°.

USS Fort Marion (LSD-22)

Dock landing ship with a normal complement of 326. Participated only in one shot (STARFISH Prime) at Johnston Island as a unit of the Scientific Element (8.3.6.4). At shot time (Johnston Island, 8 July, 2300), steaming independently on station bearing 9°T, distance 133 nmi (246 km). Observed detonation, visibility momentarily reduced to 4 nmi (7 km) due to glare. Continued to operate in same area until 12 July.

USS Fortify (MSO-446)

Ocean minesweeper with normal complement of 74. Participated in Johnston Island operations during October and November as a unit of TE 8.3.2.4 (Surface Recovery). The ship operated off Kauai about 700 nmi (1,297 km) from shot area. For shot CHAMA (Johnston Island, 18 October, 0601), Fortify was moored at Pearl Harbor. At 1743 on 18 October underway for recovery operations off Kauai. Fortify had no potential for radiation exposure.

USS Frontier (AD-25)

This ship was not assigned to JTF 8 and was either at Long Beach or Pearl Harbor during DOMINIC. One person was badged with a zero reading and may have been assigned for temporary duty or as an observer.

USS Gannet (MSC-290)

Coastal minesweeper with a normal complement of 37. Participated only in shot SWORDFISH in the Vela Program to study hydroacoustic propagation from an underwater detonation. Arrived in assigned operating area 200 nmi (370 km) off San Diego coast on 7 May. At shot time, lying to on station, approximately 170 nmi (315 km) from surface zero. Departed 12 May for the Naval Electronics Laboratory.

USS Grapple (ARS-7)

Salvage ship with a normal complement of 120. Participated in Johnston Island operations during June and July as a unit of TE 8.3.6.3 (Recovery Unit). Departed Johnston Island on 10 July. During STARFISH Prime (Johnston Island, 8 July, 2300), steaming in column formation with Arikara, Sioux, and McCain, which joined and assumed guide and tactical command in rendezvous area. The ship was approximately 25 nmi (46 km) north of the detonation. At 2247 the rocket lifted off in the air, and at 2300 the detonation occurred. Ten minutes later the ship proceeded to the recovery area. On 9 July at 0305 the pod was secured alongside starboard quarter. The maximum radiation reading of any pod was 2 R per hour. At 1500 discontinued nosecone search.

USS Gurke (DD-783)

Destroyer with a normal complement of 336. Element of the Area One (Christmas Island) Operations Unit. Operational activities for each shot that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Steaming en route to Pearl Harbor from Christmas Island, approximately 700 nmi (1,297 km) northeast of the island.
- ENCINO (Christmas Island, 12 May, 0803). Steaming to Christmas Island from Pearl Harbor, approximately 700 nmi (1,297 km) north of Christmas Island.
- SWANEE (Christmas Island, 14 May, 0622). Steaming to Christmas Island from Pearl Harbor, approximately 600 nmi (1,112 km) north-northeast of Christmas Island.
- CHETCO (Christmas Island, 19 May, 0637). Underway in patrol area. Observed nuclear test bearing 255°, distance 45 nmi (83 km).
- TANANA (Christmas Island, 25 May, 0709). Observed nuclear detonation, bearing approximately 270°, distance 55 nmi (102 km).

- NAMBE (Christmas Island, 27 May, 0803). Observed nuclear detonation, bearing 68°, distance 42 nmi (78 km).
- ALMA (Christmas Island, 8 June, 0803). Steaming independently on Christmas Island patrol. Observed nuclear detonation, bearing 205°, distance 54 nmi (100 km).
- TRUCKEE (Christmas Island, 9 June, 0637). Steaming independently on Christmas Island patrol. Observed nuclear detonation, bearing 263°, distance 71 nmi (132 km).
- YESO (Christmas Island, 10 June, 0701). Steaming independently on Christmas Island patrol, approximately 120 nmi (222 km) west of the island.
- HARLEM (Christmas Island, 12 June, 0637). Underway for Christmas Island patrol. At 0629 all topside personnel took shelter; observed nuclear detonation, bearing 200°, range 40 nmi (74 km).
- RINCONADA (Christmas Island, 15 June, 0701). Steaming independently on patrol approximately 125 nmi (232 km) from Christmas Island.
- DULCE (Christmas Island, 17 June, 0701). Underway for Pearl Harbor. Observed nuclear detonation, bearing 220°, range 200 nmi (371 km).
- PETIT (Christmas Island, 19 June, 0601). Steaming from Christmas Island to Pearl Harbor, approximately 1,000 nmi (1,853 km) north of Christmas Island.
- STARFISH Prime (Johnston Island, 8 July, 2300). Steaming independently on patrol in station Alfa-2, at Christmas Island area, approximately 950 nmi (1,761 km) southeast of Johnston Island.
- SUNSET (Christmas Island, 10 July, 07[illegible]). Steaming independently on Christmas Island patrol, approximately 230 nmi (426 km) north of the island.
- PAMLICO (Christmas Island, 11 July, 0637). Steaming independently on Christmas Island patrol. Observed nuclear detonation on bearing 175°, range 50 nmi (93 km).

USNS Harris County (T-LST-822)

Tank landing ship with a complement of 43. Participated as a unit of the logistics and scientific element and as part of the rollup phases for both Christmas and Johnston Islands. Operational activities for each shot that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Anchored off English Harbor Entrance, Fanning Island, approximately 180 nmi (334 km) northwest of Christmas Island.

- AZTEC (Christmas Island, 27 April, 0702). Proceeding towards Washington Island. The ship was approximately 160 nmi (297 km) northwest of Christmas Island.
- ARKANSAS (Christmas Island, 2 May, 0902). Steaming en route to Pearl Harbor from Washington Island. The ship was approximately 540 nmi (about 1,000 km) north of Christmas Island.
- MUSKEGON (Christmas Island, 11 May, 0637). Steaming en route to Christmas Island from Pearl Harbor. The ship was approximately 780 nmi (1,446 km) north of Christmas Island.
- ENCINO (Christmas Island, 12 May, 0803). Steaming en route to Christmas Island from Pearl Harbor. The ship was approximately 585 nmi (1,084 km) north of Christmas Island.
- SWANEE (Christmas Island, 14 May, 0622). Steaming en route to Washington Island from Pearl Harbor. The ship was approximately 225 nmi (417 km) north of Christmas Island.
- CHETCO (Christmas Island, 19 May, 0637). Anchored off Christmas Island about 23 nmi (43 km) from surface zero. At 0643 the blast was heard.
- TANANA (Christmas Island, 25 May, 0709). Steaming towards Pearl Harbor. The ship was approximately 315 nmi (584 km) north of Christmas Island.
- NAVAR (Christmas Island, 27 May, 0803). Steaming towards Pearl Harbor. The ship was approximately 705 nmi (1,307 km) north of Christmas Island.
- YESO (Christmas Island, 10 June, 0701). Steaming en route from Pearl Harbor to Christmas Island with 43 crewmembers. The ship was approximately 990 nmi (1,835 km) north of Christmas Island.
- HARLEM (Christmas Island, 12 June, 0637). Steaming en route from Pearl Harbor to Christmas Island. The ship was approximately 540 nmi (about 1,000 km) north of Christmas Island.
- RINCONADA (Christmas Island, 15 June, 0701). Anchored at Christmas Island about 30 nmi (56 km) from surface zero.
- DULCE (Christmas Island, 17 June, 0701). Anchored at Christmas Island about 23 nmi (43 km) from surface zero.
- PETIT (Christmas Island, 19 June, 0601). Proceeding towards Fanning Island with 43 crewmembers and 1 USPHS (U.S. Public Health Service) passenger. The ship was approximately 155 nmi (287 km) northwest of Christmas Island.
- OTOWI (Christmas Island, 22 June, 0701). Anchored off Christmas Island about 23 nmi (43 km) from surface zero.
- BIGHORN (Christmas Island, 27 June, 0619). Steaming en route to Pearl Harbor from Washington Island. The ship was approximately 675 nmi (about 1,250 km) north of Christmas Island.

- SUNSET (Christmas Island, 10 July, 0732). Anchored off Christmas Island about 30 nmi (56 km) from surface zero.
- PAMLICO (Christmas Island, 11 July, 0637). Anchored off Christmas Island about 36 nmi (67 km) from surface zero.
- BUMPING (Johnston Island, 6 October, 0552). Steaming en route from Pearl Harbor to Johnston Island. The ship was approximately 180 nmi (334 km) north of the de onation.
- CHAMA (Johnston Island, 18 October, 0601). Anchored in outer anchorage, Johnston Island, about 130 nmi (241 km) from detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Steaming on assigned station from Johnston Island. The ship was approximately 80 nmi (148 km) south-southeast of detonation.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Steaming on assigned station in formation with USS Summit County (LST-1146). The ship was 15 nmi (28 km) south of detonation.
- CALAMITY (Johnston Island, 27 October, 0546). Proceeding within a 10-nmi (18.5-km) radius of assigned station. The ship was approximately 120 nmi (222 km) north-northwest of the detonation.
- HOUSATONIC (Johnston Island, 30 October, 0602). Anchored in Turning Basin, Johnston Island, about 240 nmi (445 km) from detonation.
- KINGFISH (Johnston Island, 1 November, 0210). Steaming on assigned station. Radiac monitor rounds were made on entire open weather deck and results were nil. The ship was approximately 40 nmi (74 km) south of the detonation.
- TIGHTROPE (Johnston Island, 3 November, 2130). Anchored in Johnston Island harbor about 20 nmi (37 km) from detonation. At 2145 radiac readings were taken of saltwater samples and results were nil.

USS Hassayampa (AO-145)

Oiler with a normal complement of 324. Element of Johnston Island Operations Unit (TU 8.3.6). Participated only in Johnston Island shots. Operational activities for each shot that it participated in are summarized below.

- BUMPING (Johnston Island, 6 October, 0552). Steaming to Johnston Island operations area. At 0815 sighted Johnston Island, 17 nmi (31 km). No shot time position data available.
- CHAMA (Johnston Island, 18 October, 0601). Underway off Johnston Island. Observed nuclear detonation. The ship was approximately 180 nmi (334 km) north-northeast of the detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Steaming in Johnston Island operation area. Observed nuclear detonation. The ship was approximately 130 nmi (241 km) north-northeast of the detonation.

- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Steaming independently on Station S-6, bearing 38°, 175 nmi (324 km) from detonation.
- CALAMITY (Johnston Island, 2[illegible] October, 0546). Steaming en route to Pearl Harbor, approximately 570 nmi (1,056 km) north-northeast of the detonation.
- HOUSATONIC (Johnston Island, 30 October, 0602). Underway from Pearl Harbor en route to Johnston Island, Station S-6. Observed nuclear shot. The ship was approximately 520 nmi (964 km) north-northeast of the detonation.
- KINGFISH (Johnston Island, 1 November, 0210). Steaming in assigned operations area S-6. Observed nuclear shot test. Bearing 11°, 310 nmi (574 km) from detonation.
- TIGHTROPE (Johnston Island, 3 November, 2130). Steaming north of Johnston Island. Observed nuclear test. The ship was approximately 108 nmi (200 km) north-northeast of the detonation.

USS Henry County (LST-824)

Tank landing ship with a normal complement of 266. Arrived Johnston Island 6 October. Element of the Scientific Unit (TG 8.3.6.4). Participated only in Johnston Island shots. Departed the island 8 November. Operational activities for each shot that it participated in are summarized below.

- BUMPING (Johnston Island, 6 October, 0552). Steaming in company with Summit County and Harris County en route from Pearl Harbor to Johnston Island, about 150 nmi (278 km) northeast of detonation.
- CHAMA (Johnston Island, 18 October, 0601). Steaming independently. The ship was approximately 120 nmi (222 km) southeast of the detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Steaming independently on station 76 nmi (141 km) west of Johnston Island. At 1432 proceeded to new station. Ship reported sighting detonation bearing 90°T, 100 nmi (185 km) from Johnston Island. A scientific report states ship was 82 nmi (152 km) west of detonation (Reference C.2053).
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Steaming in scientific formation in company with Summit County. The ship was approximately 13 nmi (24 km) south-southwest of the detonation.
- CALAMITY (Johnston Island, 27 October, 0546). Steaming independently, remaining within 10 nmi (19 km) of station, approximately 140 nmi (259 km) northwest of detonation.
- HOUSATONIC (Johnston Island, 30 October, 0602). Anchored at Inner Harbor, Johnston Island, about 240 nmi (445 km) northeast of detonation.

- KINGFISH (Johnston Island, 1 November, 0210). Steaming independently on station. At 0210 the ship reported observing nuclear detonation, distance 65 nmi (120 km), bearing 190°T to surface zero. A scientific report places ship 43 nmi (80 km), bearing 12.5°T from surface zero (Reference C.2053).
- TIGHTROPE (Johnston Island, 3 November, 2130). Steaming independently on assigned station. The ship was approximately 6 nmi (11 km) north of detonation.

USS Hitchiti (ATF-103)

Fleet ocean tug with a normal complement of 85. Member of the Scientific Element (TE 8.3.6.4). Anchored at Johnston Island 17 October and departed 7 November. Operational activities for each shot that it participated in are summarized below.

- BUMPING (Johnston Island, 6 October, 0552). Underway independently en route from Pearl Harbor for special operation. No position data available.
- CHAMA (Johnston Island, 18 October, 0601). Underway independently to station S-7. The ship was approximately 300 nmi (556 km) north of the detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Underway independently in operational area, 162 nmi (300 km) from Johnston Island. The ship was 192 nmi (356 km), bearing 10°T from the detonation according to a scientific report (Reference C.2053).
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Underway independently on station S-7, bearing 10°T, 135 nmi (250 km) from detonation. A scientific report (Reference C.2053) places ship 76 nmi (141 km), bearing 10°T from surface zero.
- CALAMITY (Johnston Island, 27 October, 0546). Underway independently on station S-7, approximately 225 nmi (417 km) north-northwest of the detonation.
- HOUSATONIC (Johnston Island, 30 October, 0602). Underway independently en route to station S-7, approximately 360 nmi (667 km) north-northeast of the detonation.
- KINGFISH (Johnston Island, 1 November, 0210). Underway independently in operating area S-7, bearing 10°T, 175 nmi (324 km) from detonation.
- TIGHTROPE (Johnston Island, 3 November, 2130). Underway independently in operating area S-7, bearing 10°T, 55 nmi (102 km) from detonation.

USS Hopewell (DD-681)

Destroyer with a normal complement of 319. Participated as an element of the SWORDFISH Operational Unit (TU 8.9.3). During SWORDFISH (370 nmi [685 km] off San Diego, 11 May, 1300), Hopewell was approximately 4,025 yards (3.7 km) from surface zero, bearing 200°T. At about H+10 minutes the ship began searching for submarine simulators and continued for 7 hours. Except for Bausell, which was part of the target array and whose crew had evacuated before the shot, the ship was the nearest to surface zero. The base surge did not initially reach Hopewell but shortly after the shot, the ship "cut through" the formation to search for simulators. Exposures (Table 24) do not show any significant effects of these maneuvers.

USS Hornet (CVS-12)

This ship was not assigned to JTF 8 and operated either off California or Pearl Harbor during DOMINIC. It was originally scheduled to operate in open seas south of Hawaii as a ship platform for scientific instrumentation. The change in concept of operation from open seas tests to concurrent tests at Christmas and Johnston islands caused the termination of ship work and the reconversion of the ships. One person was badged with a 0.021 R reading and was probably assigned to JTF 8 on temporary duty (Reference C.1.B, p. C-3).

USS Impervious (MSO-449)

Ocean minesweeper with a normal complement of 72. Element of the Land Based Naval Air Unit (TU 8.3.2). The ship engaged in surveillance and patrols off Kauai Island, Hawaii. Operational activities for each shot that it participated in were restricted to an area about 700 nmi (about 1,300 km) from shot sites.

USS Inflict (MSO-456)

Ocean minesweeper with a normal complement of 72. The ship was never in the Christmas-Johnston Island danger area. For most of June and July operations at Johnston Island, the ship operated out of Pearl Harbor as an element of TE 8.3.6.6. Inflict was involved in underwater measurements of electromagnetic signals (Project 7.1). The only shot observed was STARFISH Prime (Johnston Island, 8 July, 2300). At 2302 streaming special antenna equipment. Observed nuclear detonation, bearing 265°, 7° above horizon, distance approximately 750 nmi (1,390 km) northeast of Johnston Island.

USS Iwo Jima (LPH-2)

Amphibious assault ship with a normal complement of 594. Element of Area Two (Johnston Island) Operation Unit (TU 8.3.6). Arrived first time at Johnston Island 29 April. Participated only in the June and July Johnston Island events as the evacuation ship and was never in Christmas Island danger area. Left Johnston Island 26 July. Operational activities for each shot it participated in are summarized below.

- STARFISH (Johnston Island, 19 June, 2240). At 1719 underway for STARFISH position, 310°T, 12.5 nmi (23.2 km) from Johnston Island, on 20 June from 0000 to 0400 steaming on station; at 1332 underway to Pearl Harbor.
- STARFISH Prime (Johnston Island, 8 July, 2300). On 1 July at 1052 underway from Pearl Harbor to Johnston Island. On 3 July at 0755 anchored south of Johnston Island. On 8 July at 1636 underway from Johnston Island anchorage for assigned station approximately 35°T, 17.5 nmi (32.4 km) from Johnston Island (545 evacuees aboard). Observed shot STARFISH. On 9 July at 0825 anchored south of Johnston Island. At 0855 commenced debarkation of Johnston Island evacuees. At 1559 underway for Pearl Harbor.

USS Jenkins (DD-447)

Destroyer with a normal complement of 273. Element of Johnston Island Operations Unit. Was never in Christmas Island danger area. Departed Johnston Island 4 November. No exposure data are available. Operational activities for each shot that it participated in are summarized below.

- STARFISH Prime (Johnston Island, 8 July, 2300). Steaming independently on assigned station in Johnston Island nuclear test area. Approximately 500 nmi (927 km) northeast of the island.
- CHAMA (Johnston Island, 18 October, 0601). Steaming to Johnston Island assigned station, approximately 450 nmi (834 km) northeast of detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Steaming independently to assigned station in Johnston Island nuclear test area. Observed nuclear detonation, bearing 223°T from the detonation, approximately 400 nmi (741 km).
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Proceeding to new surveillance station, bearing 220°, distance 385 nmi (713 km) from Johnston Island.
- CALAMITY (Johnston Island, 27 October, 0546). Steaming on station southwest of Johnston Island. Observed nuclear detonation, bearing 082°T, distance 350 nmi (649 km).
- HOUSATONIC (Johnston Island, 30 October, 0602). Steaming on station in the Johnston Island nuclear test danger area, bearing 180°T, 300 nmi (556 km) from Johnston Island. Observed nuclear detonation, bearing 300°T, approximately 200 nmi (370 km).
- KINGFISH (Johnston Island, 1 November, 0210). Steaming to intercept Liberian merchant ship Napier within Johnston Island test danger area. Observed nuclear detonation bearing 180°T, approximately 550 nmi (1,019 km). Clouds obscured the fireball.

- TIGHTROPE (Johnston Island, 3 November, 2130). Steaming on assigned station, bearing 315°, distance 320 nmi (593 km) from detonation. Observed detonation on horizon, bearing 138°T. Fireball partially covered by low clouds.

USS Jerome County (LST-848)

Tank landing ship with a normal complement of 266. Member of TU 8.3.3 (Mobile Logistics Unit). Participated in Christmas Island survey in February and also in the rollup phase, but was not in the Christmas Island during shots. During STARFISH Prime (Johnston Island, 8 July, 2300), the only shot that it participated in, Jerome County was underway for Johnston Island operating area, approximately 25 nmi (46 km) north of detonation.

USS Lansing (DER-388)

Radar picket escort with a normal complement of 186. Element of the Surface Surveillance Unit (TE 8.3.6.1). Arrived Johnston Island on 27 September and departed for Pearl Harbor 24 October. Operational activities for each shot that it participated in are summarized below.

- ANDROSCOGGIN (Johnston Island, 2 October, 0617). Underway on station 10°N, 170°W. Observed nuclear detonation, bearing 350°T. The ship was approximately 240 nmi (444 km) south-southeast of the detonation. At 0711 underway for observation station S-2. At 1237 launched weather balloon.
- BUMPING (Johnston Island, 6 October, 0552). Patrolling surveillance station. The ship was approximately 285 nmi (528 km) south-southeast of the detonation. Observed nuclear detonation bearing 350°T.
- CHAMA (Johnston Island, 18 October, 0601). Independently patrolling station 11°N, 165°W, approximately 315 nmi (584 km) south-southeast of the detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Underway independently on way to surveillance station, approximately 430 nmi (797 km) south of the detonation. Observed nuclear blast, bearing 5°T.

USS Lipan (ATF-85)

Fleet ocean tug with a normal complement of 85. Participated in Vela Project for shot SWORDFISH. Operational activities for each shot that it participated in are summarized below.

- SWORDFISH (370 nmi [685 km] off coast of San Diego, 11 May, 1300). Underway independently about 800 nmi (1,483 km) west of shot SWORDFISH. At 1414 underway to Pearl Harbor.

- CHECKMATE (Johnston Island, 19 October, 2230). Underway independently to Johnston Island, approximately 660 nmi (1,223 km) north-northeast of the detonation.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Underway independently for designated area, approximately 40 nmi (74 km) north-northeast of the detonation.
- CALAMITY (Johnston Island, 27 October, 0546). Anchored in turning basin, Johnston Island, about 140 nmi (259 km) northwest of detonation.
- HOUSATONIC (Johnston Island, 30 October, 0602). Underway independently en route to Christmas Island from Johnston Island. The ship was approximately 615 nmi (1,140 km) south-southeast of the detonation.
- KINGFISH (Johnston Island, 1 November, 0210). Underway en route to Christmas Island from Johnston Island. The ship was approximately 975 nmi (1,807 km) south-southeast of the detonation.
- TIGHTROPE (Johnston Island, 3 November, 2130). Anchored off Bridges Point, Christmas Island.

USS Loyalty (MSO-457)

Ocean minesweeper with a normal complement of 75. Member of TE 8.3.6.5, with Inflict. The ship was not in the Johnston-Christmas Islands danger areas during DOMINIC. Loyalty participated in Project 7.1, Underwater Measurements of Electromagnetic Signals.

USS Maddox (DD-731)

Destroyer with a complement of 219. Participated only in shots SWORDFISH and FRIGATE BIRD as part of the surveillance unit centered around the anti-submarine warfare support aircraft carrier, Yorktown. Departed Long Beach on 26 April for the FRIGATE BIRD operating area. Operational activities for each shot that it participated in are summarized below.

- FRIGATE BIRD (Christmas Island, 6 May, 1430). Steaming in company with Task Group 8.8 composed of Norton Sound, CARDIV 19, Destroyer Division 232, and Ethan Allen. At 1417 the Polaris missile was launched from Ethan Allen. Maddox was 2,000 yards (1.8 km), bearing 333°T from the submerged submarine. Approximately 6 hours after the detonation, Maddox was detached from the FRIGATE BIRD Task Group and proceeded to SWORDFISH operating area.
- SWORDFISH (370 nmi [685 km] off San Diego, 11 May, 1300). Steaming in special operating area, approximately 5,000 yards (4.6 km) from surface zero, bearing 217°T. At 1301 the ship experienced the shock wave from the blast, but no damage was reported. An hour after the shot the ship took station north of Yorktown and held it

for several hours. Later in the afternoon Maddox was detached from the task group and steamed for Long Beach, arriving the next afternoon.

USS Marshall (DD-676)

Destroyer with a normal complement of 319. Element of the Surface Surveillance Unit. Operational activities for each shot that Marshall participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Steaming independently in area Alfa-3. No position data available.
- AZTEC (Christmas Island, 27 April, 0702). Steaming independently from Christmas Island to station A-4, approximately 40 nmi (74 km) southwest of detonation.
- ARKANSAS (Christmas Island, 2 May, 0902). Steaming independently in surveillance station A-3, approximately 210 nmi (389 km) northeast of Christmas Island.
- QUESTA (Christmas Island, 4 May, 1005). Steaming independently in Christmas Island surveillance area A-3, approximately 255 nmi (473 km) east of Christmas Island.
- FRIGATE BIRD (Christmas Island, 6 May, 1430). Steaming independently in Christmas Island surveillance station A-3, approximately 500 nmi (927 km) southwest of the detonation.
- YUKON (Christmas Island, 8 May, 0901). Steaming independently en route to Pearl Harbor, approximately 885 nmi (1,640 km) north of Christmas Island.
- TANANA (Christmas Island, 25 May, 0709). Underway 120 nmi (222 km) north of surface zero.
- NAMBE (Christmas Island, 27 May, 0803). Steaming independently in Christmas Island surveillance area A-3. No position data available.
- ALMA (Christmas Island, 8 June, 0803). Steaming independently in Area I (Christmas Island) station A-2, approximately 230 nmi (426 km) north of the detonation.
- TRUCKEE (Christmas Island, 9 June, 0637). Steaming independently in Christmas Island surveillance area 1, station A-2, approximately 230 nmi (426 km) north of the surface zero.
- YESO (Christmas Island, 10 June, 0701). Steaming independently in Christmas Island surveillance area 1, station A-2, approximately 230 nmi (426 km) north of the detonation.
- HARLEM (Christmas Island, 12 June, 0637). Anchored at Christmas Island about 30 nmi (56 km) from surface zero.

- RINCONADA (Christmas Island, 15 June, 0701). Steaming independently within Johnston Island danger area II, to point bearing 135°T, distance 720 nmi (1,334 km) north-northwest of Christmas Island.
- DULCE (Christmas Island, 17 June, 0701). Steaming independently to rendezvous with Chemung to take on fuel. The ship was approximately 900 nmi (1,668 km) north-northwest of Christmas Island.
- STARFISH Prime (Johnston Island, 8 July, 2300). Steaming independently in Johnston Island danger area on station, approximately 400 nmi (741 km) southeast of the detonation.

USS Mataco (ATF-86)

Fleet ocean tug with a normal complement of 97. Element of Johnston Island Operations Unit (TU 8.3.6). Operational activities that Mataco participated in did not take it into the Christmas Island danger area. Mataco was not in the Johnston Island area by the time of the first successful nuclear test, STARFISH Prime.

USS John S. McCain (DL-3)

Frigate with a normal complement of 403. Element of the Johnston Island Operations Unit (TU 8.3.6), where it led pod recovery activities. Operational activities for each shot that it participated in are summarized below.

- STARFISH Prime (Johnston Island, 8 July, 2300). Steaming independently approximately 25 nmi (46 km) north of the detonation. Launched and tracked weather balloons at 0132, 0759, 1313, 1816, and fired HASP rockets at 0106, 1236. At detonation time ship was steaming with Arikara, Grapple, and Sioux 25 nmi (46 km) north of the shot. After shot proceeded independently to pod area.
- ANDROSCOGGIN (Johnston Island, 2 October, 0617). In Johnston Island area about 460 nmi (852 km) northeast of detonation.
- BUMPING (Johnston Island, 6 October, 0552). Steaming in vicinity of 15°45'N, 165°0'W, approximately 195 nmi (361 km) east of the detonation.
- CHAMA (Johnston Island, 18 October, 0601). Steaming on assigned SAR/NAVAID station, approximately 270 nmi (500 km) north-northeast of the detonation. At 0601 made background radiation readings, conditions normal.
- CHECKMATE (Johnston Island, 19 October, 2230). Steaming in company with Engage and Safeguard, approximately 40 nmi (74 km) north of the observed detonation.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Steaming with Engage and Safeguard in vicinity of Johnston Island, conducting random barrier ASW patrol, approximately 35 nmi (65 km) north of the detonation. The next day recovered pod and transferred to mechanized landing craft (LCM).

- CALAMITY (Johnston Island, 27 October, 0546). Steaming en route to SAR/NAVAID station, approximately 180 nmi (334 km) northeast of the detonation.
- HOUSATONIC (Johnston Island, 30 October, 0602). Steaming on station for SAR/NAVAID. Sighted flash from detonation of nuclear device, bearing 220°T, 440 nmi (815 km) from Johnston Island.
- KINGFISH (Johnston Island, 1 November, 0210). On 31 October arrived on station at 1830. At 0000 steaming in company with Safeguard en route to station bearing 330°T. Ship about 50 nmi (93 km) north-northwest of detonation. At 0155 rocket lifted off and detonation occurred at 0210. At 1631 completed recovery of missile parts and pods.

USS Medregal (SS-480)

Submarine with normal complement of 76. Participated only in shot FRIGATE BIRD, along with Carbonero as TU 8.3.5 (FRIGATE BIRD Test Unit). No position information is available for the boat at shot time; however, its planned station was on a bearing 0°T, 25 nmi (46 km) from the burst point. At periscope depth, Medregal was outfitted with special instruments and cameras. Safety precautions were followed concerning viewing the detonation directly through the periscope. After photographs and instrument readings were obtained, technical observers were transferred to Southerland for return to Christmas Island.

USS Moctobi (ATF-105)

Moctobi was not present in the test area during any shot. The ship made two supply trips in March between Pearl Harbor and Christmas Island towing an open lighter.

USS Molala (ATF-106)

Fleet ocean tug with a normal complement of 85. Participated only in shot SWORDFISH as the towing ship for target array and in Projects 1.1 (Underwater Phenomena) and 1.2 (Surface Phenomena). Arrived in operating area 9 May and departed 12 May. On SWORDFISH D-day at 0655 a 4,200-yard (3.8-km) towline was connected to Bausell. At H-hour Molala was heading 13°T, bearing 342°T, 6,750 yards (6.2 km) from surface zero. Blast from the explosion was felt, but no damage was reported for Molala. By 1929 towline was disconnected from Bausell.

USS Monticello (LSD-35)

Dock landing ship with a normal complement of 304. Member of TU 8.9.3 (SWORDFISH Operational Unit), TE 8.9.3.2 (Towed Array Streaming Element) and TU 8.3.7 (Area One, Christmas Island Operating Unit). Arrived at Christmas Island on 27 February and again on 28 March for preoperational activities. Participated during shot SWORDFISH in Projects 1.1 (Underwater Phenomena) and

1.2 (Surface Phenomena) and also served as flagship for CJTG 8.9. During the June and July operations at Johnston Island, it provided Christmas Island Logistic Support. Departed Christmas Island on 18 June. Operational activities for each shot are summarized below.

- SWORDFISH (370 nmi [685 km] off San Diego, 11 May, 1300). At 0602 ship maneuvered to maintain heading into wind. CJTG 8.9 left ship aboard Marine helicopter for Agerholm. By 1156 ship was on station bearing 60°T, 9,000 yards (8.2 km) with Bauzell as a guide. At 1301 Agerholm fired the rocket. Monticello was 7,865 yards (7.2 km), bearing 250° to surface zero at shot time. At 1301:45 first shock wave hit ship. From 2000 to 2400 maneuvered while recovering test equipment and units of the target array.
- RINCONADA (Christmas Island, 15 June, 0701). Anchored off Christmas Island. Observed nuclear explosion starboard side about 30 nmi (56 km) from surface zero.
- DULCE (Christmas Island, 17 June, 0701). Steaming independently outside the western boundary of Christmas Island danger area, approximately 350 nmi (649 km) west of Christmas Island.
- PETIT (Christmas Island, 19 June, 0601). Steaming en route to Pearl Harbor, approximately 250 nmi (463 km) northwest of Christmas Island.

USS Samuel N. Moore (DD-747)

Destroyer with a normal complement of 345. Participated in FRIGATE BIRD in the Destroyer Unit and in SWORDFISH in the destroyer screen. Operational activities for shots FRIGATE BIRD and SWORDFISH are summarized below.

- FRIGATE BIRD (Christmas Island, 6 May, 1430). Steaming independently as TE 8.8.1.3 en route to rendezvous with TU 8.8.1 off coast of Southern California, approximately 750 nmi (1,390 km) north-northeast of detonation.
- SWORDFISH (370 nmi [685 km] off San Diego, 11 May, 1300). Steaming independently as a unit of TE 8.9.4.2 on surveillance station 15 nmi (28 km) east of Point Alfa. Underwater explosion occurred, and base surge sighted 180°T, range 3 nmi (5.6 km). The ship was approximately 7,170 yards (6.6 km) from surface zero.

USS Munsee (ATF-107)

Fleet ocean tug with a complement of 73. Munsee laid moors and set up target rafts for Christmas Island operations. Departed Christmas Island 5 June. Operational activities for each shot that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Anchored off Christmas Island. Observed detonation, bearing 150°T, 23 nmi (43 km). At 1031 underway to surface zero and sank target raft.
- AZTEC (Christmas Island, 27 April, 0702). Anchored at Anchorage B, Christmas Island. Observed blast, bearing 149°T, distance 22.8 nmi (42.3 km). Radiation readings taken at 0712, 0728, 0748, 0848, and 0930 and reported normal. At 1059 underway for surface zero.
- ARKANSAS (Christmas Island, 2 May, 0902). Anchored at Anchorage B, Christmas Island, 28 nmi (52 km) from surface zero. At 1240 underway for surface zero.
- QUESTA (Christmas Island, 4 May, 1005). Anchored at Anchorage B, Christmas Island. Observed nuclear test, bearing 151°T, approximately 28 nmi (52 km).
- YUKON (Christmas Island, 8 May, 0901) Observed nuclear explosion, bearing 159°T, distance 23 nmi (43 km). At 0930 no radiation detected. Underway at 1120 for surface zero.
- MESILLA (Christmas Island, 9 May, 0801). Anchored at Anchorage B, Christmas Island. Observed nuclear explosion, bearing 149°T, distance 23 nmi (43 km). At 1013 underway for surface zero site. At 1258 radiation readings negative in water and throughout ship.
- MUSKEGON (Christmas Island, 11 May, 0637). At 0648 [sic] observed nuclear explosion, bearing 150°T, distance 23 nmi (43 km). Underway at 0904 for surface zero.
- ENCINO (Christmas Island, 12 May, 0803). Anchored at Anchorage B, Christmas Island. Observed nuclear blast, bearing 153°T, range 25 nmi (46 km). At 1004 underway for surface zero.
- SWANEE (Christmas Island, 14 May, 0622). Anchored at Anchorage B, Christmas Island. Observed nuclear explosion, bearing 148°T, distance 23 nmi (43 km). At 0910 underway for surface zero. At 1005 no radiation in air or sea water. At 1202 rubber liferaft cleared the side with decontamination team and raft crew aboard. Target raft was cut adrift and was sunk.
- CHETCO (Christmas Island, 19 May, 0637). Anchored at Anchorage B, Christmas Island. Observed detonation, bearing 151°T, range 23 nmi (43 km).
- TANANA (Christmas Island, 25 May, 0709). Anchored at Anchorage B, Christmas Island. Observed nuclear explosion, bearing 150°T, range 23 nmi (43 km). At 0902 underway for surface zero. At 1030 radiation count normal. At 1158 radiation reading on target raft was 0.00004 R/hr.
- NAMBE (Christmas Island, 27 May, 0803). Anchored at Anchorage B, Christmas Island. Observed nuclear explosion, bearing 150°T, range 23 nmi (43 km).

- ALMA (Christmas Island, 8 June, 0803). Underway for San Diego, approximately 1,062 nmi (1,968 km) from Christmas Island.

USS Newell (DER-322)

Radar picket escort ship with a normal complement of 186. Element of Area One (Christmas Island) Operating Unit. Arrived at Christmas Island area in late March-early April. Participated in Christmas Island operations and the June and July Johnston Island shots. Provided weather observations (Christmas Island) and surveillance (Johnston Island). Left Johnston Island area on 25 July. Operational activities for each shot are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). 650 nmi (1,205 km) northeast of Christmas Island at shot time; at 1500 identified radar contact as a Greek freighter. Launched and tracked weather balloons.
- AZTEC (Christmas Island, 27 April, 0702). 650 nmi (1,205 km) northeast at shot time; at 0803 set material condition Zebra; at 0841 set material condition Yoke; at 0845 secured from general quarters; launched weather balloons and made bathythermograph (B/T) drops throughout day; on 29 April at 1612 moored Pearl Harbor.
- TANANA (Christmas Island, 25 May, 0709). On 21 May at 1503 underway from Pearl Harbor; on 23 May at 0812 condition Zebra set throughout the ship; at 0832 secured from general quarters. On 25 May at shot time steaming 650 nmi (1,205 km) northeast Christmas Island; launched and tracked weather balloons, made B/T drops during day.
- NAMBE (Christmas Island, 27 May, 0803). Steaming 600 nmi (1,112 km) northeast of Christmas Island; launched weather balloons and made bathythermograph drops during day; on 29 May at 0813 anchored in London Harbor, Christmas Island.
- ALMA (Christmas Island, 8 June, 0803). On 7 June at 1346 identified radar contact as Japanese fishing trawler; on 8 June steaming about 750 nmi (1,390 km) northeast of Christmas Island; launching weather balloons and making bathythermograph drops periodically.
- TRUCKEE (Christmas Island, 9 June, 0637). At shot time steaming 700 nmi (1,297 km) northeast of Christmas Island; launched and tracked weather balloons throughout the day.
- YESO (Christmas Island, 10 June, 0701). At shot time 700 nmi (1,297 km) northeast of Christmas Island; launched and tracked weather balloons throughout the day.
- HARLEM (Christmas Island, 12 June, 0637). On 11 June identified radar contact as a P2V; on shot day no position data given, but estimated approximately 700 nmi (1,297 km) northeast of shot site; on 13 June at 0120 identified contact as fishing trawler; at 0800 exercised crew at general quarters; at 0803 set material condition Zebra; at 0830 set ABC Condition Circle William; at 0910 set material condition Yoke; at 0917 secured from general quarters.

- RINCONADA (Christmas Island, 15 June, 0701). Launched balloons throughout the day. Shot time position estimated approximately 700 nmi (1,297 km) northeast of shot site.
- DULCE (Christmas Island, 17 June, 0701). Launched balloons throughout the day, 700 nmi (1,297 km) northeast of Christmas Island at shot time.
- PETIT (Christmas Island, 19 June, 0601). Steaming en route to Pearl Harbor about 1,000 nmi (1,853 km) north of Christmas Island at shot time.

USS Norton Sound (AVM-1)

Guided missile ship with a normal complement of 1,247. Participated in FRIGATE BIRD as task group flagship. On FRIGATE BIRD D-day at 1419 observed launching of Polaris missile from Ethan Allen, bearing 130°T, range 4,000 yards (3.7 km) from submerged submarine. At 1735 CJTG 8.8 and staff transferred by helicopter to Yorktown. Approximately 1 hour later, Norton Sound steamed independently toward Port Hueneme, California.

USS Oak Hill (LSD-7)

Dock landing ship with a normal complement of 326. Attached to the Scientific Element (TE 8.3.6.4). At the time of the STARFISH Prime detonation (Johnston Island, 8 July, 2300), Oak Hill was steaming on station S-1, 370 nmi (685 km) south. Observed detonation, 40 percent of sky was colored red and white (Reference C.3.2, Oak Hill). [A radiac reading of 0.040 R/hr was reported. Since the detonation occurred at a slant range of about 750 km, this reading could not be associated with the weapon test.]

USS O'Bannon (DDE-450)

Destroyer escort with a normal complement of 273. Element of Surface Surveillance Unit (TE 8.3.6.1). Did not enter the Christmas Island danger area. Operational activities for each of the shots it participated in are summarized below.

- STARFISH Prime (Johnston Island, 8 July, 2300). Steaming northwest of Johnston Island, approximately 450 nmi (833 km) north-northwest of detonation.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Underway en route to special operation area northeast of Johnston Island, approximately 400 nmi (741 km) north-northeast of Johnston Island.
- CALAMITY (Johnston Island, 27 October, 0546). Steaming en route to special station northeast of Johnston Island, approximately 500 nmi (926 km) from detonation.
- HOUSATONIC (Johnston Island, 30 October, 0602). Steaming independently on station, northeast of Johnston Island, approximately 600 nmi (1,112 km) northeast of detonation.

- KINGFISH (Johnston Island, 1 November, 0210). Steaming independently on station, northeast of Johnston Island, approximately 600 nmi (1,112 km) northeast of detonation. Observed nuclear explosion.

USS Page County (LST-1076)

Tank landing ship with a complement of 111. The ship transported cargo between islands and engaged in island reconnaissance. Departed Christmas Island on 28 July. Operational activities for each shot are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Steaming en route to Christmas Island, approximately 200 nmi (371 km) northeast of the surface zero.
- AZTEC (Christmas Island, 27 April, 0702). Anchored off Christmas Island about 23 nmi (43 km) from surface zero.
- ARKANSAS (Christmas Island, 2 May, 0902). At 0903 off Washington Island, approximately 250 nmi (463 km) northwest of Christmas Island.
- QUESTA (Christmas Island, 4 May, 1005). At 0845 off Fanning Island, approximately 150 nmi (278 km) northwest of Christmas Island.
- FRIGATE BIRD (Christmas Island, 6 May, 1430). Steaming 2 nmi (3.7 km) off the western coast of Fanning Island, approximately 150 nmi (278 km) northwest of Christmas Island.
- YUKON (Christmas Island, 8 May, 0901). Steaming off Fanning Island, approximately 150 nmi (278 km) northwest of Christmas Island.
- MESTILA (Christmas Island, 9 May, 0801). Steaming off Fanning Island, approximately 150 nmi (278 km) northwest of Christmas Island.
- MUSKEGON (Christmas Island, 11 May, 0637). Steaming en route from Christmas Island to Fanning Island, approximately 150 nmi (278 km) northwest of Christmas Island.
- ENCINO (Christmas Island, 12 May, 0803). Steaming for Washington Island. No position data available.
- ALMA (Christmas Island, 8 June, 0803). Steaming en route to Christmas Island, approximately 100 nmi (185 km) north of detonation.
- TRUCKEE (Christmas Island, 9 June, 0637). Anchored off Christmas Island about 23 nmi (43 km) north of detonation.
- YESO (Christmas Island, 10 June, 0701). Anchored off Christmas Island about 30 nmi (56 km) north of detonation.
- HARLEM (Christmas Island, 12 June, 0637). Underway to Fanning Island. At 0523 the ship was approximately 14 nmi (26 km) from Fanning Island.
- RINCONADA (Christmas Island, 15 June, 0701). Anchored off Christmas Island about 30 nmi (56 km) north of surface zero.

- DULCE (Christmas Island, 17 June, 0701). Steaming en route to Pearl Harbor, approximately 200 nmi (370 km) north of Christmas Island.
- PETIT (Christmas Island, 19 June, 0601). Steaming to Pearl Harbor, approximately 400 nmi (741 km) north of Christmas Island.

  SUNSET (Christmas Island, 10 July, 0732). Anchored at Christmas Island about 30 nmi (56 km) north of surface zero.
- PAMLICO (Christmas Island, 11 July, 0637). Anchored at Christmas Island about 36 nmi (67 km) north of surface zero.

USNS Pvt. Frank S. Petrarca (T-AK-250)

MSTS cargo ship with a crew of 38. Participated in logistic support to personnel and in the Christmas and Johnston Island rollup phase. Petrarca was also scientifically instrumented for the October and November shots of DOMINIC. Operational activities for each shot that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Anchored at Christmas Island about 23 nmi (43 km) from surface zero. Detonation occurred and shock wave encountered.
- BIGHORN (Christmas Island, 27 June, 0619). Anchored at London Roads, Christmas Island. Shot occurred starboard side about 37 nmi (69 km) from surface zero. At 0623:30 shock wave hit ship.
- BLUESTONE (Christmas Island, 30 June, 0621). Anchored at London Roads, Christmas Island about 36 nmi (67 km) from surface zero. Radiac readings taken hourly. At 0623.7 shock wave reached ship (double wave).
- ANDROSCOGGIN (Johnston Island, 2 October, 0617). Proceeding to assigned station on special project with 38 crewmembers and 7 technical personnel. The ship was approximately 180 nmi (334 km) north of the detonation.
- BUMPING (Johnston Island, 6 October, 0552). Steaming on assigned station for special project. The ship was approximately 105 nmi (195 km) northwest of the detonation.
- CHAMA (Johnston Island, 18 October, 0601). Anchored off Johnston Island about 140 nmi (259 km) from detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Steaming in vicinity of assigned station. The ship was approximately 120 nmi (222 km) northwest of detonation.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Steaming on assigned station for special project. The ship was approximately 180 nmi (334 km) northwest of the detonation.
- CALAMITY (Johnston Island, 27 October, 0546). Anchored off Johnston Island about 140 nmi (259 km) north of detonation.

- HOUSATONIC (Johnston Island, 30 October, 0602). Steaming on assigned station for special project. The ship was approximately 180 nmi (334 km) north of the detonation.
- KINGFISH (Johnston Island, 1 November, 0210). Steaming on assigned station for special project. The ship was approximately 160 nmi (297 km) northwest of the detonation.
- TIGHTROPE (Johnston Island, 3 November, 2130). Steaming on assigned station for special project. The ship was approximately 190 nmi (352 km) west of the detonation.

USNS Point Barrow (T-AKD-1)

MSTS dock cargo ship with a normal complement of 67. Member of the Scientific Element (TE 8.3.6.4). Participated in rollup operations for Christmas Island, which were completed by 17 August. On 12 December Point Barrow returned to Johnston Island for the rollup phase. No log has been located for the ship, however, some of its activities were documented and are summarized below.

- STARFISH Prime (Johnston Island, 8 July, 2300). Steaming on scientific station, 153 nmi (284 km), bearing 279.3°T from blast.
- CHECKMATE (Johnston Island, 19 October, 2230). Steaming on scientific station, 94 nmi (174 km), bearing 8.5°T from blast.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Steaming on scientific station, 16 nmi (30 km), bearing 185.8°T from blast.
- KINGFISH (Johnston Island, 1 November, 0210). Steaming on scientific station, bearing 187.2°T, 35 nmi (65 km) from blast.
- TIGHTROPE (Johnston Island, 3 November, 2130). Steaming on scientific station, bearing 24°T, 7 nmi (13 km) from blast.

USS Point Defiance (LSD-31)

Dock landing ship with a normal complement of 766. Participated in island reconnaissance before the June-July operations at Johnston Island, during the operations pause from August through September, and during rollup phase. No exposure data are available; however, known ship activity does not suggest that it was placed in any potential exposure areas during DOMINIC.

The ship departed Pearl Harbor on 19 January and conducted a survey of Baker, Jarvis, and Malden islands. It departed Christmas Island on 22 January, picking up 13 military and civilian passengers by helicopter and then travelling to Jarvis Island (23 January), Canton Island (25 January), Baker Island (26 January), Howland Island (27 January), and Canton Island (28 January). On 28 January the visitors departed the ship while at Canton Island. Ship departed for Pearl Harbor on 29 January, arriving 1 February.

On 4 August Point Defiance was anchored at Christmas Island and loaded personnel, scientific vans, boats, and equipment. It completed loading and sailed for San Diego, arriving 12 August.

USS Polk County (LST-1084)

Tank landing ship with a normal complement of 119. Member of the Scientific Element (TE 8.3.6.4). In February the ship made two trips to Johnston Island, two trips to Christmas Island, and one trip each to Fanning, Jarvis, and Palmyra islands for logistical support. The ship was not in the Christmas Island danger area during shots there. During STARFISH Prime (Johnston Island, 8 July, 2300), Polk County was steaming independently on assigned station S-3, east of Johnston Island. At 2230 designated personnel manned stations for nuclear test. Observed nuclear blast bearing 255°T, approximately 310 nmi (574 km) east of detonation.

USS Ponchatoula (AO-148)

Oiler with a complement of 277. Arrived Christmas Island on 6 April. Before the start of testing the ship left anchorage to replenish task force ships. Operational activities in each shot that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Anchored at Christmas Island about 23 nmi (37 km) north of surface zero.
- AZTEC (Christmas Island, 27 April, 0702). Anchored at London Roads, Christmas Island about 23 nmi (37 km) north of surface zero.
- ARKANSAS (Christmas Island, 2 May, 0902). Anchored at London Roads, Christmas Island, about 28 nmi (52 km) from detonation.
- QUESTA (Christmas Island, 4 May, 1005). Steaming independently en route to rendezvous with Moore, approximately 850 nmi (1,575 km) northeast from the detonation.
- FRIGATE BIRD (Christmas Island, 6 May, 1430). Steaming independently en route to rendezvous with Yorktown, remaining clear of launch area, approximately 720 nmi (1,334 km) north-northeast from the detonation.

USS Halsey Powell (DD-686)

Destroyer with a normal complement of 319. Arrived Christmas Island 6 April. Element of the Christmas Island Operations Unit (TU 8.3.7). Operational activities for each shot that it participated in are summarized below.

- ARKANSAS (Christmas Island, 2 May, 0902). Steaming en route to Christmas Island from Pearl Harbor. The ship was approximately 780 nmi (1,445 km) north of Christmas Island.
- QUESTA (Christmas Island, 4 May, 1005). Steaming en route to Christmas Island from Pearl Harbor. The ship was approximately 105 nmi (195 km) north of Christmas Island.

Powell (continued)

- YUKON (Christmas Island, 8 May, 0901). On special operations south of Christmas Island, approximately 100 nmi (185 km) south of surface zero.
- MESTILLA (Christmas Island, 9 May, 0801). On special operations east of Christmas Island, approximately 150 nmi (278 km) from surface zero.
- MUSKEGON (Christmas Island, 11 May, 0637). Steaming on special operations east of Christmas Island, approximately 150 nmi (278 km) from surface zero.
- ENCINO (Christmas Island, 12 May, 0803). Steaming on special operations south of Christmas Island, approximately 120 nmi (222 km) from surface zero.
- SWANEE (Christmas Island, 14 May, 0622). Steaming east of Christmas Island on special operations, approximately 135 nmi (250 km) northeast of surface zero.
- CHETCO (Christmas Island, 19 May, 0637). Steaming on special operations northeast of Christmas Island, approximately 60 nmi (111 km) north of surface zero.
- RINCONADA (Christmas Island, 15 June, 0701). Steaming en route to Christmas Island. The ship was approximately 600 nmi (1,112 km) north of Christmas Island.
- DULCE (Christmas Island, 17 June, 0701). Steaming south of Christmas Island, approximately 55 nmi (102 km) southwest of surface zero.
- PETIT (Christmas Island, 19 June, 0601). Steaming east of Christmas Island, no position data given. At 0819 anchored at Christmas Island.
- OTOWI (Christmas Island, 22 June, 0701). Underway north of Christmas Island, approximately 45 nmi (83 km) north of surface zero.
- BIGHORN (Christmas Island, 27 June, 0619). Steaming south of Christmas Island, approximately 80 nmi (148 km) southwest of surface zero.
- BLUESTONE (Christmas Island, 30 June, 0621). Steaming southwest of Christmas Island, approximately 120 nmi (222 km) southwest of surface zero.
- SUNSET (Christmas Island, 10 July, 0732). Steaming south of Christmas Island, approximately 80 nmi (148 km) south of surface zero.
- PAMLICO (Christmas Island, 11 July, 0637). Operating independently on patrol north of Christmas Island, approximately 45 nmi (83 km) northwest of surface zero.

USS Preston (DD-795)

Destroyer with a normal complement of 320. Participated only in shots FRIGATE BIRD and SWORDFISH on surveillance patrols and also as an element of the Destroyer Unit (TU 8.8.2). Departed operating area on 11 May. Operational activities for shots FRIGATE BIRD and SWORDFISH are summarized below.

- FRIGATE BIRD (Christmas Island, 6 May, 1430). At 0705 rendezvoused with Ethan Allen. At 1430 Preston's position was 90°T, 2,000 yards (1.8 km) from Ethan Allen.
- SWORDFISH (370 nmi [685 km] from San Diego, 11 May, 1300). At 1110 proceeded to take station for SWORDFISH, approximately 4,730 yards (4.3 km) from surface zero, bearing 300°T, heading 15°. Shock caused some damage to ship equipment.

USS Princeton (LPH-5)

Amphibious assault ship with a normal complement of 3,448. Participated in Flagship Element (TE 8.3.6.0) and provided JTF 8 Operations Control Center. Departed Johnston Island 4 November. Operational activities for each shot that it participated in are summarized below.

- ANDROSCOGGIN (Johnston Island, 2 October, 0617). Underway in assigned area east of surface zero. No position data available, but at 1200 it was 120 nmi (222 km) from detonation. Observed nuclear detonation, bearing 270°T.
- BUMPING (Johnston Island, 6 October, 0552). Observed nuclear detonation, bearing 135°T, distance 40 nmi (74 km).
- CHAMA (Johnston Island, 18 October, 0601). At 0245 arrived at position off marker SZ-2, maintaining a racetrack pattern east of surface zero at a distance greater than 30 nmi (56 km). Two hours after the detonation ship was 70 nmi (130 km) from surface zero.
- CHECKMATE (Johnston Island, 19 October, 2230). Observed nuclear blast overhead from a point 10 nmi (19 km) northeast of Johnston Island, approximately 50 nmi (93 km) from surface zero.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Steaming approximately 10 nmi (19 km) northeast of Johnston Island, around 30 nmi (56 km) from surface zero.
- CALAMITY (Johnston Island, 27 October, 0546). Steaming on assigned station. Observed nuclear detonation, bearing 90°T, distance 40 nmi (74 km).
- HOUSATONIC (Johnston Island, 30 October, 0602). Steaming on assigned station, approximately 50 nmi (93 km) from surface zero raft.
- KINGFISH (Johnston Island, 1 November, 0210). Steaming independently. Observed high-altitude nuclear blast overhead, approximately 50 nmi (93 km) from surface zero.

- TIGHTROPE (Johnston Island, 3 November, 2130). At 1425 underway. Observed nuclear blast overhead, approximately 15 nmi (28 km) from surface zero.

USNS Range Tracker (T-AGM-1)

Missile range instrumentation ship with a normal complement of 89. The ship was moored at Johnston Island for all shots of Operation DOMINIC and remained there during the operational pause from August through September, arriving at Johnston Island 10 April and departing 5 November. Range Tracker operated as a major part of JTF 8 range safety control facility throughout DOMINIC for all high-altitude tests. It was also used to assist in the checkout and verification of performance of a Pacific Missile Range (PMR) shore-based safety system installed at Johnston Island. It also provided headquarters facilities for CTU 8.3.6 and CTE 8.3.6.2 land-based naval aircraft.

USS Razorback (SS-394)

Submarine with a normal complement of 81. Participated only in shot SWORDFISH as a member of Weapons Systems and Effects Test Group. Specifically, the submarine was employed for shock evaluation and for firing submarine simulations prior to the shot. It also participated in Projects 1.3 (Effects of Hydroacoustic Propagation) and 3.1 (Ship Response). During SWORDFISH (370 nmi [685 km] off San Diego, 11 May, 1300), Razorback submerged at 1144 and remained there at periscope level for the detonation until 1333, approximately 4,477 yards (4.1 km), 249°T bearing, heading 343°T. At 1249 the submarine launched two submarine simulations (SQQ-925) which it tracked until H+3 minutes when they were 2,000 yards (1.8 km) from surface zero.

USS Reclaimer (ARS-42)

Salvage ship with a normal complement of 120. During the June and July Johnston Island operations, it helped in logistics and deep sea mooring operations. Operational activities for each shot that it participated in are summarized below.

- NAMBE (Christmas Island, 27 May, 0803). Underway from Pearl Harbor to Christmas Island. No position data available.
- ALMA (Christmas Island, 8 June, 0803). Anchored at London Roads, Christmas Island, about 28 nmi (52 km) from surface zero.
- TRUCKEE (Christmas Island, 9 June, 0637). Anchored at London Roads, Christmas Island, about 23 nmi (37 km) from detonation.
- YESO (Christmas Island, 10 June, 0701). Anchored at London Roads, Christmas Island, about 30 nmi (56 km) from detonation.
- HARLEM (Christmas Island, 12 June, 0637). Anchored at London Roads, Christmas Island, about 30 nmi (56 km) from detonation.

- RINCONADA (Christmas Island, 15 June, 0701). Anchored at London Roads, Christmas Island, about 30 nmi (56 km) from detonation.
- DULCE (Christmas Island, 17 June, 0701). Anchored at London Roads, Christmas Island, about 23 nmi (37 km) from detonation.
- PETIT (Christmas Island, 19 June, 0601). Anchored at London Roads, Christmas Island, about 30 nmi (56 km) from detonation.
- OTOWI (Christmas Island, 22 June, 0701). Anchored at London Roads, Christmas Island, about 23 nmi (37 km) from detonation.
- BIGHORN (Christmas Island, 27 June, 0619). Anchored at London Roads, Christmas Island, about 37 nmi (69 km) from detonation.
- BLUESTONE (Christmas Island, 30 June, 0621). Anchored at London Roads, Christmas Island, about 36 nmi (67 km) from detonation.
- SUNSET (Christmas Island, 10 July, 0732). Anchored at London Roads, Christmas Island, about 30 nmi (56 km) from detonation.
- PAMLICO (Christmas Island, 11 July, 0637). Anchored at London Roads, Christmas Island, about 36 nmi (67 km) from detonation.

USS Rowan (DD-782)

Destroyer with a normal complement of 336. Element of Christmas Island Operations Unit (TU 8.3.7). Departed Christmas Island on 6 July. Operational activities for each shot that it participated in are summarized below.

- AZTEC (Christmas Island, 27 April, 0702). Underway for station Alfa-Two, approximately 890 nmi (1,649 km) north of Christmas Island.
- ARKANSAS (Christmas Island, 2 May, 0902). Anchored at London Roads, Christmas Island. Observed atomic test, bearing 125°T, 30 nmi (56 km).
- QUESTA (Christmas Island, 4 May 1005). Anchored at London Roads, Christmas Island. Observed atomic test, bearing 150°T, 28 nmi (52 km).
- FRIGATE BIRD (Christmas Island, 6 May, 1430). Underway for patrol in Christmas Island area, approximately 550 nmi (1,019) southwest of detonation.
- YUKON (Christmas Island, 8 May, 0901). Steaming independently on station A-3 northeast of island, approximately 200 nmi (370 km).
- MESILLA (Christmas Island, 9 May, 0801). Steaming independently on station Alfa-4 south of island. Observed nuclear detonation, bearing 23°T, 130 nmi (241 km).
- MUSKEGON (Christmas Island, 11 May, 0637). Steaming independently south of the island, approximately 110 nmi (204 km).

- ENCINO (Christmas Island, 12 May, 0803). Steaming on station A-3. No position data available.
- SWANEE (Christmas Island, 14 May, 0622). Steaming south of Christmas Island. Observed atomic burst, bearing 333°T, 40 nmi (74 km).
- CHETCO (Christmas Island, 19 May, 0637). Monitoring Soviet research vessel Shokalskiy. Observed brilliant flash of light on horizon, bearing 87°T, approximately 330 nmi (612 km) from Christmas Island.
- TANANA (Christmas Island, 25 May, 0709). Steaming independently on assigned surveillance station, approximately 450 nmi (834 km) southwest of Christmas Island.
- NAMBE (Christmas Island, 27 May, 0803). Steaming in assigned surveillance station, approximately 350 nmi (649 km) south of the island.
- OTOWI (Christmas Island, 22 June, 0701). Steaming independently from Pearl Harbor to Christmas Island, approximately 120 nmi (222 km) north of the detonation.
- BIGHORN (Christmas Island, 27 June, 0619). Steaming independently on surveillance station 90 nmi (167 km) west of Danger Area One. Observed nuclear explosion, on 90°T bearing, 350 nmi (649 km).
- BLUESTONE (Christmas Island, 30 June, 0621). Steaming independently on surveillance station A-11. Illumination from nuclear blast observed in east. Position was approximately 270 nmi (500 km) west-southwest of the detonation.
- STARFISH Prime (Johnston Island, 8 July, 2300). Steaming to Pearl Harbor. Observed high-altitude nuclear detonation on bearing 260°T, approximately 695 nmi (1,290 km) east-northeast of the detonation.

USS Safeguard (ARS-25)

Salvage ship with a normal complement of 120. Member of TE 8.3.6.3 (Recovery Element). Operational activities for each shot that it participated in are summarized below.

- ANDROSCOGGIN (Johnston Island, 2 October, 0617). Moored at Pearl Harbor at shot time. At 1121 began pod recovery operations in Kauai operating area.
- CHAMA (Johnston Island, 18 October, 0601). Anchored at Johnston Island, approximately 130 nmi (241 km) north of detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Steaming on station. Observed nuclear detonation, about 40 nmi (74 km) north of detonation.

- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). Underway to maintain station astern of Engage. Observed nuclear detonation about 35 nmi (65 km) south. On 26 October at 1314 had missile debris on board.
- CALAMITY (Johnston Island, 27 October, 0546). Anchored at Johnston Island, approximately 140 nmi (649 km) northwest of detonation. On 28 and 29 October engaged in raft recovery operations.
- HOUSATONIC (Johnston Island, 30 October, 0602). Maneuvered to enter Johnston Island Inner Harbor about 250 nmi (463 km) northeast of detonation.
- KINGFISH (Johnston Island, 1 November, 0210). Underway for special operations. At 0000 steaming in company of McCain. Observed nuclear detonation bearing 180°T, distance 60 nmi (110 km). At 0719 maneuvered to recover pod.
- TIGHTROPE (Johnston Island, 3 November, 2130). Underway from Johnston Island to SZ-4, approximately 250 nmi (463 km) southwest of detonation.

USS Sea Fox (SS-402)

Submarine with a normal complement of 66. Participated in shot SWORDFISH as a member of the Weapon Systems and Effects Test Group. Specifically, it provided special submarine training to its personnel. Departed San Diego on 7 May for assigned operating area and returned 12 May. There is no entry for Sea Fox in the Consolidated List. During SWORDFISH (370 nmi [685 km] off San Diego, 11 May, 1300), at H-hour Sea Fox was submerged at periscope depth on station 30 nmi (56 km) from surface zero. This was the first sonar convergence zone and the submarine had hydrophones suspended to 1,000 feet (305 meters). At 1330 the submarine was secured from torpedo battle station and surfaced at 1422.

USS Sioux (ATF-75)

Fleet ocean tug with a normal complement of 85. Participated in shot SWORDFISH in Project 2.1 (Base Surge Radiation) for Naval Radiological Defense Laboratory (NRDL) and in the June and July Johnston Island operations during STARFISH Prime as an element of Surface Recovery Unit (TE 8.3.2.4) conducting surveillance and nosecone recovery. Operational activities for each shot are summarized below.

- SWORDFISH (370 nmi [685 km] off San Diego, 11 May, 1300). At 1000 all personnel except for 15 men boarded the command ship, Monticello. Sioux was on station at 1052. At H-hour the ship was bearing 342°T, 8,650 yards (7.9 km) from surface zero. Immediately after the shot, ship departed formation and headed for the radiation pool to obtain water samples for NRDL. Twenty minutes after detonation, Sioux entered the radioactive water pool. Gamma field rose to 0.300 R/hr and the ship maneuvered to leave quickly. The exposure rate

rose to over 500 R/hr 200 yards (183 meters) inside the pool. An invisible mist contaminated the weather deck to between 0.01 and 0.02 R/hr. After the ship left the radioactive pool, its washdown system reduced this contamination to an undetectable level. Some personnel on the bridge had contaminated skin or shoes. The project leader's left hand read about 0.400 R/hr and his hair about 0.100 R/hr (Reference C.3.1, p. H-1-1; Reference D.5, Appendix 1, p. 4). At H+3, Sioux reentered the water patch in the southern quadrant with all crewmembers who had boarded Monticello. By 1800 gamma radiation had dropped by a factor of 10 fissions per liter. On 12 May the ship continued to track the radioactive patch and collect technical data from SWORDFISH.

- STARFISH Prime (Johnston Island, 8 July, 2300). Underway for station, bearing 325°T. 4.5 nmi (8.3 km) from Johnston Island. Sortied with McCain, Grapple, and Arikara about 25 nmi (46 km) north of detonation. Recovered pod and participated in search for rocket nosecone in the rocket impact area.

USS Snohomish County (LST-1126)

Tank landing ship with a normal complement of 119. Element of Mobile Logistics Support Unit (TU 8.3.3) and Special Operations Unit (TU 8.3.9). Departed Christmas Island 24 July. Operational activities for each shot that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Steaming to Christmas Island, approximately 500 nmi (927 km) northwest of Christmas Island.
- AZTEC (Christmas Island, 27 April, 0702). Steaming from Palmyra to Christmas Island, approximately 150 nmi (278 km) south of detonation.
- ARKANSAS (Christmas Island, 2 May, 0902). Steaming en route from Christmas Island to Pearl Harbor, approximately 780 nmi (1,446 km) north of the island.
- TANANA (Christmas Island, 25 May, 0709). Underway from Palmyra to Christmas Island, approximately 200 nmi (370 km) northwest of Christmas Island.
- NAMBE (Christmas Island, 27 May, 0803). Anchored at Christmas Island about 23 nmi (37 km) north of detonation.
- ALMA (Christmas Island, 8 June, 0803). Underway from Christmas Island to Pearl Harbor, approximately 850 nmi (1,575 km) north of Christmas Island.
- TRUCKEE (Christmas Island, 9 June, 0637). Underway from Christmas Island to Pearl Harbor, approximately 1,100 nmi (2,039 km) north of Christmas Island.

- OTOWI (Christmas Island, 22 June, 0701). Underway from Pearl Harbor to Christmas Island, approximately 500 nmi (927 km) north of Christmas Island.
- BIGHORN (Christmas Island, 27 June, 0619). Underway from Christmas Island to Fanning Island with 11 passengers, approximately 160 nmi (297 km) northwest of Christmas Island.
- BLUESTONE (Christmas Island, 30 June, 0621). Anchored at Christmas Island about 36 nmi (67 km) north of surface zero.
- SUNSET (Christmas Island, 10 July, 0732). Underway from Washington Island to Pearl Harbor, approximately 350 nmi (649 km) northwest of Christmas Island.
- PAMLICO (Christmas Island, 11 July, 0637). Underway from Washington Island to Pearl Harbor, approximately 550 nmi (1,019 km) north of Christmas Island.

USS Southerland (DDR-743)

Radar picket destroyer with a normal complement of 367. Participated in FRIGATE BIRD and in the Christmas Island tests conducting surface surveillance. Member of TU 8.3.7 (Area One Operations Unit). Operational activities for each shot that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). Steaming on surveillance station. Observed nuclear test. Cloud was observed bearing 19°T, 190 nmi (352 km). At 0656 a complete monitoring of weather decks indicated no increase in radiation.
- AZTEC (Christmas Island, 27 April, 0702). Steaming en route to surveillance station A-3, approximately 160 nmi (296 km) north-northeast of detonation.
- ARKANSAS (Christmas Island, 2 May, 0902). Steaming independently in Area One, approximately 460 nmi (852 km) northeast of Christmas Island.
- QUESTA (Christmas Island, 4 May, 1005). Steaming independently to surveillance station, approximately 400 nmi (741 km) northeast of Christmas Island. At 0834 launched and tracked weather balloons.
- FRIGATE BIRD (Christmas Island, 6 May, 1430). Steaming independently in Station Radish. Observed nuclear detonation, bearing 70.5°T, range 118 nmi (218.7 km) determined by radar. Also observed an orange cloud 3 seconds after test, no fallout expected. Radiac readings taken every 5 minutes.
- YUKON (Christmas Island, 8 May, 0901). Anchored at London Roads, Christmas Island. Observed nuclear detonation, bearing 145°T, range 23 nmi (37 km). Shock wave passed the ship at 0903.

Southerland (continued)

- MERSILLA (Christmas Island, 9 May, 0801). Steaming en route to Christmas Island from Fanning Island. Observed nuclear detonation, bearing 160°T, distance 60 nmi (111 km).
- MUSKEGON (Christmas Island, 11 May, 0637). Steaming en route to Pearl Harbor, approximately 720 nmi (1,334 km) north of Christmas Island.
- ENCINO (Christmas Island, 12 May, 0803). Steaming en route to Pearl Harbor, approximately 1,100 nmi (2,039 km) north of Christmas Island.
- NAMBE (Christmas Island, 27 May, 0803). Steaming to Christmas Island, approximately 500 nmi (927 km) north of Christmas Island.
- ALMA (Christmas Island, 8 June, 0803). Steaming independently while conducting surveillance patrol of Soviet survey group, approximately 360 nmi (667 km) west of Christmas Island.
- TRUCKEE (Christmas Island, 9 June, 0637). Steaming independently while conducting surveillance patrol of Soviet survey group. Observed flash of nuclear explosion, bearing 92°T, at 320 nmi (593 km).
- YESO (Christmas Island, 10 June, 0701). Steaming independently while conducting surveillance patrol of Soviet survey group. Observed flash from nuclear detonation on bearing 100°T, approximately 300 nmi (556 km).
- HARLEM (Christmas Island, 12 June, 0637). Steaming independently while conducting surveillance patrol of Soviet survey group. Observed detonation on approximate bearing of 88°T, approximately 700 nmi (1,297 km) from Christmas Island.
- RINCONADA (Christmas Island, 15 June, 0701). Steaming independently while conducting surveillance patrol of Soviet survey group. Observed detonation on bearing 100°T, approximately 350 nmi (649 km) from Christmas Island.
- DULCE (Christmas Island, 17 June, 0701). Steaming independently while conducting surveillance patrol of Soviet survey group. Observed flash of nuclear explosion, bearing 130°T, approximately 300 nmi (556 km) from Christmas Island.
- PETIT (Christmas Island, 19 June, 0601). Steaming independently while conducting surveillance patrol of Soviet survey group. Observed flash of nuclear detonation, bearing 105°T, distance approximately 390 nmi (723 km).
- OTOWI (Christmas Island, 22 June, 0701). Steaming independently while conducting surveillance patrol of Soviet survey group. Observed flash of nuclear detonation, bearing approximately 108°T, distance 373 nmi (691 km).

- BIGHORN (Christmas Island, 27 June, 0619). Steaming independently en route to Pearl Harbor from Christmas Island, approximately 500 nmi (927 km) north of Christmas Island.
- STARFISH Prime (Christmas Island, 8 July, 2300). Moored at Pearl Harbor. Observed light from nuclear explosion in a southwesterly direction, distance of blast reported to be approximately 800 nmi (1,483 km). Ship about 720 nmi (1,334 km) from Johnston Island.

USS Summit County (LST-1146)

Tank landing ship with a normal complement of 119. Unit of TE 8.3.6.4 (Scientific). Participated in Johnston Island shots only. Operational activities in each shot that it participated in are summarized below.

- BUMPING (Johnston Island, 6 October, 0552). Underway in company with Henry County and Harris County en route to Johnston Island. The ship was approximately 180 nmi (334 km) north-northeast of detonation.
- CHAMA (Johnston Island, 18 October, 0601). Underway independently for operation area, approximately 160 nmi (297 km) southwest of detonation.
- CHECKMATE (Johnston Island, 19 October, 2230). Underway independently on assigned station in operation area. Observed detonation, reportedly approximately 200 nmi (371 km) south of shot site.
- BLUEGILL Triple Prime (Johnston Island, 25 October, 2359). At 1300 steaming on assigned station to remain with Harris County. On 26 October at 0000 observed detonation, ship approximately 15 nmi (28 km) south of detonation.
- CALAMITY (Johnston Island, 27 October, 0546). Underway independently in operating area, approximately 100 nmi (185 km) north-northwest of detonation.
- HOUSATONIC (Johnston Island, 30 October, 0602). Anchored at Johnston Island Harbor about 180 nmi (334 km) northeast of detonation.
- KINGFISH (Johnston Island, 1 November, 0210). Underway independently in KINGFISH H-hour station, approximately 40 nmi (74 km) south-southwest of the detonation.
- TIGHTROPE (Johnston Island, 3 November, 2130). Anchored at Johnston Island and observed the detonation about 3 nmi (5.6 km), bearing 20°.

USS Takelma (ATF-113)

Fleet ocean tug with a normal complement of 85. Participated in 18 shots as part of the Rocket Nose Cone Recovery Task Element for Kauai, Hawaii operations and as TE 8.3.6.4 (Scientific). Operational activities for KINGFISH shot

were in the Kauai operating area. For BLUEGILL Triple Prime the ship was operating approximately 243 nmi (450 km) north of Johnston Island as a unit of TE 8.3.6.4.

USS Tawakoni (ATF-114)

Fleet ocean tug with a normal complement of 85. Participated in shot SWORDFISH as an element of Land-Based Naval Air Unit (TU 8.3.2) and in the Rocket Nose Cone Recovery Task Element and Johnston Island Operations Unit (TU 8.3.6). The latter operations were in the Kauai area. During SWORDFISH (370 nmi [685 km] off San Diego, 11 May, 1300), Tawakoni was steaming independently in vicinity of 24°N, 54°W, approximately 1,800 nmi (1,336 km) from surface zero. At 1320 it recovered hydrophonic equipment.

USS Taylor (DDE-468)

Escort destroyer with a normal complement of 329. Element of Johnston Island Operations Unit (TU 8.3.6) and Surface Surveillance Unit (TE 8.3.6.1). The ship did not enter the Christmas Island danger area. Operational activities for each shot that it participated in are summarized below.

- o STARFISH Prime (Johnston Island, 8 July, 2300). Steaming on station, bearing 8°T, 310 nmi (575 km) from shot.
- o ANDROSCOGGIN (Johnston Island, 2 October, 0617). Steaming on assigned SAR station, approximately 420 nmi (778 km) northeast of Johnston Island.
- o BUMPING (Johnston Island, 6 October, 0552). Proceeding to SAR/NAVAID station, approximately 500 nmi (927 km) northeast of Johnston Island.
- o CHAMA (Johnston Island, 18 October, 0601). Steaming on SAR/NAVAID station, approximately 570 nmi (1,056 km) northeast of Johnston Island.

USS Tolovana (AO-64)

Oiler with normal complement of 313. Arrived in Christmas Island area 9 June. Member Christmas Island Operating Unit (TU 8.3.7). Participated only in Christmas Island shots. Underway replenishment ship. Left Christmas Island area on 11 July. Operational activities for each shot that it participated in are summarized below.

- o HARLEM (Christmas Island, 12 June, 0637). Anchored at Christmas Island. At 0602 observed atomic air blast, bearing 160°T, all conditions appeared normal. Ship about 30 nmi (56 km) from detonation. At 0757 maneuvered out of Christmas Island to replenish Gurke and Marshall. From 0938 to 1149 replenished Gurke.

- DULCE (Christmas Island, 17 June, 0701). Steaming independently to rendezvous with Gurke. At shot time 170 nmi (315 km) northwest of surface zero. From 0815 to 0941 replenished Gurke.
- PETIT (Christmas Island, 19 June, 0601). Steaming from rendezvous point to Christmas Island operating Area A-2, about 170 nmi (315 km) north of surface zero at shot time.
- OTOWI (Christmas Island, 22 June, 0701). On 21 June refueled Rowan from 1832 to 1953. Steaming on Christmas Island operating area A-2, 195 nmi (361 km) north of surface zero at shot time. From 1334 to 1551 replenished Powell.
- BIGHORN (Christmas Island, 27 June, 0619). On 26 June steaming for operating area, 160 nmi (297 km) northwest of surface zero at shot time.
- BLUESTONE (Christmas Island, 30 June, 0621). Steaming independently at shot time, 120 nmi (222 km) southwest of Christmas Island, to rendezvous with Powell. Anchored at Christmas Island at 1904.
- STARFISH Prime (Johnston Island, 3 July, 2300). Anchored at Christmas Island.
- SUNSET (Christmas Island, 10 July, 0732). Anchored at London Roads, Christmas Island. Observed shot bearing 155°T, at distance 30 nmi (56 km). At 0830 underway to replenish Cabildo and Powell. At 1622 anchored at Christmas Island.
- PAMLICO (Christmas Island, 11 July, 0637). Anchored at London Roads, Christmas Island about 36 nmi (67 km) north of surface zero. At 0749 sailed for U.S. west coast.

USS Tunny (SSG-282)

This ship was not assigned to JTF 8 and operated either at Pearl Harbor or Yokosuka, Japan during DOMINIC. It did not participate in the operation. However, one person under this ship heading was badged and had a zero reading. He was probably assigned to JTF 8 on a temporary duty basis.

USS Tuscumbia (YTB-762)

Nine personnel on this large harbor tug were badged with a mean 0.123 R reading. The ship provided tug and tow services operating out of Pearl Harbor.

USS Ute (ATF-76)

Fleet ocean tug with a normal complement of 85. Arrived Johnston Island on 8 April, took YCV-17 in tow, and sailed for Pearl Harbor on 10 April. Arrived Christmas Island 23 April. Member Christmas Island Operations Unit (TU 8.3.7). Participated in Christmas and Kauai operations. Christmas Island logistics and Kauai surveillance. Left Christmas Island 25 April. No exposure data are available. Operational activities for shots that it participated in are summarized below.

- ADOBE (Christmas Island, 25 April, 0646). On 16 April at 1748 underway for Christmas Island to Pearl Harbor with YC-1420, YC-1412, and YC-1397 in tow. On 23 April at 0908 anchored anchorage Echo, Christmas Island. On 25 April at 0602 exercised at general quarters about 23 nmi (43 km) from surface zero. Secured from general quarters at 0718. At 2000 sailed for Pearl Harbor with YC-1397, YC-1414, and YFN-914 in tow.
- NAMBE (Christmas Island, 27 May, 0803). On 25 May at 1757 underway from Pearl Harbor to Kauai. On 26 May at 2305 released to proceed independently to Pearl Harbor. About 1,158 nmi (2,146 km) north of Christmas Island at shot time. On 27 May at 1033 moored at Pearl Harbor.
- ALMA (Christmas Island, 8 June, 0803). On 7 June at 1243 underway from Pearl Harbor to Kauai surveillance area. About 1,200 nmi (2,224 km) north of Christmas Island. On 8 June 1517 moored at Pearl Harbor.

USS Walker (DDE-517)

Escort destroyer with a normal complement of 329. Arrived Johnston Island on 17 May. Member of Johnston Island Operations Unit (TU 8.3.6). Participated as a surveillance ship in Johnston Island shots only. Left Johnston Island on 4 June before nuclear shots there. Did not enter Christmas Island danger area.

USS Yorktown (CVS-10)

Antisubmarine warfare support aircraft carrier with a normal complement of 3,448. Left San Diego on 27 April for FRIGATE BIRD and SWORDFISH. Element of FRIGATE BIRD Air Element (TE 8.8.1.1) and SWORDFISH Surveillance Unit (TG 8.9). Participated in SWORDFISH and FRIGATE BIRD events for flight operations. Sailed for San Diego on 11 May. Operational activities for shots that it participated in are summarized below.

- FRIGATE BIRD (Christmas Island, 6 May, 1430). Conducted flight operations off California, 1,050 nmi (1,946 km) northeast of FRIGATE BIRD.
- SWORDFISH (370 nmi [685 km] south of San Diego, 11 May, 1300). Steaming out of San Diego, conducting flight operations for SWORDFISH; at 1235 sounded general quarters; at 1323 secured from general quarters, steaming en route to San Diego. Heading 134° from true north, 309° bearing from surface zero, 9,800 yards (9 km) from surface zero.

NAVAL AIR UNITS

The following Navy operational air units participated.

Commander Fleet Air Wing 2 (COMFAIRWING 2, or CFAW-2). There were 35 badged personnel. CFAW-2 provided communications at NAS Barbers Point for CTU

8.3.2 (Land Based Naval Units) during Kauai operations. CFAW-2 participated in DOMINIC operations from April to November 1962. In addition to its Kauai functions, it supported surveillance operations at Christmas and Johnston islands through the patrol squadrons listed below.

Air Anti-Submarine Squadron 23 (VS-23) and Air Anti-Submarine Squadron 25 (VS-25). These squadrons were based on Yorktown during FRIGATE BIRD and SWORDFISH. The exposures for these units are included under Yorktown in Table 24.

Airborne Early Warning Barrier Squadron Pacific (Detachment) (AEWB SQDN PACNAVY 14, or AEW BARRON PAC). Exposure data exist for 62 personnel. Two or three (sources differ) WV-2 early warning patrol planes were assigned to the detachment. It was at DOMINIC in May, June, and July. The WVs were used for observation and range clearance. The detachment supported Johnston Island operations and FRIGATE BIRD as a communications liaison.

Carrier Airborne Early Warning Squadron 11 (VAW-11). Detachment Tango of this unit was based on Yorktown during DOMINIC and its personnel exposures are included with Yorktown exposures itn Table 24.

Heavy Photo Air Squadron 62 (VAP-62), Detachment 35. There were 28 badged personnel. VAP-62 (composed of two A3D-2P aircraft) and Marine Aircraft Repair Squadron 37 with two R5D-3 operating out of Marine Corps Air Station, El Toro, were designated to provide crews and aircraft for aerial technical photography for shot SWORDFISH. VAP-62 operated out of NAS Miramar, California.

Helicopter Anti-Submarine Squadron 5 (HS-5). This unit was based on Yorktown during DOMINIC. Exposures for this unit are included with Yorktown's in Table 24.

Patrol Squadron 6 (VP-6). This squadron operated from NAS Barbers Point. There were 4 badged personnel. It participated in both spring and fall operations providing surveillance at Christmas Island and Johnston Island. The squadron was composed of 12 SP-2E Mod II Neptune patrol aircraft (P2V-5s).

Patrol Squadron 9 (VP-9). There were 305 badged personnel. On 5 September 1962 VP-9 departed NAS Alameda, for NAS Barbers Point, Hawaii, to operate under CFAW-2 in support of Operation DOMINIC. Aircraft were P2V-7s. From September to November 1962 it was engaged in Johnston Island surveillance.

Patrol Squadron 28 (VP-28), NAS Barbers Point, Hawaii. There were 142 badged personnel. From 17 April to 7 July, aircraft from VP-28 were deployed to Christmas and Johnston islands for surveillance. On 11 June VP-28 relieved VP-872 and assumed responsibility for the conduct of all surveillance, special mission, and ASW flights assigned by CTE 8.3.7.2. Squadron was composed of P2V-5Fs, PAR/MOD. VP-28 flew 290 flights totalling 2,334.1 hours for DOMINIC.

Patrol Squadron 46 (VP-26), NAS North Island, San Diego, California. There were 14 badged personnel. From 1 to 17 May 1962, P2V-7 aircraft were involved in

monitoring the SWORDFISH radioactive pool for Project 2.2, making 21 flights. From 22 June to 17 July, three crews were detached to CFAW-2 to conduct air surveillance during Johnston Island, Phase I (Kauai) operations.

Patrol Squadron 872 (VP-872). There were 249 badged personnel. They engaged in Christmas and Johnston island surveillance with four PZV-5FS aircraft from March to 11 June. VP-28 relieved VP-872 on 1 June.

Transport Squadron 3 (VR-3), McGuire AFB, New Jersey. In this Fleet Tactical Supply Squadron, 49 persons were badged with a high exposure of 0.571 R. This unit provided crews for the C-118 aircraft of Project 4.1 and may also have provided air transport of radioactive device debris samples from the test sites to Hickam AFB for trans-shipment to the U.S. laboratories via MATS jet transports.

In addition single individuals were badged from the Naval Air Stations at Norfolk, Virginia, and Sanford, Florida, but their duties are not known. The Navy Air Development Center is discussed with the Navy scientific units.

OTHER NAVAL UNITS AND ORGANIZATIONS

A variety of other groups provided special support for DOMINIC operations or had personnel present on special temporary assignment or as observers.

Navy Amphibious Unit, and Amphibious Construction Battalion (ACB-1), Detachment Zulu, Coronado, California. The unit augmented TE 8.3.9.7 (Christmas Island Boat Element) and consisted of one officer, 37 enlisted, with one utility landing craft (LCU). In addition, after USCGS Pathfinder charted anchorage areas off the west coast of Christmas Island and established six reference points on the shore opposite the anchorage, ACB-1, Detachment Zulu, constructed three ship navigational aids. One LCU was required to stay at Christmas Island for the duration of the operation (about 4 months). Before the testing this unit provided one officer and nineteen men to install the ship-to-shore pipeline for aircraft fuel. This group also maintained this.

Chief of Naval Operations, 128. There were two badged personnel. Their assignment is unknown.

Navy Communications Station, San Diego, California. There were two badged individuals, one assigned to MOPHOUPAC, the other to CTG 8.3.

Navy Communications Station, Kodiak, Alaska. One badged individual.

Navy Communications Station, Pearl Harbor. There were two badged personnel. One was assigned to CTG 8.3.

Navy Communications Center, Barbers Point. The Communications Center at Barbers Point was a major relay point for CJTF 8 circuits between Christmas and Johnston islands and designated relay stations on Oahu. Additionally, it supported communications for units of CJTG 8.4 and JTF 8 scientific task units based at Barbers Point. It also provided communications facilities

(through CFAW-2) for Kauai Operations for CTU 8.3.2 (Land Based Operations Unit). There was one badged individual.

Commander Destroyer Squadron 5. There was one badged individual. Commander Destroyer Squadron 5 was present for SWORDFISH aboard Agerholm as CTG 8.9 (SWORDFISH Unit).

Commander Destroyer Squadron 7. There were eight badged individuals. Commander Destroyer Squadron 7 and his staff, in addition to normal command responsibilities, also supplemented CTU 8.3.7 (Christmas Island Operations Area). He was TU 8.3.7 Deputy Commander and Chief of Staff and CTE 8.3.7.1 (Destroyer Element). He and his staff for TU 8.3.7 totalled five officers and six enlisted men.

Explosive Ordnance Disposal Unit 1 (EODU-1), Pearl Harbor. There were 14 badged personnel. Following the 19 June STARFISH aborted firing, Navy provided an EODU and a Underwater Demolition Team (UDT) at Johnston Island to assist in recovery of contaminated missile parts from the lagoon and reef areas. Grapple and a 20-man UDT/EOD team assisted in recovering many alpha contaminated STARFISH missile parts over a 2-week period. This 20-man joint UDT/EOD team has also been identified as a 20-man UDT team. The former composition is considered to be correct.

Navy Hospital Bethesda, Maryland. Two badged, one of whom was a Lt. Col. (service affiliation unknown) stationed at the Armed Forces Radiobiology Research Institute at Bethesda. Duties of either man are not known.

Commander Mine Division 113, Long Beach, California. There was one badged representative with an unknown function.

Nuclear Weapons Training Center, Norfolk, Virginia. There was one badged individual, assignment unknown.

Commander in Chief, Pacific Fleet, Pearl Harbor. There were seven badged personnel.

Navy Security Station. One individual was badged and listed as a member of CJTF 8 Staff.

Commander Service Force Pacific (COMSERVPAC), Pearl Harbor. There were two badged personnel. During Christmas Island operations, COMSERVPAC coordinated a special airlift of food to ships and boats at Christmas Island.

Utility Landing Craft (LCU) Division 13, Detachment B. No exposure data are available. This detachment augmented TE 8.3.9.7 (Christmas Island Boat Element). LCU Div. 13, Det. B was composed of one officer, 48 enlisted, and three LCUs.

There were also a few men from the following bases, most of whose assignments are not known: Advanced Submarine Base, Pearl Harbor, 3 badged, one a member of CTG 8.3; Clarksville Base, 2 badged; Navy Unit, Lake Meade, 1 badged; Naval Station, Long Beach, 1 badged; Naval Station, Pearl Harbor, 2 badged individuals.

CHAPTER 10

U.S. AIR FORCE PARTICIPATION IN OPERATION DOMINIC

Functions performed by the Air Force included airdropping the nuclear devices for most of the tests, collection of nuclear detonation debris samples from the clouds, weather reconnaissance and prediction, communications support, operation of the Christmas and Johnston island airbases, air transport support, as well as participation in or management of a number of scientific experiments.

In performing these tasks, the personnel associated with cloud-sampling operations gave the Air Force the largest number of individual exposures that exceeded 3 R, the Maximum Permissible Exposure (MPE). For these operations a special MPE of 20 R was authorized. Other exposures for the Air Force were not high, and the mean for Air Force personnel was 0.375 R.

Air Force participation was from many regular Air Force units and some Air National Guard (ANG) units. Normally, however, only a few men from these units, rather than the whole unit, participated.

There were 400 separate organization codes established to document the exposures of personnel in Air Force organizations participating in DOMINIC; however, 30 of those organizations had no participants, and 33 organizations were given more than one code. For example, the 1369th Photo Squadron has three different organizational codes: 4016, 4686, and 4691. The 337 Air Force organizations provided about 2,800 men for DOMINIC, making the average contribution per unit fewer than 9.

Table 25 lists the participating Air Force organizations, their organizational codes, total number of badged participants, and distribution of total exposures. The table is in alphabetical order of organizational title and is further ordered by state or country. Appendix B contains the complete list of organizational codes and titles as defined by the Joint Task Force 8 (JTF 8) Radsafe Branch. The list in the appendix can be compared to Table 25, but the data in Table 25 represent the results of checking numerous individual 5x8 cards to identify as accurately as possible both the complete organizational title and home station location. In the course of this effort a large number of discrepancies were identified. Discrepancies included such items as the same individual being listed more than once within the same organization, or one individual being listed with two different organizations. It was also discovered that in a few cases, accumulated exposures were incorrectly totaled.

It is important to note that the data presented in Table 25 have been copied directly from the microfilmed Consolidated List (Reference C.1.3). No corrections based upon the discrepancies discovered in researching through 5x8 card data have been made on this table. As units are treated in this chapter, however, the discrepancies discovered are discussed.

Table 25. DOMINIC personnel exposures, U.S. Air Force organizations.

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	High (R)
4123	Aeronautical Systems Division, Wright Patterson AFB OH	7	1	5	1						0.859
4124	Aeronautical Systems Division, Wright Patterson AFB OH	1	1								0.000
4553	Aeronautical Systems Division, Wright Patterson AFB OH	22	13	9							0.492
4687	Aerospace Systems Division, Edwards AFB CA	1		1							0.145
4164	Air National Guard, Stead AFB NV	2	1				1				2.160
4054	Air Proving Ground Command, Eglin AFB FL	2		2							0.075
4699	Air Proving Ground Command, Eglin AFB FL	1		1							0.067
4703	Air University, Maxwell AFB AL	1		1							0.102
4670	Air Weather Service Detachment, Andrews AFB MD	1	1								0.000
4079	Air Weather Service, Scott AFB IL	3	1				1			1	12.324
4638	Air Weather Service, Scott AFB IL	1		1							0.073
4680	Cambridge Research Laboratory, Bedford MA	3	2	1							0.065
4704	Combat Defense Squadron, Clinton Sherman OK	1	1								0.000
4019	Combat Support Squadron, March AFB CA	1	1								0.000
4110	Combat Support Squadron, Walker AFB NM	3	3								0.000
4589	Communications Service, Sioux City IA	2		2							0.384
4624	Flight Test Center, Edwards AFB CA	2		2							0.169
4570	Ground Electronic Equipment Intl Agcy, Wheeler AFB HI	7	6	1							0.020
4663	Air Force Headquarters, Washington DC	2	1	1							0.050
4062	Headquarters USAF Detachment, Hickam AFB HI	7	7								0.000
4113	Headquarters USAF Detachment, Roswell NM	1	1								0.000
4149	Headquarters USAF, Washington DC	3	3								0.000
4150	Headquarters USAF, Washington DC	5	4	1							0.079
4136	Headquarters, Amarillo AFB TX	4	1	3							0.086
4707	Headquarters, Biggs AFB TX	5		4	1						0.705
4655	Headquarters, Blytheville AFB AR	1		1							0.061
4711	Headquarters, Carswell AFB TX	1		1							0.030
4015	Headquarters, Castle AFB CA	12	6	6							0.088
4163	Headquarters, Chanute AFB IL	1	1								0.000
4092	Headquarters, Columbus AFB MS	1	1								0.000
4510	Headquarters, Davis Monthan AFB AZ	2		2							0.092
4658	Headquarters, Dyess AFB TX	1		1							0.088
4172	Headquarters, Edwards AFB CA	3	1	2							0.239
4048	Headquarters, Eglin AFB FL	4		4							0.097
4710	Headquarters, Ent AFB CO	1		1							0 071
4174	Headquarters, Hamilton AFB CA	2		2							0.239
4157	Headquarters, Itazuke Air Base, Japan	1	1								0.000
4712	Headquarters, Itazuke Air Base, Japan	1	1								0.000
4671	Headquarters, Lackland AFB TX	1		1							0.136
4608	Headquarters, Lockbourne AFB OH	2	2								0.000
4008	Headquarters, McClellan AFB CA	48	14	33	1						0.970
4028	Headquarters, McClellan AFB CA	2	1	1							0.020
4094	Headquarters, McConnell AFB KS	1	1								0.000
4104	Headquarters, Nellis AFB NV	2	2								0.000
4025	Headquarters, Norton AFB CA	2	2								0.00
4099	Headquarters, Offutt AFB NE	6	5	1							0.072

(continued)

Table 25. DOMINIC personnel exposures, U.S. Air Force organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
4676	Headquarters, Orlando AFB FL	1		1							0.050
4692	Headquarters, Orlando AFB FL	3	1	2							0.447
4603	Headquarters, Paine AFB WA	2	1	1							0.082
4635	Headquarters, Randolph AFB TX	1		1							0.221
4715	Headquarters, Richards Gebauer AFB MO	1	1								0.000
4078	Headquarters, Scott AFB IL	2	1	1							0.078
4131	Headquarters, Sewart AFB TN	22		22							0.225
4134	Headquarters, Sheppard AFB TX	8	5	3							0.079
4152	Headquarters, Tachikawa Air Base, Japan	5	2	3							0.062
4126	Headquarters, Tinker AFB OK	2	2								0.000
4056	Headquarters, Turner AFB GA	27	9	18							0.219
4569	Headquarters, Vandenberg AFB CA	2		2							0.071
4668	Headquarters, Robins AFB GA	1	1								0.000
4561	Headquarters, Wurtsmith AFB MI	1		1							0.088
4511	Air Force Hospital, Lackland AFB TX	1		1							0.091
4650	Air Force Logistics Command, Wright Patterson AFB OH	1	1								0.000
4165	Military Air Transport Service Det, Robins AFB GA	2	1	1							0.054
4072	Military Air Transport Service Pacific Div, Hickam AFB HI	9	6	3							0.065
4628	Air Force Missile Development Center, Holloman AFB NM	1		1							0.134
4049	Air Force Missile Test Center, Cape Canaveral FL	1	1								0.000
4069	Pacific Air Forces, Hickam AFB HI	16	12	4							0.071
4647	Pacific Air Forces, Hickam AFB HI	1	1								0.000
4560	Pacific Command, Rear, Wheeler AFB HI	3	2	1							0.045
4070	Sacramento Air Materiel Area Detachment, Hickam AFB HI	9	9								0.000
4623	Sacramento Air Materiel Area Detachment, Hickam AFB HI	2	2								0.000
4632	San Bernadino Air Material Area, Norton AFB CA	1							1		2.700
4137	Air Force School of Aerospace Medicine, Brooks AFB TX	2	2								0.000
4178	Air Force School of Aerospace Medicine, Brooks AFB TX	1	1								0.000
8150	Air Force Space Systems Division	2	2								0.000
4633	Air Force Space Systems Division Det, Andrews AFB MD	1						1			2.250
4631	Air Force Space Systems Division, Vandenberg AFB CA	5		5							0.390
4001	Air Force Special Weapons Center, Kirtland AFB NM	36	11	24		1					1.151
4108	Air Force Special Weapons Center, Kirtland AFB NM	120	42	71	3			3		1	6.163
4662	Air Force Special Weapons Center, Kirtland AFB NM	2		2							0.102
8007	Air Force Special Weapons Center, Kirtland AFB NM	50	25	23	1	1					1.046
4600	Strategic Air Command, Offutt AFB NE	1		1							0.050
4679	Air Force Systems Command Engring Office, Brookley AFB AL	1		1							0.030
4087	Air Force Systems Command, Andrews AFB MD	5	3	2							0.095
4002	Warfare Systems School, Maxwell AFB AL	2		2							0.050
4160	Warner-Robins Air Material Area, Robins AFB GA	1	1								0.000
3518	Weather Central, Andrews AFB MD	1		1							0.080
4652	Weather Central, Barksdale AFB LA	1		1							0.127
4673	Weather Central, Beale AFB CA	1	1								0.000
4657	Weather Central, Hanscom Field MA	2	2								0.000
4641	Weather Central, Offutt AFB NE	1	1								0.000
4654	Weather Central, Tinker AFB OK	1	1								0.000

(continued)

Table 25. DOMINIC personnel exposures, U.S. Air Force organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	High (R)
4672	Weather Central, Walker AFB NM	1	1								0.000
4642	Weather Central, Westover AFB MA	1		1							0.086
4173	Western Air Force, Travis AFB CA	11	10	1							0.031
4501	1st Air Postal Squadron, Itazuke Air Base, Japan	2	1	1							0.104
4664	1st Combat Evaluation Group, Barksdale AFB LA	2		2							0.113
4158	1st Communications Group (Mobile), Clark AFB, Philippines	1		1							0.110
4598	1st Field Maintenance Squadron, Selfridge AFB MI	1	1								0.000
4021	1st Strategic Aerospace Division, Vandenberg AFB CA	8	5	3							0.114
4634	1st Strategic Aerospace Division, Vandenberg AFB CA	2	1	1							0.023
4648	2nd Weather Group, Langley AFB VA	1		1							0.018
4640	3rd Armament & Electrncs Maint Sq, Yokota Air Base, Japan	1		1							0.065
4562	4th Air Base Group, Johnson AFB NC	1		1							0.070
4146	4th Tactical Control Squadron, McChord AFB WA	5	5								0.000
4596	4th Weather Group, Kansas City MO	1		1							0.048
4161	5th Field Maintenance Squadron, Travis AFB CA	4	2	2							0.090
4029	5th Orgn Maintenance Squadron, Travis AFB CA	2		2							0.289
4115	6th Bombardment Squadron, Walker AFB NM	4	3	1							0.063
4519	6th Bombardment Wing, Walker AFB NM	1	1								0.000
4112	6th Support Squadron, Walker AFB NM	2	1	1							0.062
4125	6th Weather Squadron, Tinker AFB OK	64	27	36	1						0.632
4574	6th Weather Squadron, Tinker AFB OK	1		1							0.050
4144	7th Tactical Control Squadron, McChord AFB WA	8	8								0.000
4604	8th Weather Group, Williams AFB AZ	2	1		1						0.763
4053	8th Weather Squadron, MacDill AFB FL	1		1							0.066
4083	9th Support Squadron, Mountain Home AFB ID	2	1	1							0.047
4026	9th Weather Recon Group, McClellan AFB CA	14	7	7							0.111
4706	9th Weather Squadron, Malstrom AFB MT	1		1							0.093
4656	9th Weather Squadron, March AFB CA	1		1							0.042
4543	11th Bombardment Wing, Altus AFB OK	2	1	1							0.088
4020	13th Aeromedical Transport Sq, Travis AFB CA	1		1							0.128
4010	Headquarters, 15th Air Force, March AFB CA	10	2	8							0.132
4584	15th Weather Squadron, Maxwell AFB AL	1		1							0.030
4118	18th Air Transport Squadron, McGuire AFB NJ	11	1	10							0.105
4084	18th Communications Squadron, Westover AFB MA	1		1							0.129
4520	18th Communications Squadron, Westover AFB MA	1		1							0.044
4684	18th Tactical Fighter Wing, Kadena Air Base, Okinawa	1		1							0.037
4597	22nd Civil Engineering Squadron, March AFB CA	2		2							0.120
4040	22nd Food Service Squadron, March AFB CA	1		1							0.297
4007	22nd Support Squadron, March AFB CA	10	2	8							0.252
4032	23rd Bombardment Squadron, Travis AFB CA	1		1							0.023
4592	24th Weather Squadron, Lowry AFB CO	2		2							.046
4661	24th Weather Squadron, Travis AFB CA	2	1	1							.046
4651	26th Weather Squadron, Bergstrom AFB TX	1	1								0.000
4557	26th Weather Squadron, Hill AFB UT	1		1							0.040
4627	28th Field Maintenance Squadron, Ellsworth AFB SD	1			1						0.645

(continued)

Table 25. DOMINIC personnel exposures, U.S. Air Force organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	High (R)
4507	30th Air Division, Truax AFB WI	1		1							0.125
4119	30th Air Transport Squadron, McGuire AFB NJ	7	7								0.000
4548	30th Communications Squadron, Offutt AFB NE	6	1	5							0.067
4538	32nd Communications Squadron, Elkhorn, NE	1		1							0.024
4155	33rd Air Rescue Squadron, Kadena Air Base, Okinawa	2	2								0.000
4154	36th Air Rescue Squadron, Tachikawa Air Base, Japan	8	2	6							0.092
4117	38th Air Transport Squadron, McGuire AFB NJ	7	7								0.000
4637	38th Air Transport Squadron, McGuire AFB NJ	4	2	1	1						0.645
4587	42nd Air Base Wing, Loring AFB ME	1	1								0.000
4148	43rd Air Refueling Squadron, Larson AFB WA	3	2	1							0.072
4005	44th Air Transport Squadron, Travis AFB CA	130	102	28							0.184
4147	44th Tactical Control Squadron, McChord AFB WA	1	1								0.000
4526	46th Communications Squadron, Barksdale AFB LA	3		3							0.065
4636	48th Air Transport Squadron, Hickam AFB HI	1	1								0.000
4077	48th Air Transport Squadron, Hickam AFB HI	55	42	13							0.228
4063	50th Air Transport Squadron, Hickam AFB HI	142	140	2							0.030
4167	52nd Consolidated Acft Maint Squadron, Suffolk AFB NY	1						1			2.298
4003	55th Weather Recon Squadron, McClellan AFB CA	195	65	103	7						0.791
4176	55th Weather Recon Squadron Detachment, Eilson AFB AK	3	2	1							0.053
4097	Headquarters 56th Fighter Wing, K.I. Sawyer AFB MI	3	2	1							0.040
4705	56th Weather Squadron, Yokota Air Base, Japan	1	1								0.000
4057	61st Tactical Control Squadron, Stewart AFB GA	1		1							0.097
4145	62nd Tactical Control Squadron, McChord AFB WA	2	1	1							0.135
4143	74th Weather Squadron, Hill AFB UT	2	2								0.000
4066	76th Air Rescue Squadron, Hickam AFB HI	16	11	5							0.124
4061	79th Air Rescue Squadron, Andersen AFB, Guam	23	14	9							0.074
4618	92nd Civil Engineering Squadron, Fairchild AFB WA	4	1	3							0.102
4545	93rd Civil Engineering Squadron, Castle AFB CA	2	1	1							0.020
4036	93rd Field Maintenance Squadron, Castle AFB CA	7	1	6							0.136
4135	96th Bombardment Wing, Dyess AFB TX	4	1	3							0.111
4531	96th Operations Squadron, Osan Air Base, Korea	1		1							0.196
4179	105th Air Transport Squadron, Memphis Municipal Arpt TN	7	7								0.000
4006	114th Air Transport Squadron, Travis AFB CA	1	1								0.000
4659	115th Aircraft Control & Warning Sq, Dothan AL	1	1								0.000
4093	117th Tactical Recon. Squadron, Hutchinson AFB KS	3		3							0.385
4607	124th Weather Squadron, Williams AFB AZ	1	1								0.000
4181	128th Air Transport Squadron, Dobbins AFB GA	15	14	1							0.050
4649	133rd Weather Squadron, Duluth International Airport MN	1		1							0.053
4035	146th Air Transport Wing, Van Nuys CA	1	1								0.000
4034	146th Consolidated Acft Maint Squadron, Van Nuys CA	2	1	1							0.040
4180	155th Air Transport Squadron, Memphis Municipal Arpt TN	7	6	1							0.021
4142	191st Air Transport Squadron, Salt Lake City, UT	1	1								0.000
4541	305th Air Refueling Squadron, McGuire AFB NJ	1		1							0.169
4171	310th Bombardment Wing, Shilling AFB KS	1		1							0.211
4130	314th Consolidated Acft Maint Squadron, Sewart AFB TN	10		9	1						0.524
4096	343rd Fighter Group, Duluth International Airport MN	1		1							0.129

(continued)

Table 25. DOMINIC personnel exposures, U.S. Air Force organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
4506	343rd Fighter Group, Duluth MN	1		1							0.090
4502	339th Missile Wing, Warren AFB MI	1		1							0.022
4024	414th Consolidated Acft Maint Squadron, Oxnard AFB CA	2						2			2.413
4626	551st Air Base Squadron, Otis AFB MA	1		1							0.059
4616	551st Air Refueling Squadron, Otis AFB MA	1		1							0.374
4011	552nd Airbrn Early Wrning & Cntrl Sq, McClellan AFB CA	53	23	30							0.149
4018	552nd Field Maintenance Squadron, McClellan AFB CA	7	2	5							0.132
4043	552nd Orgn Maintenance Squadron, McClellan AFB CA	5	2	3							0.107
4528	648th Support Squadron, Gunther AFB AL	2		2							0.110
4573	688th Aircraft Control & Warning Sq, Amarillo TX	1		1							0.148
4682	728th Aircraft Control & Warning Sq, Cannon AFB NM	6	4	2							0.040
4689	729th Aircraft Control & Warning Sq, Nellis AFB NV	2	2								0.000
4537	745th Aircraft Control & Warning Sq, Duncanville TX	1		1							0.224
4586	763rd Radar Squadron, Niagara Falls NY	1		1							0.092
4536	771st Radar Squadron, Cape Charles Air Force Sta VA	2		2							0.068
4568	782nd Radar Squadron, Rockville Air Force Sta IL	1		1							0.092
4601	803rd Civil Engineering Squadron, Davis Monthan AFB AZ	3	2	1							0.020
4533	815th Operations Squadron, Forbes AFB KS	1		1							0.213
4509	817th Combat Support Group, Pease AFB NH	1		1							0.093
4565	818th Operations Squadron, Lincoln AFB NE	1		1							0.032
4614	820th Operations Squadron, Plattsburg NY	1		1							0.083
4540	821st Radar Squadron, Baker OR	1		1							0.023
4513	825th Operations Squadron, Littlerock AFB AR	1		1							0.062
4128	857th Medical Group, Clinton Sherman OK	1		1							0.064
4088	1001st Air Base Wing, Andrews AFB MD	12		11	1						0.557
4643	1001st Air Base Wing, Andrews AFB MD	2		2							0.046
4539	1001st Field Maintenance Squadron, Andrews AFB MD	1		1							0.088
4033	1003rd Installations Group, Norton AFB CA	2	1	1							0.032
4182	1030th Medical Service Group, Gunther AFB AL	2	2								0.000
4677	1090th USAF Special Reporting Wing, Sandia Base NM	11	6	4		1					1.112
4114	1094th Aviation Depot Squadron, Manzano Base NM	1						1			2.249
4688	1095th USAF Special Reporting Squadron, Bossier Base LA	1	1								0.000
4605	1100th Air Base Squadron, Bolling AFB DC	1	1								0.000
4014	1155th Technical Operations Squadron, McClellan AFB CA	35	17	18							0.214
4107	1211th Test Squadron, Kirtland AFB NM	329	22	147	43	26	20	12	12	47	18.080
4170	1215th Weather Squadron, Olmsted AFB PA	1	1								0.000
4090	1254th Air Transport Wing, Andrews AFB MD	12	12								0.000
4162	1294th Air Transport Group, Andrews AFB MD	2	2								0.000
4089	1298th Air Transport Squadron, Andrews AFB MD	15	15								0.000
4246	1350nd Photo Group, Colorado Springs CO	2		2							0.220
4027	1352nd Photo Group, Lookout Mountain Air Force Sta CA	19	5	14							0.192
4697	1352nd Photo Group, Lookout Mountain Air Force Sta CA	4	1	3							0.234
4051	1360th Photo Squadron, Orlando AFB FL	3	1	2							0.192
4036	1365th Photo Squadron, Westover AFB MA	1		1							0.023
4016	1369th Photo Squadron, Vandenberg AFB CA	2		2							0.242
4056	1369th Photo Squadron, Vandenberg AFB CA	1		1							0.058

(continued)

Table 25. DOMINIC personnel exposures, U.S. Air Force organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	High (R)
4691	1369th Photo Squadron, Vandenberg AFB CA	1		1							0.117
4068	1370th Photo Mapping Squadron, Hickam AFB HI	7	7								0.000
4059	1371st Mapping and Charting Squadron, Turner AFB GA	4		4							0.143
4055	1375th Mapping and Charting Squadron, Turner AFB GA	3	1	2							0.065
4060	1376th Consolidated Acft Maint Squadron, Turner AFB GA	5	2	3							0.182
4080	1405th Air Base Squadron, Scott AFB IL	1		1							0.159
4030	1501st Consolidated Acft Maint Squadron, Travis AFB CA	7	2	5							0.177
4027	1502nd Air Base Group, Hickam AFB HI	40	33	7							0.235
4610	1502nd Air Transport Squadron, Hickam AFB HI	3	1	2							0.072
4065	1502nd Air Transport Wing, Hickam AFB HI	20	16	4							0.101
4572	1502nd Air Transport Wing, Johnston Island	9	2	7							0.370
4583	1502nd Field Maintenance Squadron, Hickam AFB HI	2	2								0.000
4004	1511th Orgn Maintenance Squadron, Travis AFB CA	11	9	2							0.039
4037	1511th Orgn Maintenance Squadron, Travis AFB CA	3	2	1							0.051
4639	1611th Air Transport Wing, McGuire AFB NJ	1		1							0.095
4120	1611th Orgn Maintenance Squadron, McGuire AFB NJ	1	1								0.000
4121	1612th Orgn. Maintenance Squadron, McGuire AFB NJ	2	1	1							0.045
4127	1616th Air Division, Altus AFB OK	1			1						0.598
4606	1691st Flight Line Maint Sq, Tachikawa Air Base, Japan	1		1							0.050
4013	1701st Communications Squadron, Travis AFB CA	1		1							0.081
4527	1701st Communications Squadron, Travis AFB CA	3	1	2							0.450
4178	1703rd Communications Squadron, Davis Monthan AFB AZ	1	1								0.000
4555	1709th Communications Squadron, Andrews AFB MD	1	1								0.000
4612	1711th Communications Squadron, Lowry AFB CO	1		1							0.050
4066	1715th Communications Squadron, Bunker Hill AFB IN	1		1							0.028
4525	1731st Communications Squadron, Scott AFB IL	2		2							0.063
4554	1951st Communications Group, Hickam AFB HI	1	1								0.000
4564	1952nd Communications Group, Hickam AFB HI	1		1							0.158
4527	1953rd Communications Squadron, Honshu, Japan	4		3	1						0.600
4522	1955th Communications Squadron, Itazuke Air Base, Japan	16	5	11							0.314
4573	1956th Communications Squadron, Honshu, Japan	16	6	10							0.215
4021	1957th Communications Group, Hickam AFB HI	12	5	7							0.123
4513	1957th Communications Group, Hickam AFB HI	60	25	33		2					1.210
4593	1957th Communications Group, Hickam AFB HI	2	1	1							0.057
4573	1958th Communications Group, Andersen AFB, Guam	9		9							0.384
4626	1958th Communications Sq, Andersen AFB, Guam	1		1							0.240
4595	1961st Communications Group, Clark AFB Philippines	2		2							0.082
4120	1962nd Communications Squadron, Kadena Air Base, Okinawa	2		2							0.131
4572	1962nd Communications Squadron, Kadena Air Base, Okinawa	10		9	1						0.631
4552	1962nd Communications Squadron, Stewart AFB NY	1		1							0.060
4534	1967th Communications Squadron, Richards Gebauer MO	1		1							0.107
4515	1967th Communications Squadron, Dover AFB DE	1	1								0.000
4515	1970th Communications Squadron, Kirtland AFB NM	1		1							0.026
4565	1970th Communications Squadron, Kirtland AFB NM	1		1							0.094
4617	1970th Communications Squadron, Cannon AFB NM	1		1							0.051
4516	1970th Communications Squadron, Andrews AFB MD	13	5	7	1						0.990

(continued)

Table 25. DOMINIC personnel exposures, U.S. Air Force organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	High (R)
4590	2045th Communications Squadron, Andrews AFB MD	1		1							0.357
4629	2047th Communications Squadron, Maxwell AFB AL	1	1								0.000
4542	2049th Communications Group, McClellan AFB CA	7		5		1	1				1.930
4516	2127th Communications Squadron, Yokota Air Base, Japan	9	2	7							0.092
4517	2127th Communications Squadron, Yokota Air Base, Japan	4	4								0.000
4524	2132nd Communications Squadron, Tachikawa Air Base, Japan	8	1	7							0.346
4514	2146th Communications Group, Osan AB KO	11	2	8			1				1.606
4549	2146th Communications Group, Kunsan AB KO	1		1							0.025
4568	2146th Communications Squadron, Kunsan AB KO	1		1							0.156
4566	2152nd Communications Group, Kadena Air Base, Okinawa	1		1							0.099
4578	2165th Communications Squadron, Taiwan	4	1	3							0.117
4625	2174th Communications Squadron, Orlando AFB FL	1		1							0.061
4031	2223rd Installations Squadron, March AFB CA	1	1								0.000
4630	2727th Communications Squadron, Yokota Air Base, Japan	1	1								0.000
4567	2867th Gnd Electr Eq. Inst Agcy, McClellan AFB CA	1	1								0.000
4563	2869th Gnd Electr Eq. Inst Agcy, Norton AFB CA	1	1								0.000
4547	2875th Gnd Electr Eq. Inst Agcy, Tachikawa Air Base, Japan	11	7	4							0.030
4695	3206th Drone Squadron, Eglin AFB FL	1	1								0.000
4641	3235th Drone Squadron, Holloman AFB NM	1	1								0.000
4575	3245th Air Base Wing, Bedford MA	2		2							0.078
4086	3245th Test Group, Hanscom Field MA	1		1							0.083
4133	3276th School Squadron, Lackland AFB TX	2		2							0.051
4081	3345th Air Base Group, Chanute AFB IL	1	1								0.000
4669	3345th Air Base Group, Chanute AFB IL	1		1							0.060
4613	3350th Air Base Group, Keesler AFB MS	2	1	1							0.046
4667	3415th Maintenance & Supply Group, Lowry AFB CO	1	1								0.000
4177	3560th Flight Training Wing, Reese AFB TX	1		1							0.115
4140	3511th Flight Line Maint Squadron, Randolph AFB TX	1		1							0.050
4132	3514th Field Maintenance Squadron, Randolph AFB TX	1		1							0.071
4022	3535th Consolidated Acft Maint Squadron, Mather AFB CA	1		1							0.034
4102	3635th Flying Training Wing, Stead AFB NV	6	1	5							0.184
4130	3636th Field Maintenance Squadron, Stead AFB NV	4	3	1							0.106
4101	3636th Headquarters Detachment, Stead AFB NV	18		18							0.146
4105	3636th Helicopter Squadron, Stead AFB NV	2		2							0.133
4103	3636th Maintenance & Supply Group, Stead AFB NV	16	3	13							0.164
4106	3638th Flying Training Sqdrn (Helicopter), Stead AFB NV	4		4							0.197
4139	3750th Air Base Group, Lackland AFB TX	2	1	1							0.021
4579	3764th School Squadron, Sheppard AFB TX	1	1								0.000
4019	3993rd Orgn Maintenance Squadron, Castle AFB CA	3	1	2							0.055
4108	4080th Strategic Wing, Laughlin AFB TX	1		1							0.114
4544	4123rd Strategic Wing, Clinton Sherman, OK	1		1							0.165
4044	4126th Combat Support Group, Beale AFB CA	1		1							0.051
4589	4126th Communications & Electronics Squadron, Beale AFB CA	1		1							0.040
4013	4126th Field Maintenance Squadron, Beale AFB CA	1		1							0.051
4017	4126th Support Squadron, Beale AFB CA	5	1	4							0.242
4138	4130th Strategic Wing, Bergstrom AFB TX	1		1							0.115

(continued)

Table 25. DOMINIC personnel exposures, U.S. Air Force organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
4074	4134th Orgn Maintenance Squadron, Hickam AFB HI	1	1								0.000
4546	4141st Strategic Wing, Glasgow, MT	2	1	1							0.236
4556	4170th Combat Support Squadron, Larson AFB WA	1		1							0.118
4095	4347th Combat Crew Training Wing, McConnell AFB KS	1	1								0.000
4532	4392nd Aerospace Group, Vandenberg AFB CA	1	1								0.000
4069	4392nd Support Squadron, Vandenberg AFB CA	2	2								0.000
4041	4392nd Support Squadron, Vandenberg AFB CA	2		2							0.140
4179	4444th Reconnaissance Technical Squadron, Shaw AFB SC	1		1							0.062
4503	4603rd Air Base Group, Stewart AFB NY	1		1							0.075
4122	4603rd Consolidated Acft Maint Squadron, Stewart AFB NY	3		3							0.312
4534	4629th Support Squadron, McChord AFB WA	4	2	2							0.166
4615	4645th Support Squadron, Duluth MN	2		2							0.082
4602	4661st Communications Group, Hamilton AFB CA	1	1								0.000
4141	4677th Defense System Eval Squadron, Hill AFB UT	10	2	4	3	1					0.038
4690	4728th Detachment, Cannon AFB NM	1		1							0.120
4709	4780th Supply Squadron, Perrin AFB TX	1	1								0.000
4619	4900th Air Base Squadron, Kirtland AFB NM	2	1	1							0.091
4109	4900th Consolidated Acft Maint Squadron, Kirtland AFB NM	14	5	9							0.110
4111	4925th Test Directorate, Kirtland AFB NM	5	2	3							0.255
4500	6005th Air Postal Group, Hickam AFB HI	5	3	2							0.222
4559	6005th Air Postal Group, Hickam AFB HI	3	3								0.000
4576	6102nd Air Base Wing, Yokota Air Base, Japan	1	1								0.000
4591	6102nd Support Squadron, Yokota Air Base, Japan	3	3								0.000
4702	6313th Air Base Wing, Kadena Air Base, Okinawa	1		1							0.065
4064	6486th Air Base Wing, Hickam AFB HI	53	21	32							0.098
4581	6486th Air Base Wing, Hickam AFB HI	5	2	3							0.200
4075	6486th Civil Engineering Squadron, Hickam AFB HI	1	1								0.000
4076	6486th Consolidated Acft Maint Squadron, Hickam AFB HI	5	4	1							0.053
4644	6486th Explosive Ord Disposal Detachment, Hickam AFB HI	1	1								0.000
4073	6486th Support Squadron, Hickam AFB HI	5	5								0.000
4551	6486th Support Squadron, Hickam AFB HI	3	1	2							0.038
4151	6488th Air Base Squadron, Johnston Island	5	1	4							0.211
4571	6488th Air Base Squadron, Johnston Island	101	18	68	9	2	1	3			2.300
4580	6510th Air Base Group, Edwards AFB CA	3		3							0.240
4042	6511th Test Group, El Centro CA	1		1							0.088
4685	6512nd Test Group, Edwards AFB CA	1		1							0.115
4683	6515th Armament & Electrncs Maint Sq, Edwards AFB CA	4	3	1							0.070
4698	6515th Field Maintenance Squadron, Edwards AFB CA	1	1								0.000
4693	6550th Operations Group, Patrick AFB FL	4	4								0.334
4050	6555th Support Wing, Patrick AFB FL	2	1	1							0.055
4675	6560th Operations Group, Patrick AFB FL	2	1	1							0.035
4678	6580th Air Base Group, Holloman AFB NM	4	1	3							0.050
4674	6595th Aerospace Test, Sunnyvale CA	1	1								0.000
4666	6596th Installations Squadron, Vandenberg AFB CA	1		1							0.021
4200	Unidentifiable	13	11	2							0.117

Personnel whose exposures are presented in Table 25 may be uniformed Air Force personnel or civilians employed by Air Force organizations. Each Air Force organization is treated either separately or with a group of like organizations with similar participation in the remainder of this chapter. Air Force personnel who were DOMINIC participants with a joint-service activity organization, such as Hq JTF 8 or Defense Atomic Support Agency (DASA), are discussed at the end of this chapter.

1211th Test Squadron, Kirtland AFB, New Mexico. This organization was the largest Air Force participant with 329 badged personnel. It was the sampler unit in DOMINIC. Flight officers flew the B-57s that sampled the nuclear clouds and were observers in the aircraft. Enlisted personnel performed sample removal, maintained the B-57s, and decontaminated them.

The badging system used in this unit was unique. Aircrew members wore two or more film badges on each sampling mission. These badges were usually processed the same day. The exposure for each badge was posted on their 5x8 cards and a cumulative total was maintained by adding the highest badge reading to the previous subtotal. While not on sampling missions, these men wore another badge, which was worn for 30 days or more. The system was almost identical to that used in earlier nuclear test series where personnel wore a mission badge for entry into radiological areas and also wore a permanent badge.

Table 26 illustrates how the system worked for a sampler pilot. It shows that this pilot had duplicate mission badges for eight sampler flights and also had three permanent badges (Nos. 18235, 28991, and 53067)

Table 26. Example of sampler pilot badge system, Air Force 1211th Test Squadron, DOMINIC.

Badge Number	Issue Date	Process Date	Exposure (mR)	Cumulative (mR)
20958	4/27	4/27	1,180	
20957	4/27	4/27	1,670	1,670
18235	4/17	5/16	0	1,670
28991	3/16	6/19	0	1,670
29100	5/19	5/19	1,900	
29101	5/19	5/19	1,900	3,570
170533	5/27	5/27	3,790	
170534	5/27	5/27	3,800	7,370
53033	6/10	6/10	1,660	
170582	6/10	6/10	1,670	9,040
53165	6/12	6/12	25	
53166	6/12	6/12	26	9,066
53362	6/15	6/15	0	
53363	6/15	6/15	0	9,066
53067	6/18	7/29	48	9,114
53762	6/30	6/30	3,000	12,114
53771	6/30	6/30	2,000	
56638	7/11	7/12	20	
56639	7/11	7/12	20	12,134

that covered the period 17 April through 29 July. A likely clerical error on posting the issue date for badge 28991 is evident in that 3/16 should probably be 5/16.

This example does not follow the way the 5x8 cards were done during the airdrops at Johnston Island during September and October when sampler pilots apparently wore their "permanent" badge during the sampling missions. Table 27 is taken from a 5x8 card for a selected pilot and shows the use of three permanent badges and duplicate mission badges on four different missions. The accumulated exposure for this pilot is 6,315 mR (the total of the three permanent badge readings); but eight other entries on the card for accumulated exposure are crossed out. If the permanent badge readings (3000 + 65 + 3,250) are added to the highest reading of each mission badge (239 + 2,390 + 601 + 1,940), the total would be 11,485 mR. In this case, however, only the total of the permanent badges was used, which was 6,315. This suggests that the person who totalled the card data knew the pilot had worn both his permanent and his mission badges while sampling. The high readings for the permanent badges are indicative of this. However, it is also possible that the person who totalled the card data knew from other sources that the lesser of the possible doses was the one to be used.

Table 27. Sampler pilot exposure in Johnston Island phase, Air Force 1211th Test Squadron, DOMINIC.

Badge Number	Issue Date	Process Date	Exposure (mR)
6J662[a]	9/17	10/11	3,000
12278	10/2	10/2	232
12287	10/2	10/2	239
62038	10/6	10/7	2,390
62039	10/6	10/7	2,380
62457[a]	10/10	10/26	65
13016	10/27	10/27	601
13017	10/27	10/27	555
55376	10/30	10/30	1,940
55377	10/30	10/30	1,860
12790[a]	10/26		3,250

[a]Permanent-type badges; process date for 12790 is unknown.

The records for enlisted men do not distinguish between the airmen who performed maintenance and those who recovered samples or decontaminated aircraft. Data from their 5x8 cards, however, indicate that maintenance personnel, and indeed all enlisted personnel, were subjected to a rigorous exposure control program. Although these personnel did not have "mission

badges," they were issued new badges frequently. Each time a new badge was issued the previous one was turned in and processed in a day or so. Like the officers, a cumulative exposure total was maintained on the airmen. Table 28 contains data from the 5x8 card for one such airman. This table illustrates how the exposure control system was used. There is no explanation for the missing entries on badge 63668; possibly, the badge was not turned in. There were no detonations between 17 and 24 September, when the individual's next badge was issued.

Table 28. Exposure control system for airmen in 1211th Test Squadron, DOMINIC.

Badge Number	Issue Date	Process Date	Exposure (mR)	Cumulative (mR)
18848	4/16	5/10	100	100
27515	5/8	5/17	85	185
28696	5/14	5/22	20	205
170363	5/21	5/31	0	205
170367	5/28	6/16	700	905
53449	5/15	6/21	390	1,295
53827	6/20	6/26	140	1,435
53880	6/25	7/22	219	1,654
56594	7/2	7/7	327	1,981
63668	9/17			
12039	9/24	10/11	278	2,259
62173	10/10	10/24	298	2,557
12710	10/24	12/12	260	2,817

An 11-page document exists in the microfilm file (Reference C.1.2), entitled "Master Roster 1211th Test Squadron," dated 2 April 1962 (before the test series began), lists personnel names, rank, Air Force service number, date of birth, and component. In the component column there is an entry of "ANG" corresponding to a handwritten comment at the top of the first page "Air National Guard Underlined." In this list there are 18 officers and 100 airmen whose names are identified as Air National Guard. All these personnel, except for 23 airmen, were badged in DOMINIC and apparently performed the same duties as the rest of the men in 1211th. From the 5x8 cards it is known that ANG officers flew sampling missions. The ANG airmen obviously did decontamination, maintenance, and sample recovery work because their 5x8 cards show they were issued several badges at frequent intervals. Table 29 summarizes and compares the badged ANG personnel exposure data with the remaining 1211th personnel.

Although the highest exposure in the 1211th Test Squadron is reported in the Consolidated List as 18.080 R, this figure is in error. The exposure

Table 29. Summary of exposures, Air Force 1211th Test Squadron, DOMINIC.

Element	No. of Persons Listed	Number of Exposures (R) 0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	Over 10	High (R)
Air National Guard Component	100	12	40	13	14	4	5	5	1	3	2	1	14.005
Active Duty Air Force	229[a]	10[a]	107	30	12	16	7	7[a]	4	1	1[b]	18	18.080[c]
Total 1211th Test Sq	329[a]	22[a]	147	43	26	20	12	12[a]	5	4	19[b]	19	18.080[c]

Notes:

[a] One person listed twice.

[b] 18.08 R should be 9.04 R (see text).

[c] High should be 17.682 R.

for that individual should be 9.040 R based on his 5x8 cards. He has two cards because of numerous badge issues, and each card contains a circled value of 9.040 R, which is the correct grand total of both cards. Whoever posted his exposure on an IBM card mistakenly added the two together. With this total reduced, the highest exposure in the 1211th and in Operation DOMINIC is 17.682 R.

Personnel in other organizations were also associated with the 1211th Test Squadron activities. These activities included flying sampler aircraft on sampling missions as well as participating in ground activities involving the sampler aircraft. These are mentioned later.

Air Force Special Weapons Center (AFSWC), Kirtland AFB, New Mexico. AFSWC, the second largest Air Force organization participating, was the nucleus for advance Air Force planning for DOMINIC. In January 1962, it created the Nuclear Test Directorate, which took responsibility for all test planning and test support. This directorate later became Joint Task Group (JTG 8.4) for the duration of DOMINIC. For this reason Hq JTG 8.4 (code 4001) personnel have been included with the other three AFSWC codes (4108, 4662, and 8007) in the distributions presented in this report.

In addition to staffing a large portion of Hq JTG 8.4, AFSWC participated in several Department of Defense (DOD) experimental projects. It was responsible for four experimental projects (6.7, 8B, 8C, and 9.4b) and participated in three others (6.1, 6.5c, and 6.10). Exposures for 29 AFSWC military and civilian personnel that can be associated with specific experimental projects are all less than 0.50 R. Chapter 3 discusses these projects in some detail.

The highest exposure among AFSWC personnel was 6.163 R, recorded by a pilot who flew three sampling missions at Christmas Island, which accounted for most of the exposure. Three men with exposures between 2.001 and 2.500 R were involved with sampler aircraft, judging from the manner in

which they were badged. One of these men, an Air Force major, was the JTG 8.4 Radsafe Officer (Reference C.4.1, p. 31); the other two were enlisted men and were probably in the same section. Each of these three had several weekly badges issued over a 3-month period at Christmas Island.

Unit code 4662 (one of the four AFSWC codes) has only two men in it. A review of the 5x8 card in the microfilm file for these two reveals that one is already listed under code 4001 (also AFSWC) and that the other should have been listed under the 1211th Test Squadron (code 4107).

Air Force Cambridge Research Laboratory (AFCRL), Bedford, Massachusetts. AFCRL was involved in managing and executing several of the DOD experimental programs. Although only three men are shown under AFCRL (organization code 4680) as being badged during DOMINIC, twelve more AFCRL personnel are listed in Control Equipment Corporation (organization code 8642), one in Weather Central, Hanscom Field (organization code 4657), and two in Weapons Evaluation Test Group (WETG), Field Command (FC), DASA (code 8130). The Control Equipment Corporation is discussed in Chapter 12.

AFCRL managed eight of the DOD experimental projects: Projects 6.4, 6.5a, 6.8, 6.10, 6.12, 8A.1, 9.1a, and 9.1b. The number of personnel associated with each project, including contractors, is discussed in Chapter 3. The highest exposure among the 18 AFCRL personnel was 0.97 R, recorded for a man who worked on Project 9.1a.

Johnston Island Base Command (JTG 8.6). Air Force equipment and personnel at Johnston Island came under JTF 8 control in late 1961. Most of the personnel stationed at Johnston Island were integrated into the JTG 8.6 organization. These Air Force organizations were:

- 6488th Air Base Squadron
- 1957th Communication Group, Detachment 1
- 1502nd Air Transport Wing, Detachment 6.

The 6488th Air Base Squadron, stationed at Johnston Island, had two Consolidated List code entries (codes 4571 and 4151) with 101 men and 5 men. For the 1957th, there are three codes (4071, 4513, and 4593), all of which indicate Hickam AFB as home station. Several 5x8 cards showed that some individuals indicated Hickam AFB while others indicated Johnston Island. All three codes, when aggregated, have a total of 74 personnel. There are five codes for 1502nd Air Base organizations but only one for the wing at Johnston Island. The size of the group (nine men) is probably typical of a detachment to run the Military Air Transport Service (MATS) terminal.

The assumed exposure distribution for the Air Force contingent of JTG 8.6 is shown in Table 30, and includes the 6488th, the 1957th Communications Group codes, and the 1502nd codes. The higher exposures (over 2.0 R) in the 6488th may have been personnel who refuelled Air Force aircraft and operated the Air Force fire and crash rescue equipment. These activities could have brought personnel close to contaminated sampler aircraft, which were allowed to "cool" overnight at Johnston Island before the aircraft returned to NAS Barbers Point.

Table 30. Exposure data for Air Force personnel associated with the Johnston Island Base Command, DOMINIC.

No. of Persons Listed	Number of Exposures (R)								High (R)
	0	0.000-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3	
6488th Air Base Squadron									
106	19	72	9	2	1	3			2.300
1957th Communication Group									
74	31	41	0	2					1.210
1502nd Air Transport Wing									
9	2	7							0.370
Total									
189	52	120	9	4	1	3			2.300

Air Force Communications Units. Aside from the 1957th Communications Group, already discussed with the Johnston Island Base Command, there were several other numbered communications groups and squadrons with from 1 to 16 participants in each. These are listed in Table 25. Several organizations have duplicate codes: 1901st Communications Squadron (4013, 4577), 1962nd Communications Squadron (4156, 4521), 2040th Communications Squadron (4515, 4565, 4617), 2045th Communications Squadron (4530, 4590), 2127th Communications Squadron (4516, 4517), and 2146th Communications Group (4514, 4549, 4568). Two individuals were from the Air Force Communications Service (code 4589). Forty-two different communications organization codes encompassed 218 men. Only eight men recorded exposures over 0.5 R, the highest being only 1.93 R.

Air Force personnel with a communications specialty were used at widely varying locations in DOMINIC. They were aboard aircraft and stationed at all the main base locations, in addition to weather and project islands. Placing these men at all times during the DOMINIC operations is difficult. It is complicated by the fact that the total personnel requirement was apparently filled by men from many home bases.

Air Force Weather Units. Personnel from a large number of various Air Force weather units performed several functions in DOMINIC, including forecasting and reporting from both ground and airborne locations. Ground locations were spread throughout the Pacific at many outposts. Airborne weather reporting was done primarily by the 55th Weather Reconnaissance Squadron (code 4003) using WB-50 aircraft, but in DOMINIC there were Air Force weather specialists from 24 different organizations, including the Air Weather Service (codes 4079, 4638, 4670). On a sampling mission, an officer from the Air Weather Service at Scott AFB received 12.324 R.

Table 31 contains the consolidated exposure data for all the weather units. The first line of data is for weather reconnaissance units: 9th Weather Reconnaissance Group (code 4026) and 55th Weather Reconnaissance Squadron (codes 4003 and 4176). The second line contains exposure data for all other weather units, including the weather central activity from eight different Air Force bases. Other than the 55th Weather Reconnaissance Squadron with 195 participants, the 6th Weather Squadron at Tinker AFB, Oklahoma (codes 4125 and 4574) had the largest number of participants (65).

The second highest exposure among the weather personnel was 1.810 R for an individual who was also from the Air Force Weather Service at Scott AFB.

Table 31. Exposure data for Air Force weather units, DOMINIC.

No. of Persons Listed	Number of Exposures (R)								High (R)
	0	0.000-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3	
Weather Reconnaissance Units									
212	94	111	7						0.791
Other Units									
99	43	52	2	0	1		1	1	12.324
Total All Weather Units									
311	137	163	9	0	1		1	1	12.324

Military Air Transport Service Units. These units were primarily the various air transport wings, groups, and squadrons. Twenty different codes were used for these units and two additional codes (4072, 4165) were used for MATS detachments. Altogether there were 460 participants whose principal mission was air transportation of both personnel and supplies, including nuclear devices and radioactive cloud samples.

The exposures for these units when consolidated show that 385 men recorded no exposure (about 84 percent of the total), 74 recorded less than 0.5 R, and 1 had 0.645 R (the highest exposure for this group). Of the total number of participants, 140 were from the 50th Air Transport Squadron, 130 from the 44th Air Transport Squadron, and 55 from the 48th Air Transport Squadron. The man who received the highest exposure was from the 38th Air Transport Squadron.

Air Base Units. These include the various wing-, group-, and squadron-level Air Force organizations whose normal mission is the operation of Air Force bases and stations. The 6488th Air Base Squadron has already been discussed under the Johnston Island Base Command. The Consolidated List contains ten different groups (60 personnel), six different wings (77 personnel), and five different squadrons (106 personnel). The largest group was the 6580th

Group at Hickam AFB with 40 personnel; the 6486th Wing, also at Hickam AFB, had 58 personnel, and the 6488th Squadron had 101 personnel badged.

A total of 243 men were in these airbase units, if the 6488th Squadron is included. Without the 6488th, whose exposures are summarized in Table 30, 142 men were in the airbase units, 14 of whom had zero or less than 0.5 R exposure. The one man over this was from the 1001st Air Base Wing with 0.557 R.

Strategic Air Command (SAC) Units. SAC organizations that participated in DOMINIC were as follows:

- 2nd Air Force
- 8th Air Force
- 15th Air Force
- SAC Headquarters
- 1st Strategic Aerospace Division
- 1st Combat Evaluation Group
- 1st Communication Group
- 544th Reconnaissance Technical Group.

The 2nd Air Force furnished aircraft and crews as well as support personnel. A B-52 (No. 56-0013) for airdrops, three KC-135s (Nos. 55-3136, 58-0011, and 59-1514), two B-47s (Nos. 52-0292 and 53-2329), and three U-2s (Nos. 56-66790 and 56-6695, and one whose number is unknown) were from various units in the 2nd Air Force. The U-2s were used just for FISHBOWL. The SAC airborne command post (voice-call sign "Looking Glass") was a special KC-135 (No. 58-0011) used in Project 7.4. The 8th Air Force was on standby to provide a backup aircrew for the B-52 if needed. The 15th Air Force provided one KC-135 (No. 60-0341). Except for the B-52, all the SAC aircraft were connected with various technical and experimental projects.

The 1st Combat Evaluation Group supplied safety observers for the B-52 while the 1st Communication Group furnished radio operators and a communications controller. The 544th Reconnaissance Technical Squadron supplied trajectory information on satellites. The 1st Strategic Aerospace Division was responsible for the Air Force missile (Thor) for most of the FISHBOWL series.

The Consolidated List indicates fewer than 25 personnel from these command-level units, but this does not reflect the total SAC participation because the subordinate wings, groups, and squadrons are not included here.

Table 32 contains a list of SAC units that are listed in Table 25 and includes additional information on the association of these units with type of aircraft or missile and their parent organizations.

Only 61 SAC personnel are identified. This does not appear to be sufficient for operation of three KC-135s and the other large aircraft. The exposure distribution for these 61 men shows that 60 had zero or less than 0.5 R. The highest exposure recorded was 0.598 R for an individual with the 1816th Air Division.

552nd Airborne and Early Warning Control Squadron. This unit (code 4011) flew the RC-121 aircraft, and 53 personnel were badged. As many as six RC-121s were used in DOMINIC. Their main function was to provide platforms for the Airborne Air Operations Center, alternately operating from Hickam AFB and from Christmas Island. Two planes flew out of Nandi International Airport

Table 32. Strategic Air Command units participating in DOMINIC.

Code(s)	Unit	No. of Men	Type Aircraft	Parent Organization
4518	825th Operations Squadron	1	B-47	2nd Air Force
4044	4126th Combat Support Group	1	B-52	4126th Strategic Wing
4599	4126th Communications & Electronics Squadron	1	B-52	4126th Strategic Wing
4023	4126th Field Maintenance Squadron	1	B-52	4126th Strategic Wing
4017	4126th Support Squadron	5	B-52	4126th Strategic Wing
4010	15th Air Force	10		
4032	23rd Bomb Squadron	1	B-52	5th Bomb Wing
4021, 4634	1st Strategic Aerospace Division	10	Missiles	
4532	4392 Aerospace Group	1	Missiles	15th Air Force
4009, 4041	Support Squadron	4	Missiles	15th Air Force
4095	4347th Combat Crew Training Wing	1	B-47	2nd Air Force
4664	1st Combat Evaluation Group	2		2nd Air Force
4502	389th Missile Wing	1	Missiles	
4546	4141st Strategic Wing	2	B-52	
4585	818th Operations Squadron	1	B-47	2nd Air Force
4600	Strategic Air Command Squadron	1		
4509	817th Combat Support Group	1	B-52	8th Air Force
4541	305th Air Refueling Squadron	1	KC-135	8th Air Force
4115	6th Bomb Squadron	4	Missiles	
4519	6th Bomb Wing	1	Missiles	
4112	6th Support Squadron	2	Missiles	
4614	820th Operations Squadron	2	KC-135	8th Air Force
4543	11th Bomb Wing	2	B-52	2nd Air Force
4127	1816th Air Division	1	B-52	2nd Air Force
4544	4123rd Strategic Wing	1	B-52	2nd Air Force
4138	4130th Strategic Wing	1	B-52	2nd Air Force
4135	96th Bomb Wing	1	Missiles	
4708	4080th Strategic Wing	1	U-2	2nd Air Force

in the Fiji Islands for the high-altitude events. After some events they returned to McClellan AFB and then back to Hickam AFB for the next event. On 3 October two planes went to Midway Island to assist in National Aeronautics and Space Administration's Project Mercury recovery. On 29 October two planes were recalled to McClellan AFB for the Cuban missile crisis. The highest exposure in the Consolidated List is 0.149 R; however, the data on the 5x8 card for that individual indicates his exposure should

be 0.249 R. His 5x8 card shows he had two badges; the first covered 17 April to 31 August with 0.199 R and the second covered 27 September to December with 0.050 R.

This unit was subordinate to the 552nd Airborne and Early Warning Control Wing at McClellan AFB, California. Other units of the 552nd Wing that participated in DOMINIC were:

Organization	Total Personnel	Code
552nd Field Maintenance Squadron	7	4018
552nd Organization Maintenance Squadron	5	4043

Hq USAF, Washington, D.C. Hq USAF sponsored numerous experimental projects in the area of nuclear test detection in DOMINIC and was assisted by several other agencies that included civilian contractors, Army and Navy R&D organizations, and some non-DOD governmental organizations. These projects and the agencies associated with each have been outlined in Chapter 3.

Reference B.4.9 indicates that for DOMINIC the Hq USAF Element Pacific would conduct the experiments and would be formed by the 1035th USAF Field Activities Group (Washington, DC), the 1155th Technical Operations Squadron (McClellan AFB, California), and the 1156th Technical Operations Squadron (Wheeler AFB, Hawaii). However, the 1156th Technical Operations Squadron was not a participant according to Reference C.1.2. Organization codes for Hq USAF are 4149, 4150, and 4663. There was also a detachment (code 4062) at Hickam AFB, Hawaii, with seven personnel, all of whom received no exposure. The 1155th Technical Operations Squadron (code 4014) had 35 participants and the highest exposure was 0.214 R; 17 men had no exposure at all.

Air Force Photographic and Mapping and Charting Units. These Air Force units were responsible for providing the basic documentary photography for the DOMINIC operation.

Table 25 contains six different units with a total of 11 codes. These are:

Codes	Unit	Personnel
4697, 4027, 4046	1352nd Photo Group	25
4051, 4696	1365th Photo Squadron	4
4016, 4686, 4691	1369th Photo Squadron	4
4068	1370th Photo Mapping Squadron	7
4059	1371st Mapping and Charting Squadron	4
4055	1375th Mapping and Charting Squadron	3

Of the 47 personnel, 15 had no exposure at all. The highest exposure was 0.242 R for an individual in the 1369th Photo Squadron.

Air Force Maintenance Units. Ten different Consolidated Aircraft Maintenance Squadrons (codes 4022, 4024, 4030, 4034, 4060, 4076, 4109, 4122, 4130, and

4167) with a total of 50 personnel participated. There were also 11 different Field Maintenance Squadrons (codes 4018, 4023, 4036, 4100, 4132, 4161, 4539, 4583, 4598, 4627, and 4698) with 30 personnel and eight Organizational Maintenance Squadrons (codes 4120, 4121, 4004, 4029, 4037, 4039, 4043, and 4074). Two Maintenance and Supply Groups were present (codes 4103 and 4667), with 17 personnel and two Flight-Line Maintenance Squadrons (codes 4140 and 4606) with only one person each. Personnel of these maintenance units total 127. Exposures were predominantly low, 47 having zero and 75 having badges showing less than 0.5 R. Five exposures greater than 0.5 R, the highest of which was 2.413 R recorded by a man from the Consolidated Aircraft Maintenance Squadron. Both participants from this unit recorded over 2.0 R.

Air National Guard Units. One hundred ANG personnel from 17 states augmented the 1211th Test Squadron in DOMINIC (Table 29) as shown below:

Arkansas	2	Missouri	1	Pennsylvania	7
California	4	Montana	3	Vermont	1
Kansas	18*	Nebraska	2	Washington	3
Kentucky	7	Nevada	17	West Virginia	1
Maine	2	North Dakota	5	Wisconsin	5
Michigan	19	Oregon	3		

An ANG unit at Stead AFB, Nevada, provided two men for DOMINIC operations for whom a separate badging code (4164) was established. One of these individuals, whose duties are unknown, had zero exposure (Reference C.1.2, Morning reports of the 1211th Test Squadron, 1962, RSECO microfilm, roll 27G). The second was an enlisted man who worked with the Reconnaissance Element (TU 8.4.2). His first badge, issued 17 April and processed 10 May, showed an extremely high exposure of 16 R. An examination of the badge (numbered 18801) showed that the exposure pattern on the film was predominantly from one direction and the pattern indicated that the radiation was not from a mixed group of radioisotopes such as characterize nuclear weapon debris. An investigation showed that the man usually worked without his shirt and that his badge was attached to his shirt. The shirt was usually left over a chair where it apparently came into contact with a radioactive source used to calibrate instruments. His fellow workers whose duties were the same had from 1 to 2 R exposure for this period. At the task group level it was decided that this man's exposure should be considered 5 R for this period, that is, three times the average of his fellow workers (Reference C.1.2, roll 7, index 90). Upon review by the task force Radsafe Officer, the factor of 3 was dropped and he was credited with the average, 1.5 R. One other badge for the single day, 10 May, added to make his total 2.16 R.

The ANG units flew missions near Johnston Island with C-97 aircraft to calibrate various tracking beacons there. This took place before the actual

* All but three of these personnel used the 1211th Test Squadron code 4107. Three from Kansas are listed under code 4093.

start of the tests, and therefore this unit was not badged. Men were drawn from the Hawaii, California, and Tennessee ANG units for these flights.

Air Force Space System Division (AFSSD). This Air Force organization, operating as TU 8.1.5, provided the Thor missiles and launch personnel for many of the high-altitude shots at Johnston Island. Only three men were badged with SSD, one from Andrews AFB, Maryland, and two from Vandenberg AFB, California, although up to 128 manned the task unit. The contractor that built the missile provided a significant number of men and subordinate AFSSD organizations probably did also.

Miscellaneous Air Force Units. In addition to the abovementioned units, only two more had exposures over 2.0 R. These units were:

Code	Unit	No. of Men	High
4114	1094th Aviation Depot Squadron	1	2.249
4632	San Bernardino Air Material Area	1	2.700

Table 33 contains an overall summary of Air Force exposure data. Included in this table are Air Force personnel who were with Hq JTF 8 and DASA or were VIPs. The grand total represents the aggregate for these groups, together with all the Air Force organizations listed in Table 25.

Table 33. Summary of Air Force exposure data, DOMINIC.

No. of Persons Listed	Number of Exposures (R)											
	0	0.000-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	10-15	Over 15
Air Force Organizations												
2,707	1,182	1,296	79	35	25	23	13	5	4	20	15	5
Joint Task Force 8												
45	10	33	1	1								
Defense Atomic Support Agency												
33	15	16	2									
VIPs												
11	11											
Total												
2,791	1,218	1,345	82	36	25	23	13	5	4	20	15	5

CHAPTER 11

U.S. MARINE CORPS PARTICIPATION IN OPERATION DOMINIC

The Marine Corps provided support for the DOMINIC operation in two primary ways. The first was helicopter service at Johnston Island for instrument-pod retrieval and ship-to-shore personnel movement, and the second was fuel service for the Christmas Island weapon development tests. Marines were also present as ships' company detachments on the major Navy units for DOMINIC. USS Princeton (LPH-5), USS Iwo Jima (LPH-2), and USS Yorktown (CVS-10).

The majority of Marine Corps personnel involved in Operation DOMINIC were deployed aboard Navy ships as part of three helicopter squadrons. One of these squadrons searched for and retrieved pods and nosecones. Although some of the pods were radioactive, the squadron's exposures were low. Personnel of the Bulk Fuel Company stationed at Christmas Island had very little exposure to radiation and their low readings reflect this. The highest recorded exposure for an individual Marine was for a noncommissioned officer (NCO) in the hangar deck crew aboard Princeton who received 2.290 R. Both the Support & Ground Company and the Air Company aboard Princeton had the highest exposures of all the Marines in the operation. The relatively high recorded exposures of personnel on Princeton are further discussed in Chapter 13. The exposure of the enlisted man who received the 2.29 R was recorded on a badge issued 22 September and processed 11 December.

The particular Marine units identified as providing participants for DOMINIC are discussed below. The exposures for their personnel are shown in Table 34.

Air Base Squadron 36 (MABS-36). This unit provided six men who worked in the Bulk Fuel Company at Christmas Island. Three were badged as "NCAF Santa Ana" on the Consolidated List, a fourth was badged as "MCAS El Toro," and the remaining two were badged as "Third Marine Air Wing Santa Ana CA."

Air Base Squadron 37 (MABS-37). This unit provided one man for the Bulk Fuel Company. He was badged as "Third Marine Air Wing Santa Ana CA."

Marine Aircraft Repair Squadron 37 (MARS-37). This unit provided flight crews and ground maintenance crews for two aircraft involved in technical photography for SWORDFISH. The R5D-3s flew in a circular flight path at 10,000 feet (3 km), one at a horizontal range of 10,000 yards (9.2 km), and the other at 13,100 yards (12 km) from surface zero. One R5D was also used to obtain radiological readings at 3,000 feet (914 meters) and 1,500 feet (46 meters) and to drop smoke bombs in the radioactive water patch (Reference C.2007 pp. 254 ff). These aircraft operated out of NAS Miramar, San Diego, California, and apparently were assigned for temporary duty to the Navy Heavy Photo Air Squadron 62. Four Marines were badged with this organization.

Table 34. DOMINIC personnel exposures, U.S. Marine Corps organizations.

Element	No. of Persons Badged	Number of Exposures (R)				High (R)
		0	0.001-0.5	0.5-1	Over 1	
Marine Barracks, Naval Air Station Barbers Point	2		2			0.035
Bulk Fuel Company, 1st Forces Regiment	37	14	23			0.159
Marine Aircraft Repair, Squadron 35	4	3	1			0.027
Medium Helicopter Squadron 161 (HMM-161)	3	3				
Medium Helicopter Squadron 363 (HMM-363)[a]						
Medium Helicopter Squadron 364 (HMM-364)	246	91	155			0.269
USS Princeton (LPH-5) Support and Guard Company	138	53	84	1		0.505
USS Princeton Air Company	117	3	110		4	2.290
USS Yorktown (CVS-10) Marine Detachment	39	39				0.000
Marine observers	3	3				0.000
Total	589	209	375	1	4	2.290

Note:

[a]No data available.

Marine Barracks, Naval Air Station Barbers Point. Twenty-four Marines participated in the operation and two were badged.

Bulk Fuel Company, 1st Forces Service Regiment. A Marine Corps Bulk Fuel Detachment consisting of 2 officers and 101 enlisted personnel from Camp Pendleton and Marine Corps Air Station, El Toro, California, were deployed to Christmas Island on 16 February to install two Marine Corps Assault Airfield Fuel Storage Systems near Port London and two Tactical Airfield Fuel Dispensing Systems at airfields. This detachment provided essential primary petroleum, oil and lubricants (POL) storage, pumping, and underwater fuel line facilities at Christmas Island for a period of 6 months. From the Consolidated List and medical records, exposures are available for 37 personnel from this organization.

Marine Medium Helicopter Squadron 161 (HMM-161). A Marine helicopter squadron deployed aboard the dock landing ship, USS Point Defiance (LSD-31), from 19 January through 1 February 1962. Assigned missions were to:

- Ferry JTF 8 Teams to Christmas Island
- Transport teams to and from Jarvis, Baker, Howland and Canton islands

- Conduct aerial surveys and photograph islands and surrounding reefs
- Conduct standby search and rescue (SAR) for Underwater Demolition Team (UDT) operations
- Estimate the number of birds on each island.

From 14 May through 8 June four aircraft were flown to Auxiliary Landing Field (ALF) Bonham, on Kauai to make the first recovery of nosecones launched from Barking Sands, Kauai, Hawaii. These helicopter crews were also utilized for range sweeps prior to the rocket firing at Barking Sands.

On 19 June six aircraft were flown to ALF Bonham for the BLUEGILL shot at Johnston Island. During the period 19 June through 2 November aircraft were sent to Kauai seven times to support DOMINIC operations. Marine Corps data have identified 80 personnel in the unit, but only 3 were badged. The unit was erroneously identified as HMM-361 on the Consolidated List.

Marine Medium Helicopter Squadron 363 (HMM-363). A Marine Detachment deployed aboard USS Monticello (LSD-35) from April through May 1962 in support of SWORDFISH photography. A helicopter from this squadron also dropped two positioning buoy transponders to the east of the towed array's rear portion in support of Project 1.3a (Effects of Underwater Nuclear Explosions on Sonar Systems at Close Range) (Reference C.2002, p. 13). The squadron was detached from Monticello on 13 May (Reference C.3.1; Reference C.3.2, Monticello). Only one individual has been identified from this unit and there is no badging information.

Marine Medium Helicopter Squadron 364 (HMM-364). A Marine helicopter squadron deployed aboard the amphibious assault ship, Iwo Jima, during the period from 17 April through 10 August and for the period 30 August through 14 November aboard Princeton. The squadron's missions included over water search and recovery of instrument capsules (pods and nosecones), the evacuation of civilian and military personnel not required at Johnston Island during the nuclear tests, and ship-to-shore shuttle runs. At Pearl Harbor normal squadron training was conducted from ALF Ford Island.

A total of 246 men were badged with this unit for both deployments.

USS Princeton Support and Guard Company. Of 164 Marines assigned to this company, badge information is available for 138.

USS Princeton Air Company. This company had 152 Marines assigned and badge data is available for 117. Their duties included aircraft handling and/or maintenance.

USS Yorktown Marine Detachment. A total of 106 personnel were on Yorktown according to Marine Corps records. Thirty-nine were badged.

Marine Observers. One Marine Corps observer was sent from each of three commands: the Defense Atomic Support Agency, Fleet Marine Force Atlantic, and Marine Corps Air Station, El Toro. All were badged.

CHAPTER 12

DEPARTMENT OF DEFENSE, ATOMIC ENERGY COMMISSION, OTHER GOVERNMENT, CONTRACTOR, AND FOREIGN PARTICIPATION IN OPERATION DOMINIC

INTRODUCTION

A variety of groups and organizations other than the military services participated in DOMINIC. Included among these are Department of Defense (DOD) agencies, the Atomic Energy Commission (AEC) organizations, various Federal agencies, DOD and AEC contractors, visitors, and foreign personnel. DOMINIC had an unusually large number (85) of DOD contractors participating. Some of these contractors had hundreds of persons involved for the entire test period, while others had only one or two involved for short periods.

Table 35 lists the agencies and companies, the number of persons badged, and their exposures for DOMINIC. Discussion of the organizations follows the sequence shown in the table. Some organizations are not discussed in the text because they had very few persons badged and no significant radiation exposures. Some contractor organizations are also discussed in Chapter 3 if they participated in one of the DOD experimental projects.

DEPARTMENT OF DEFENSE AGENCIES

Advanced Research Projects Agency (ARPA), Washington, D.C. Four persons were listed as being assigned to ARPA in Washington, D.C. However, according to the 5x8 cards only two were actually from ARPA. They both spent a couple of months on Johnston Island. The other two were visitors from the Office of the Secretary of Defense who spent only a few days in the test area. All four badge readings were zero or less than 0.5 R.

Army--Air Force Exchange System. The Army--Air Force Exchange System personnel from Hawaii had 11 persons badged, roughly half were on Christmas Island and half on Johnston Island. They operated the Post Exchanges on the islands for extended periods. No badge readings above 0.5 R were recorded.

Defense Atomic Support Agency (DASA), Washington, D.C., and Sandia Base, New Mexico. DASA had 135 personnel badged. Twenty from the headquarters in Washington were badged, some for the whole series, some only for the Christmas or Johnston Island portion, and some for only a few days. The Weapons Effects Test Group (WETG) at Field Command, DASA (FCDASA), had 65 badged. This group was responsible for managing the DOD experimental program for DOMINIC. Because of the group's importance, it was assigned a separate task unit number in Joint Task Force 8 (JTF 8), Task Unit (TU) 8.1.3. The programs it managed consisted of a wide variety of experimental projects, which have been discussed in some detail in Chapter 3.

The 65 WETG personnel were badged under two organization codes, 8008 and 8130. Those listed under 8008 were all from FCDASA according to their 5x8 cards. However, the 39 5x8 cards for those in code 8130 show that this code was apparently used for personnel from other organizations. There are

Table 35. DOMINIC personnel exposures, Department of Defense, Atomic Energy Commission, other government, and contractor organizations.

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
Department of Defense Agencies											
4169	Advanced Research Projects Agency, Washington DC	1	1								0.000
8009	Advanced Research Projects Agency, Washington DC	3	2	1							0.019
8212	Army-Air Force Exchange Service, Fort Schafter HI	11	8	3							0.135
8004	Defense Atomic Support Agency, Washington DC	20	11	9							0.356
8006	Defense Atomic Support Agency Fld Cmnd, Sandia Base NM	50	12	37	1						0.519
8008	Defense Atomic Support Agency Fld Cmnd, Sandia Base NM	26	13	13							0.245
8130	Defense Atomic Support Agency Fld Cmnd, Sandia Base NM	39	14	24	1						0.570
8000	Headquarters, Joint Task Force 8, Washington DC	195	74	116	4	1					1.370
8214	United Service Organization	5	5								0.000
	Total DOD Agencies	350	140	203	6	1					0.570
Atomic Energy Commission Agencies											
8590	Atomic Energy Commission	48	39	8	0	0	0	0	1		2.783
8120	Lawrence Radiation Laboratory, Livermore CA	410	276	130	1	0	1	0	1	1	7.149
8110	Los Alamos Scientific Laboratory, Los Alamos NM	145	62	79	3	0	0	1			2.049
8140	Sandia Corporation, Sandia Base NM	318	168	149	1						0.590
	Total AEC Agencies	921	545	366	5	0	1	1	2	1	7.149
Other Government Agencies											
8672	Bureau of Commercial Fisheries, Honolulu HI	11	10	1							0.059
4612	Federal Aviation Agency, Honolulu HI	1	1								0.000
8652	National Bureau of Standards, Boulder CO	2	2								0.000
8600	U.S. Coast Guard Loran Station, Johnston Island	18	11	6	1						0.922
8619	U.S. Customs, Honolulu HI	1	1								0.000
8005	U.S. Public Health Service, Washington DC	17	5	12							0.232
8625	U.S. Weather Bureau, Washington DC	4	2	2							0.073
	Total Other Government Agencies	54	32	21	1						0.922
Contractor Organizations											
8679	A & M Corporation, Honolulu HI	2	2								0.000
8678	ABL, Cumberland MD	1	1								0.000
8616	AC Spark Plug, Milwaukee WI	5	2	3							0.100
8662	Adcole Corporation, Cambridge MA	1	1								0.000
8644	Aero Lab, Pasadena CA	13	12	1							0.112
8635	Aerojet General, Azusa CA	16	7	9							0.063

(continued)

Table 35. DOMINIC personnel exposures, Department of Defense, Atomic Energy Commission, other government, and contractor organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
Contractor Organizations (continued)											
8631	Aerospace Research, Newton MA	3	3								0.000
8657	Allied Research Associates, Boston MA	4	0	4							0.349
8636	American Science & Engineering, Cambridge MA	25	10	15							0.325
8656	Aracon Laboratories, Concord MA	1	1								0.000
8564	Armour Research Foundation, Chicago IL	5	5								0.000
8640	Atlantic Research Corporation, El Monte CA	23	19	4							0.083
8649	Avco Corporation, Wilmington MA	11	10	1							0.034
8605	BTL, Greensboro NC	3	1	2							0.135
8680	Barnes Engineering, Stamford CT	21	12	9							0.040
8646	Bell and Howell, Pasadena CA	3	2	1							0.050
8610	Bell Telephone Lab, Homedale NJ	3	1	2							0.092
8614	Bendix Radio Corporation, Baltimore MD	11	6	5							0.102
8663	Cohu Electric, San Diego CA	1	1								0.000
8618	Collins Radio, Dallas TX	4	3	0	0	0	1				1.670
8666	Columbia University, New York NY	4	1	3							0.093
8669	Comstock Wescott, Cambridge MA	2	2								0.000
8642	Control Equipment Corporation, Bedford MA	12	8	3	1						0.970
8667	Cook Electric Company, Morton Grove IL	1	1								0.000
8603	Cubic Corporation, San Diego CA	40	22	17	0	1					1.270
4045	Denver Research Institute, Denver CO	1	1								0.000
4047	Denver Research Institute, Denver CO	1	1								0.000
8602	Douglas Aircraft Company, Santa Monica CA	160	46	108	2	1	2	1			2.250
8160	EG&G, Inc., Boston MA	183	95	87	1						0.760
8624	Eberline Instruments Corporation, Sante Fe NM	2	0	1	1						0.560
8634	Electro Optical Systems, Pasadena CA	22	10	12							0.128
8661	Electronic Communications, St. Petersburg FL	7	4	3							0.352
8650	Electronics Associates, Inc., San Jose CA	1	0	1							0.032
8609	Federal Electric Corporation, Port Hueneme CA	39	4	33	2						0.900
8601	Ford Aeronutronic, Newport Beach CA	8	1	7							0.352
8670	G.T. Schjeldahl Company, Northfield MN	2	2								0.000
8660	General Dynamics, San Diego CA	6	0	6							0.380
8607	General Electric Company, Philadelphia PA	18	7	9	1	0	1				1.610
8638	Geophysics Corporation of America, Boston MA	21	10	10	1						0.915
8647	Geophysics Corporation of America, Bedford MA	3	1	2							0.104
8500	Holmes & Narver	2,038	713	1,295	19	1	0	2	8		2.920
8643	Hughes Aircraft, Culver City CA	9	3	6							0.109
8606	IBM Corporation, Honolulu HI	1	0	1							0.088
8658	Kaman Nuclear, Colorado Springs CO	2	0	2							0.153

(continued)

Table 35. DOMINIC personnel exposures, Department of Defense, Atomic Energy Commission, other government, and contractor organizations (continued).

Org Code	Organization and Home Station	Total Badged	Exposure Range (R)								High (R)
			0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	Over 3.0	
Contractor Organizations (continued)											
8633	Marquardt	1	1								0.000
4166	Martin Plant, Baltimore MD	1	0	1							0.258
8632	Massachusetts Inst of Tech, Lincoln Labs, Lexington MA	12	7	4	1						0.760
8665	Matrix R&D Corporation, Nashau NH	1	1								0.000
8611	Milgo Electronics, Miami FL	2	1	1							0.022
8645	Mitre Corporation, Bedford MA	4	4								0.000
8637	New Mexico State University, Las Cruces NM	10	4	6							0.072
8651	Northrop Ventura, Van Nuys CA	3	2	1							0.036
8675	Oklahoma State University, Stillwater OK	1	1								0.000
8622	Onan Studebaker Company	1	1								0.000
8621	Philco Corporation, Philadelphia PA	1	0	1							0.040
8655	Polytechnic Engineering Company, Silver Springs MD	1	1								0.000
8608	Radio Corporation of America, Cherryhill NJ	94	56	38							0.440
8629	Raytheon, Falmouth MA	1	1								0.000
8615	Rocketdyne, Los Angeles CA	4	2	2							0.061
8653	Schimmelman, Santa Ana CA	2	1	1							0.040
8673	Scripps Institution of Oceanography, La Jolla CA	9	8	1							0.152
8623	Stanford Research Institute, Menlo Park CA	17	12	4	1						0.615
8628	Sweinhart Electric	1	1								0.000
8641	Sylvania Corporation, Mountain View CA	4	2	2							0.129
8613	Sylvania Corporation, Mountain View CA	39	22	17							0.118
8639	TechOps, Burlington MA	2	1	1							0.026
8620	Tele Signal Company, Hicksville NY	2	2								0.000
8677	Univac, San Diego CA	1	0	1							0.270
8676	University of Dayton, Dayton OH	1	1								0.000
8648	University of Utah, Salt Lake City UT	6	3	3							0.023
8671	University of Washington, Seattle WA	6	4	2							0.039
8627	Varian Associates, Palo Alto CA	3	1	2							0.110
8612	Viron Corporation, Minneapolis MN	1	1								0.000
8668	Wentworth Institution, Bostor MA	2	2								0.000
8674	Western Electric Company, New York NY	6	6								0.000
8626	Westinghouse Electric, Los Angeles CA	1	1								0.000
8654	Zimney Corporation, Monrovia CA	5	5								0.000
	Total Contractor Organizations	2,984	1,186	1,750	30	3	4	3	8		2.920
VERY IMPORTANT PERSONS											
8001		65	56	9							0.062

28 cards marked "TU 8.1.3" that show no organization or home station for the individual. This is a most unusual occurrence since even one such card is rarely found in other codes. One of these 28 cards is for the Project Officer of Project 9.1B, an employee of Air Force Cambridge Research Laboratories (AFCRL). Of the remaining 11 cards, 9 list home addresses outside the state of New Mexico, making their assignment to FCDASA unlikely. Of the remaining, one shows Air Force Special Weapons Center (AFSWC) as his home organization and one shows AFCRL as his home organization.

An additional 50 men from other directorates within FCDASA were badged. Some of these were short-term visitors to the test area, while others spent several months on site performing full-time tasks in Headquarters Joint Task Force 8 (Hq JTF 8.) No one in DASA received an exposure greater than 1.0 R.

JTF 8 Headquarters. Hq JTF 8 had 195 men badged in DOMINIC. These staffed the various divisions and sections of the headquarters. Most were initially stationed on Christmas Island and then moved to Johnston Island in July after the last shot at Christmas. A few were located on Johnston Island for the duration and a few remained in Hawaii for all or part of the testing. Only one received an exposure greater than 1 R (1.370 R). He participated on both Johnston and Christmas islands.

United Services Organization (USO). The USO sent five men to Christmas Island in June for 2 days to do a USO show for task force personnel. Their badges recorded no exposure.

ATOMIC ENERGY COMMISSION ORGANIZATIONS

Lawrence Radiation Laboratory (LRL), Livermore, California. LRL, one of the two nuclear device development laboratories, had 410 persons badged as a separate task unit (TU 8.1.2) during DOMINIC. LRL was responsible for providing 16 of the 29 nuclear devices airdropped during DOMINIC. These men were involved in the details of device design, construction, test, checkout, detonation timing, and diagnostics. The LRL person who flew as scientific controller in the sampler control B-57D aircraft received the highest exposure (7.149 R). Only one other individual in the organization received more than 2.0 R (during June and July), but his specific duties are unknown. The remainder of the LRL personnel received exposures below 1.0 R.

Los Alamos Scientific Laboratory (LASL), Los Alamos, New Mexico. LASL, designated TU 8.1.1, had 145 men badged for DOMINIC. It was the other laboratory involved in weapon design and development. LASL was responsible for 13 of the 29 airdropped nuclear devices. Only one LASL person received more than 1 R, the scientific controller who directed the efforts of the sampler pilots from a B-57D aircraft on these same 13 shots.

Sandia Corporation, Albuquerque, New Mexico. Sandia Corporation had 318 personnel badged in DOMINIC. It was also assigned a separate task unit within JTF 8, TU 8.1.4. Sandia performed several missions including assistance to the Air Force in checking, testing, mating, and loading nuclear devices aboard the B-52s at NAS Barbers Point. It operated an accurate radar system at Christmas Island for air array control purposes. It was also responsible for procuring, modifying, assembling, and launching the Strypi

rocket at Johnston Island that carried the CHECKMATE warhead. In addition it was responsible for the fuzing and firing systems in the nuclear devices, and had substantial diagnostic equipment on both Christmas and Johnston islands as well as aboard the two C-130 aircraft. None of 318 Sandia personnel received over 0.6 R.

OTHER GOVERNMENT AGENCIES

National Bureau of Standards, Central Radio Propagation Laboratory (CRPL), Boulder, Colorado. The National Bureau of Standards, CRPL, had two persons working with WETG, FCDASA, at Johnston Island. These men could have been connected with Project 6.5c, a CRPL project, or with EMP measurements being made under the sponsorship of Hq USAF. One was there in June and July, the other from October to November. Neither received any exposure.

U.S. Coast & Geodetic Survey (USCGS). USCGS provided the ship, Pioneer, which was active in the long-term tracking of the SWORDFISH radioactive pool. A second USCGS ship, Pathfinder, participated during March and April in Christmas Island hydrographic surveys. It was not present during DOMINIC and therefore not exposed to any radiological risk.

U.S. Coast Guard, Johnston Island. The U.S. Coast Guard operated a Loran Station on Sand Island, which is a few hundred yards from Johnston Island. This was a permanent facility and not established for the DOMINIC operation. None of the 18 persons badged received as much as 1.0 R.

U.S. Public Health Service, Washington, D.C. This organization managed an extensive radiation monitoring program throughout the Pacific during DOMINIC.

U.S. Weather Bureau, Washington, D.C. The U.S. Weather Bureau had four persons badged; three worked in the weather prediction section of Hq JTF 8 on Christmas Island and one in the same area on Johnston Island. No badge readings exceeded 0.50 R. The Weather Bureau also managed the Project Stemwinder cloud-tracking activities described in Chapter 3, although actual conduct was by Air Force B-57s.

CONTRACTORS

Contractors at DOMINIC ranged from very large corporations to very small enterprises, and the number of personnel provided by each contractor varied from one to over two thousand. Certain contractors continued in the roles that they had played in prior Pacific Ocean atmospheric weapon test series and new contractors appeared.

The functions of the contractors varied. Some, such as Holmes & Narver, Inc. (H&N) and Edgerton, Germeshausen & Grier (EG&G), provided services for the whole or large parts of the operation. Some were manufacturers of hardware whose personnel were at the test areas to assist in the operation and maintenance of their hardware. Finally, some were there as consultants to the government scientific organizations, and their personnel participated in the design, execution, and reporting of the projects.

The contractors will be discussed here in alphabetical order. Some of those with less than two representatives will not be discussed, however, and the functions of the contractors discussed may not be completely documented. Where inferences are drawn relative to test-site activities, they are noted.

AC Spark Plug Company. Five persons were badged from this company, all on Johnston Island assisting TU 8.1.5 (Air Force Space Systems Division) in the Thor missile program. All badge readings were less than 0.50 R.

Aero Lab Development Company. The 13 badged personnel from Aero Lab assisted Ballistic Research Laboratories (BRL) on Projects 6.2 and 6.3 and the Army Missile Command (AMC) on Project 6.13 with small rocket launch equipment. Chapter 3 provides additional discussion on these projects. All persons were on Johnston Island and badge readings were all less than 0.20 R.

Aerojet General. The 16 Aerojet personnel badged were in the Johnston Island area. They worked for the Army Electronics Research and Development Activity (ERDA) on Project 6.1, which is described in Chapter 3. Badge readings were less than 0.10 R.

Aerospace Research Corporation. Three persons from this company operated riometers for AFCRL on Project 6.8 at various offsite locations on Johnston Island. Three were badged with no exposure.

Allied Research Associates. This group and its subsidiary, Aracon Laboratories, had a total of five men badged. These assisted AFSWC in the conduct of Project 8B. Exposures were all less than 0.4 R.

American Science and Engineering. Twenty-five were badged, all in the Johnston Island area. They worked for AFCRL on Projects 6.4, 6.10, and 8A.1, and for the Aeronautical Systems Division at Wright-Patterson AFB on Project 8A.3. No badge readings exceeded 0.40 R.

Aracon Laboratories (see Allied Research Associates).

Armour Research Foundation. This organization, whose name was changed to Illinois Institute of Technology Research Institute during DOMINIC, had five persons badged, all on Johnston Island. None received any exposure. They were responsible for managing Project 6.5b (see Chapter 3). Several others from this organization worked in the Southern Conjugate Area; they were not badged because of their remote location.

Atlantic Research Corporation. Twenty-three were badged, all for the FISHBOWL high-altitude tests at Johnston Island. They worked for BRL on Projects 6.2 and 6.3 in small rocket support. All badge readings were less than 0.10 R.

Avco Corporation. Eleven were badged, all for the FISHBOWL high-altitude series at Johnston Island. They worked for AFSWC on Project 8C. All badge readings were less than 0.10 R.

BTL. This acronym probably stands for Bell Telephone Laboratories in Greensboro, North Carolina. However, one of the three persons in the Consolidated

List under BTL was actually employed by BRL. All three worked at Johnston Island and their badge readings were less than 0.20 R.

Barnes Engineering Company. Twenty-one were badged from this organization, all working for AMC on Project 6.13 during the FISHBOWL high-altitude tests. Most, if not all, of these men were on board USAS American Mariner. Badge readings were less than 0.10 R.

Bell and Howell. This company provided instrumentation for Project 6.4 for AFCRL. Three badges were issued, the highest exposure being 0.050 R.

Bell Telephone Laboratories, Homedale, New Jersey. Three men are included with this group on the Consolidated List; however, like BTL (above), one of these worked for BRL and was mistakenly listed under Bell Telephone Laboratories. Exposures for all three were less than 0.10 R.

Bendix Radio Corporation. Eleven men were badged, all during the FISHBOWL high-altitude tests at Johnston Island from September to November. Their specific duties are unknown; however, they worked under the supervision of JTG 8.6, Johnston Island Base Command. Exposures were less than 0.20 R.

Control Equipment Corporation, Bedford, Massachusetts. Organization code 8642 was set up as one of the contractors participating in DOMINIC. However, a review of the 5x8 cards for the 12 men badged thereunder reveals that all 12 show their organization as AFCRL. One of the twelve also showed "Cont. Equip. Corp." on his 5x8 card, which could mean that he was a contractor employee at the test site under AFCRL sponsorship. The other eleven with this individual were Air Force officers or civilians at AFCRL and should have been placed in the same grouping as other AFCRL personnel; organization code 4680. AFCRL was responsible for managing Projects 6.4, 6.5a, 6.8, and 9.1a. Only one of these twelve received an exposure greater than 0.5 R. This exposure was 0.97 R. He was a civilian from the AFCRL Photochemistry Laboratory who also arrived at Johnston Island in May and remained through the last shot in November working on Project 9.1a.

Cubic Corporation. The 40 persons badged for DOMINIC from this organization were based at Johnston Island for the FISHBOWL high-altitude tests. Cubic Corporation was responsible for Project 9.6, the tracking of various missiles and rockets and recoverable pods and nosecones that were launched from Johnston Island. One person received an exposure of more than 1 R (1.27 R).

Denver Research Institute (DRI). Two men were badged with no exposure. DRI made EMP measurements for Hq USAF.

Douglas Aircraft Company. All 160 personnel badged were on Johnston Island. Douglas was the prime contractor for the Thor missile and its personnel were responsible for test, assembly, countdown, and launch of the Thor missiles fired at Johnston Island, although not directly involved with the nuclear devices that the Thor missiles carried. Four from Douglas received more than 1 R. According to the Consolidated List, the highest exposure was 2.25 R; however, that man's 5x8 card revealed a recorded exposure of

6.0 R. This badge was reevaluated in 1982 (see discussion in Chapter 13) and was found to be damaged and unreadable. The damage was probably related to environmental factors. The other three badges recording over 1 R were worn by men who were on Johnston Island from 4 to 7 months.

Eberline Instrument, Inc. Two men were badged; the highest exposure was 0.76 R. Eberline provided radiation measurement equipment.

Edgerton, Germeshausen & Grier, Inc (EG&G). EG&G was designated TU 8.1.6 and had 183 persons badged during DOMINIC. About one-third of the contingent was on Christmas Island with the remainder on Johnston Island. A few worked at both islands. EG&G worked for the AEC and DASA providing photography, yield determination measurements, and timing-firing signals for the various laboratories with scientific projects. They installed and operated much of the equipment in the two diagnostic C-130s, the Hq USAF KC-135, and the three KC-135 photo planes. The Consolidated List has two duplicates so there were actually 181 persons badged. The highest exposure was only 0.76 R.

Electro-Optical Systems. Twenty-two persons were badged, all for the FISHBOWL high-altitude shots at Johnston Island. These worked for the BRL on Projects 6.2 and 6.3. Chapter 3 discusses these projects in some detail. All badge readings were less than 0.20 R.

Electronic Communications, Inc. Seven were badged, all for the FISHBOWL high-altitude shots at Johnston Island. These worked for the Aeronautical Systems Division, Wright-Patterson AFB, on Project 7.4. All badge readings were less than 0.40 R.

Federal Electric Corporation. Thirty-nine were badged, all working for JTG 8.3 in the Johnston Island area. Their specific duties are not known, but as their home office was at Port Hueneme, California, they may have been stationed on the Pacific Missile Range (PMR) ship, USNS Range Tracker (T-AGM-1), at Johnston Island. All badge readings were less than 1.0 R.

Ford Aeronutronic. A division of Ford Motor Company, this group badged eight persons for the series. Aeronutronic assisted the Navy at the PMR. One of the eight badged was stationed aboard the PMR ship, USS Norton Sound (AVM-1). The other seven were on Johnston Island installing a shore-based missile flight safety system to replace the function of Range Tracker, another PMR ship, which was at the pier at Johnston Island providing tracking services during the series. All badge readings were less than 0.40 R.

General Dynamics. Six men were badged, all on Johnston Island. General Dynamics designed and built the instrumentation pods that were attached to the Thor missiles and carried to high altitudes, close to where the detonations occurred. The six on Johnston Island were probably involved with the details of pod check-in, storage, and mating to the Thor missiles. Additional information is available in the discussion on Project 9.4b in Chapter 3. Exposures were all less than 0.40 R.

General Electric Company. Eighteen were badged, all located on Johnston Island and all involved in the high-altitude FISHBOWL shots. Most of the 18 were stationed at Johnston Island from May through the last shot in November. One person worked with Stanford Research Institute (SRI) on Project 6.8. Specific duties of the others are unknown. One person received 1.61 R.

Geophysics Corporation of America (GCA). GCA was responsible for managing and fielding Project 6.6 and for assisting BRL on Projects 6.2 and 6.3, which are discussed in Chapter 4 in some detail. There was a total of 24 GCA persons badged, all working on Johnston Island. All badge readings were less than 0.10 R.

Holmes & Narver, Inc. A major contractor for the AEC. Its personnel staffed TU 8.5.1.

Hughes Aircraft. Nine were badged. They maintained and flew the B-57 used in Project 7.3 (see Chapter 3). All were stationed on Christmas Island. Exposures received were less than 0.20 R.

Kaman Nuclear. This company manned Project 7.1, involving operations on Navy ships near the Hawaiian Islands, well away from operations area. Two men were badged, one of whom was actually a scientific observer and not connected with the project. The highest exposure was 0.183 R.

Lincoln Laboratory, Massachusetts Institute of Technology. Twelve were badged in the test area on Palmyra and Johnston islands, managing and fielding Project 7.2 experiments (see Chapter 3). Exposures were all less than 0.80 R.

Mitre Corporation. This organization was a research group for the Air Force and involved in Air Force communications. The four men badged may have been involved with the Air Force communications experiment designated Project 7.4 or in the tests of the MUDETS system. No exposures were recorded.

New Mexico State University Physical Science Laboratory. Ten persons were badged during DOMINIC. These assisted AMC on Project 6.1 in the Johnston Island area. Exposures were less than 0.10 R.

Northrop Ventura. This organization worked for AFSWC on Project 9.1b. The highest exposure of the three men badged was 0.036 R.

Radio Corporation of America (RCA). RCA had 94 badged. Except for a couple at Wheeler AFB, Hawaii and a few on Johnston Island, everyone was on board American Mariner, which operated in the Johnston Island area. RCA's primary purpose was to support AMC in executing Project 6.13. Exposures were all less than 0.50 R.

Rocketdyne. Four men were badged for DOMINIC, probably representing the manufacturer of the Thor missile rocket engine. Exposures were lower than 0.040 R.

G.T. Schjeldahl Company. This company provided the radar reflectors used by Project 7.3 at Christmas Island. Two men were badged with no exposure recorded.

Scripps Institution of Oceanography. This organization formed TU 8.5.2; its mission and duties are described in Chapter 1 under JTG 8.5. The Consolidated List shows nine persons, but one is listed twice. Three of the eight were stationed on Christmas Island; the remainder were on Christmas and then transferred to Johnston Island to continue operations after the last shot at Christmas Island. One of their duties was placement of instrumentation on target rafts used in the airdrops. Exposures were all below 0.20 R.

Stanford Research Institute (SRI), Palo Alto, California. SRI managed and executed Project 6.9 during DOMINIC. It also assisted the Army on Project 6.11, and the Air Force on Projects 6.8 and 7.4. Chapter 3 describes these projects in some detail. SRI operated from aboard MV Acania. SRI had 17 badged during DOMINIC. The highest exposure recorded was 0.615 R.

Sylvania. The 43 personnel badged (one is listed twice) worked for the Army on Projects 6.1 and 7.3. Most were on Johnston Island working on Project 6.1; however, three were on Christmas Island working on Project 7.3. Exposures were all less than 0.20 R.

Tech Ops, Inc. This organization provided personnel for Project 8A.2, managed by AFCRL, who were aboard the KC-135s operated as photo-optical stations. Three men were badged, one of whom did not return his badge. The two badges returned recorded 0.026 R and zero.

Tels Signal Company. Two persons from this organization are on the Consolidated List; however, one was actually an Army enlisted man from Ft. Dix, New Jersey, who was counted in this organization. Exposures for both individuals were zero.

University of Utah. Six were badged, all in the Johnston Island area for the high-altitude FISHBOWL tests. They assisted AFCRL in executing DOD experimental Projects 6.4 and 9.1. Exposures for these six were less than 0.10 R.

University of Washington. This organization was designated as a separate task unit, TU 8.5.3. Their duties are described under JTG 8.5 in Chapter 1. Six were badged, some of whom were only on Christmas Island, while others were on both Christmas and Johnston islands. Exposures were less than 0.10 R.

Varian Associates. This instrument maker developed a specialized magnetometer for rocket flight for AFSWC and such instruments were flown on Project 6.7 rockets. It is reasonable to presume that the three Varian employees badged for DOMINIC worked at Johnston Island on these specialized instruments. Highest exposure of the three was 0.11 R.

Wentworth Institution. Wentworth provided two men who worked on the AFCRL Project 9.1. No exposure was recorded.

Western Electric. Six were badged during DOMINIC. All were on Christmas Island in April and May working for JTG 8.5. Specific duties are not described, but they may have been helping to put the island communications facilities in operable condition. All exposures were zero.

Zimney Corporation. Three were badged during DOMINIC. The Consolidated List shows five, but one person is listed three times. The three Zimney personnel worked for AFCRL on Project 6.4 (see Chapter 3). All three had zero exposure.

VERY IMPORTANT PERSONS

VIPs, visitors to Christmas/Johnston Island, comprised 65 persons badged for short periods of time. No exposures exceeded 0.50 R.

FOREIGN PERSONNEL

The United Kingdom had two persons badged under organization code 8002. One was on Christmas Island from April through June and the other was on Johnston Island from September through the last shot in November.

A second organization code used for foreign personnel was 9000, which was supposedly for persons from Gilbert and Ellice islands living on Christmas Island. However, an examination of all 591 names on the list seems to indicate that the names were English in form.

A random check of 15 5x8 cards revealed that 8 of the 15 visitors at Christmas Island were badged for periods of from 6 days to 60 days, while the other 7 were badged from the first to the last shot on Christmas Island. One of these United Kingdom personnel received an exposure of 1.327 R during his 3-month stay at Christmas Island. He was issued three badges over the 3-month period, receiving 0.360, 0.840, and 0.127 R in May, June and July, respectively. His duties are not known. No one else received an exposure over 0.10 R.

OTHER

There were nine men grouped under two organization codes who were recorded as "unidentifiable" in the Consolidated List. The two codes are 8700 and 8900; both are captioned "Unidentifiable." All nine have 5x8 cards. The 5x8 cards for these men show the following:

- An enlisted man assigned to the 3rd Brigade (25th Infantry Division) at Schofield Barracks, Hawaii
- A civilian from the AMC, Redstone Arsenal, Alabama
- A civilian from Navy Materials Laboratory, Brooklyn Navy Yard, New York
- An Army Master Sergeant whose card was marked TG 6.2, APO, MO (there was no TG 6.2 in DOMINIC)
- An Army E-4 whose card was marked TG 8.7 (Christmas Island Base Command)

- A civilian from Las Vegas, Nevada, whose card was marked TG 8.7
- A civilian whose card was marked TG 8.7
- An Air Force E-4 from Tachikawa Air Base, Japan, who was in TG 8.7
- An Army Staff Sergeant who had two 5x8 cards. One card had only his name, and thus it was coded "Unidentifiable." The other showed that he was assigned to USASCC, Ft. Bragg, North Carolina (Unit Code 8265). He was on Christmas Island from April until July and received a total of 0.02 R.

CHAPTER 13

SUMMARY OF PERSONNEL EXPOSURES

The DOMINIC operation was one in which, because of the nature of the test shots, there was little or no exposure to ionizing radiation for the large majority of the participants. The tests, with one exception, were detonated high enough above the Earth's surface that no involvement of the surface material with the fireball occurred to produce local fallout. Burst altitudes ranged from a few to 400 kilometers. The exception was the SWORDFISH underwater test, which did pose a potential for radiation exposure to participants because of the formation of a radioactive base surge. However, careful placement of the ship units involved prevented exposure of most support units.

The significant exposures were experienced by:

- Personnel who were required to collect samples of the radioactive device debris from the clouds formed by the airbursts or from the pool of radioactive seawater formed by SWORDFISH
- Personnel who directly helped in these sampling operations
- Personnel who retrieved instrumentation pods and rocket nosecones that were either activated by exposure to the burst or contaminated by passage through the device debris cloud.

There was one accident of radiological note. A missile poised to lift a test device to high altitude from Johnston Island malfunctioned and as a safety precaution the nuclear warhead was destroyed using explosives set off by radio command; the missile also burned. The warhead destruction and burning missile fuel spread radioactive device material in the area of the launch pad and downwind. The launch pad was located such that very little of the island was downwind and only a skeleton force had remained on the island for the shot. Cleanup activity was carefully controlled to protect the workers and to prevent the spread of contaminated material.

Table 36 displays the summary of the radiological exposures and basically confirms the summarization made in the preceding paragraphs. Only the Air Force shows a significant number of personnel exceeding the 3 R Maximum Permissible Exposure (MPE) and all these were associated with the cloud-sampling activities and were authorized a special MPE of 20 R, which none exceeded.

A study of radiological documentation has, however, raised questions concerning some of the entries in the Consolidated List of Exposures, the document on which the table is based. The questions are concerned with the way the film badges recorded the exposures and the way the task force recorded what the badges recorded. The film badges used in DOMINIC were treated with wax and encased in a plastic holder to prevent damage resulting from humidity. This

Table 36. DOMINIC personnel exposures.

Element	No. of Persons Listed	Number of Exposures (R)												High (R)	Collective Exposure (man-R)	Mean Exposure (R)
		0	0.001-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-4	4-5	5-10	10-15	Over 15			
U.S. Army	623	306	293	8	10	2	3	4	2					3.539	128	0.203
U.S. Navy	16,420	7,365	8,542	163	141	86	90	29	0	4				4.15	2,937	0.176
U.S. Air Force	2,702	1,182	1,296	79	35	25	23	13	5	4	20	15	5	18.08[a]	1,014	0.375
U.S. Marine Corps	589	209	375	1			4							2.290	40	0.067
DOD Agencies	350	140	203	6	1									1.37	162	0.461
AEC Organizations	921	545	366	5	0	1	1	2	0	0	1			7.15	112	0.121
Other Government Agencies	119	88	30	1										0.92	8	0.071
Contractors	2,984	1,186	1,750	30	3	4		8						2.920	500	0.167
Foreign	596	222	372	1	1									1.32?	95	0.159
Total	25,309	11,243	13,227	294	191	118	124	[illegible]	7	8	21	15	5	18.08[a]	4,996	0.197

Note:

[a]Actual high was 17.68 R; see Chapter 10.

method of sealing had worked well in previous Pacific operations but apparently was not successful in DOMINIC. This was suspected toward the end of the operation as badges processed for personnel showed much higher exposures than could possibly have been experienced considering the operations in which the wearers took part. This was recorded in the Radsafe Officer's report, but there was no assessment of the magnitude of the changes or the number of badges involved (Reference C.1.N, p. A-1-1).

A 1980 study of certain DOMINIC film badges was made under a Navy contract by a company experienced with film badge interpretation. The study involved a sample from selected Navy ships of 1,349 badges that are still on file at the Department of Energy's Nevada Test Site (NTS). The ships selected were ones that had personnel with high recorded exposures but were not involved in any activities which justified these exposures, ships that had high readings with some operational justification, and other ships for comparison. The badges were reread for darkening due to ionizing radiation and checked for damage attributable to light leaking, moisture, heat, and age. This environmental damage would have increased the optical density (darkening) of the badges and densities could have been misinterpreted and excessive gamma exposures assigned. However, the film experts could detect some differences between film changes due to ionizing radiation exposure and damage due to moisture, light leaks, etc.

Results of the study indicated that 45 percent of the badges sampled showed damage, and 90 percent of the damaged badges showed moisture damage. Further, 98 percent of the badges in the sample, which had been read as higher than 0.4 R in 1962, showed damage. For several reasons the amount of damage could not simply be subtracted from the 1962 readings, but it could be concluded that for all of the DOMINIC badges there is a high probability that some portion of the exposure recorded on the Consolidated List and its background documents, notably the 5x8 cards and NAVMED 1432 forms, is due to film damage. This probability increases with increased exposure readings, so that at 0.4 R and above it is 98 percent (Reference D.8).

The effect of this film damage on the exposures shown in Table 36 is to indicate higher readings than individuals actually had received. However, the amount of this difference is not quantified. Table 36 reflects the readings without reduction for environmental or other damage except for a few cases discussed below.

The manner in which badge readings, with or without extraneous damage, were further processed also introduces some errors into the Table 36 data. This is discussed below. The DOMINIC radsafe organization was not prepared for the large number (43,000) of badges issued. The Radsafe Officer's report stated that, "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" (Reference C.1.N, p. A-21).

It is probable that, because only selective badging was contemplated, the automated system for handling personnel dosimetry records developed during the

1958 HARDTACK test series in the Pacific was not reinstituted, nor was an equivalent system developed. Thus, all badges were issued manually. Some of the 1958 equipment that read the density of the developed film badge, automatically converted it to an equivalent gamma exposure, and then punched it on an IBM card was used in 1962. These exposures were then manually entered on either the 5x8 card or the NAVMED 1432 form, or both, for manual cumulation. Later these cumulations were manually entered, probably through a keypunch, into a computer that prepared the final lists.

These manual activities were done at Christmas Island, at Honolulu, and finally, for the last quarter of the badges and for the complete cumulations, at NTS. Personnel employed were from JTF 8 Radsafe Branch, clerks in Honolulu, and employees of the AEC operating contractor at NTS, Reynolds Electrical & Engineering Company (REECo). Activities began in April 1962 and badges were still being processed in January of the next year. Thus, it is not surprising that some numerical errors and inconsistent entries exist. The sum of most of these effects on the source document for Table 36 is probably small. One kind of error that does affect Table 36 is the duplication of names that appear on the Consolidated List. There are instances in which a 14-man contingent was boosted to 23 because of multiple entries of names. In terms of percentages, worse cases exist, but these are in smaller organizations. A random sampling of larger organizations shows some duplications up to 5 percent, but no systematic study was made of this and no corrections have been applied to any of the tables extracted from the Consolidated List, including Table 36. The effect is that Table 36 probably overstates by a few percent the number of badged DOMINIC participants and consequently similarly overstates the collective exposure resulting from the test series. However, this problem does not affect the exposure record for individuals. Current dosimetry files provide the correct total for each individual.

After the last DOMINIC shot the dosimetry program moved to NTS and was completed there. Personnel from the Army Chemical Unit at Dugway (acting for JTF 8) and personnel from the REECo Radiological Safety Division finished the dosimetry work and issued the final Consolidated List of Exposures. This phase of work began in mid-November 1962 and was completed 11 January 1963. It consisted of developing and reading the last 10,000 to 15,000 badges and checking 30,000 5x8 cards and NAVMED forms for accuracy.

Apparently at the time when exposure totals were transferred from the 5x8 or NAVMED cumulations to the punch cards from which the Consolidated List was compiled, some totals were reevaluated. This was probably an attempt to compensate for the recognized damage to the badges due to seal failures described above. A JTF 8 letter of February 1963 covering the transmittal of naval personnel exposures to the Navy Surgeon General gives information on the reevaluation (Reference C.1.3):

> All dosage cards indicating accrued exposures greater than 3 roentgen were evaluated regarding possible environmental damage. Dose assignments for damaged badges were generally commensurate with the highest dosage accrued within the group that the individual was attached to. No adjustments were made to the indicated doses for individuals who normally could receive radiation exposure due to their work assignment (cloud-

samplers, etc.) even though the badges did indicate possible environmental damage.

A study of the 5x8 cards and the NAVMED forms found only 78 cases in the Consolidated List total exposures which were different than the earlier total. Most of these showed a decrease in the total exposure from over 3 R to under 3 R, but 20 showed increases to some value less than 3 R. The former cases are probably those referred to in the JTF 8 letter. The latter appear to be the result of a clerical or keypunch error. Almost all of the badge totals that were increased were from consecutively numbered badges issued on USS Princeton (LPH-5), and the totals were all increased exactly 2.0 R. However, personnel exposures with the higher readings have not been reduced on Navy records.

Seventy-six of the seventy-eight film badges were retrieved from storage at NTS in 1982 and were reevaluated by dosimetry personnel from REECo.* All of the badges that had totals noted in 1962 as being over 3 R showed significant damage due to light or water damage or both. Only 18 of these had readable areas from which current analysts could infer radiation exposure information. All but four of these showed less than 3 R exposure (Reference D.14).

These four badges were worn by personnel on USS Sioux (ATF-75) at SWORDFISH and the current reevaluation confirms the original 5x8 or NAVMED entry of from 4 to 5 R for the three. The fourth badge now reads possibly as high as 3.2 R, but was originally noted as being 0.78 R. However, current analysts note that the badge is unexplainably melted (Reference D.14). With these few exceptions, the values for personnel radiation exposure used in the construction of Table 36, as well as other tables in this report, are derived from the Consolidated List.

As a result of the 1980 and 1982 studies of the 1,349 film badges from units selected because of their known operational activities, only four exposures of these units in the Consolidated List are considered to be lower than exposures actually received. In these four cases, which were Sioux crewmembers, the higher exposures had been recorded in their Navy Medical Records and accepted as correct.

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* An additional source of damage was also noted. Many films had been damaged by a bandsaw when cutting open the plastic holders. This caused gross light damage.

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The first section (A) contains basic references pertinent to nuclear weapons development and effects and to all or several atmospheric nuclear tests. These are generally monographs published and distributed through regular trade channels and are available in bookstores and libraries with the exceptions noted.

The second and third sections are documents generated by Joint Task Force 8 (JTF 8) and its subordinate organizations. The second section (B) contains planning documents for DOMINIC, and the third (C) after-action reports. These JTF 8 references are arranged in a fashion that reflects the JTF 8 organization.

The fourth section (D) lists other reports by non-task-force organizations concerning DOMINIC.

An availability code appears at the end of many reference citations for those who wish to read or obtain copies. Availability status was correct at the time the reference list was prepared. Many documents indicated as unavailable will become available during the declassification review process. The Department of Energy Coordination and Information Center (DOE CIC) and NTIS will be provided future DNA-POR documents bearing an "EX" after the report number.

Source documents with an availability code of DOE CIC may be reviewed at the following address:

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Coordination and Information Center
(Operated by Reynolds Electrical & Engineering Co., Inc)
ATTN: Mr. Richard V. Nutley
2753 S. Highland
P.O. Box 14100
Las Vegas, Nevada 89114
Telephone: (702) 734-3194; FTS: 598-3194.

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APPENDIX A

RADIOLOGICAL SAFETY DOCUMENTS

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ANNEX J TO CJTF 8 OP PLAN 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 command 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.

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* Editorial Note: JTF 8 Op Plan 2-62 with this annex was published 23 January 1962. This Operations Plan became the JTF 8 Operations Order by publication of Change Number 9, 27 March 1962.

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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.

APPENDIX 1

ANNEX J TO OP PLAN 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 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) Maintain 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 8.3:

(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 explosion 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. <u>MPE</u>

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 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 than 1.0 mr/hr. Complete decontamination by bathing will be utilized for readings in excess of this level. If the body is generally contaminated and especially if contamination is on the eyes or gonads, special efforts should be made to reduce the contamination level. In general, however, it his 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 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:

$1.0\ cal/cm^2$

$6.0\ cal/cm^2$

(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 (μc-microcurie):

Water: Beta-Gamma Emitter

10^{-3} μc/cc (calculated to H plus 3 days)

Air: Fission Products

10^{7} μc/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 milliroentgens 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.

CHRISTMAS ISLAND
STANDARD OPERATING PROCEDURES FOR DOSIMETRY RECORDS*

FILM ISSUE

1. Individual receiving badge fills out Film Badge Data Card with required information.

2. A member of Rad-Safe Photo-Dosimetry enters on the Film Badge Data Card the film badge number and issue date.

3. The next entry on the Film Badge Data Card is the identification or ID number. This is a four digit number which indicates the badge wearer's organization.

4. An IBM card with a number (film) identical to that on the Film Badge Card is extracted from the numerical IBM card file. On this card, IBM numerical card, is entered the badge wearer's last name, first name, middle initial, ID number, and date of issue. The IBM numerical card is then returned to its respective file location. The person who has effected the transfer of information will so indicate by initialing the lower left hand corner of the Film Badge Data Card.

5. The Film Badge Data Card is given to the Kardex section who will, if necessary, prepare a 5" x 8" Accumulated Dosage Card. If an Accumulated Dosage Card was prepared or previously maintained on file, the person making the check will so indicate by initialing the lower center of the Film Badge Data Card. The Accumulated Dosage Card is filed by Task Unit and the Film Badge Data Card is filed by badge number in the working deck

FILM RETURN

1. Film badges returned to Radsafe for processing are arranged in ascending numerical order by processing section. IBM Numerical Cards with numbers corresponding to these films are removed from the file and placed in the "being processed" container. This operation should be jointly performed by a member of the processing section and a member of the records section (see item 4, Film Issue).

2. Processed films and corresponding IBM Numerical Cards are taken to the densitometer for gamma dose evaluations. Since the densitometer and key punch operate as a coupled unit, it is suggested that when a member of the processing section operates the densitometer he be accompanied by [a member of the Radsafe Section] or an appointed alternate.

3. The completed (punched with gamma dose and processing data) data appearing on the IBM Numerical Card is transferred to the Accumulated Dosage Card, after which time both cards are returned to their respective files (see item 5, Film Issue).

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* From Reference C.1.2, Microfilm Roll 7, "Continental and Pacific Historical Records, 1962," Index 114.

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APPENDIX B

LIST OF CODES USED IN THE DOMINIC CONSOLIDATED LIST OF EXPOSURES

The code numbers with asterisks had no personnel exposures listed with them. These codes were apparently established before the operation and then were not used.

3001* USS MILNMOITE
3002 USS INFLICT
3 3* USS UTE
3 4 HMM 161 KANEOHE BAY, HI
3005 USMC BARBERS PT
3006* PMR, PT MUGU, CA
3007 VR 3 MC GUIRE AFB, NJ
3008* USS ESTES AGC 12
3009 USS TUNNY SSG 282
3500 1 MAR DIV CP PENDLETON, CA
3501 3 MAR AIR WG SANTA ANA, CA
3502* USS SPERRY AS 12
3503 USS HORNET CVS 12
3504 BULK FUEL CO CP PENDLETON, CA
3505 PMR, PT MUGU, CA
3506 MCAS, EL TORO, CA
3507 NAVCOMSTA, SAN DIEGO, CA
3508 NCAF, SANTA ANA, CA
3509 CINCPACFLT, PEARL HARBOR, HI
3510 COMSERUPAC, PEARL HARBOR, HI
3511 USNAVPHIS, CORONADO, CA
3512 NAVCOMSTA, KODIAK, AK
3513* ATLANTIC RES, EL MONTE, CA
3514 DIO 14 ND NAVY 128
3516 DIO 14 ND NAVY 128
3517 NAV HOSP, BETHESDA, MD
3518 WEA CEN ANDREWS AFB, MO
3519 FLTWEACEN, PEARL HARBOR, HI
3520 VA 215, MOFFETT FIELD, CA
3521 CNO NAVY 128
3522 COMDESRON 5 FPO, SAN FRANCISCO, CA
3523 EODU 1, PEARL HARBOR, HI
3524 BUDOCKSYARDS, WASHINGTON, DC
3525 NAVY HYDRO, WASHINGTON, DC
3526 COMPACMISRAN
3527 NUCWEATRACEN, NORFOLK, VA
3528 NAVAIRSTA, SANFORD, FL
3529 NAVCOMSTA, PEARL HARBOR, HI
3530 NAVSUPPCEN, PEARL HARBOR, HI
3531 NAVAIRSTA, NORFOLK, VA
3532 NAVSECSTA, WASHINGTON, DC
3533 VANSUBBAS, PEARL HARBOR, HI
3534 USS HALSEY POWELL DD686
3535 NAVMAT, BROOKLYN, NY
3536 CLARKSVILLE BASE, TN
3537 NAVADMUNIT, SANDIA BASE, NM
3538 NRDL, SAN FRANCISCO, CA
3539 NAVUNIT, LAKE MEAD BASE, NV
3540 USNAVORDLAB, SILVER SPRINGS, MD
3541 NADC, JOHNSONVILLE, PA
3542* BUWEAPS, WASHINGTON, DC
3543 NAVSTA, LONG BEACH, CA
3544* USS HECTOR, LONG BEACH, CA
3545 NAVCOMMSTA NAVY 85 DIV 40 M
3546 USS CONSTELLATION, SAN DIEGO, CA
3547 USS FRONTIER AD 25
3548 USNAVSTA, PEARL HARBOR, HI
3549 USNAD NAVY 66
3550* NAVAIRSTA, ALAMEDA, CA
3551 MINEDIV 113, LONG BEACH, CA
3552* MSTS, WASHINGTON, DC
3553 OFF CNO, WASHINGTON, DC
4001 HQ JTG 8.4, KIRTLAND AFB, NM
4002 WSS, MAXWELL AFB, AL
4003 55 WRS, MC CLELLAN AFB, CA
4004 1511 OMS, TRAVIS AFB, CA
4005 44 ATS, TRAVIS AFB, CA
4006 114 ATS, TRAVIS AFB, CA
4007 22 SUPP SQ, MARCH AFB, CA
4008 HQ, MC CLELLAN AFB, CA
4009 4392 SUPP SQ, VANDENBERG AFB, CA
4010 HQ 15 AF, MARCH AFB, CA
4011 552 AEWC SQ, MC CLELLAN AFB, CA
4012* GEN ELEC CO, VANDENBERG AFB, CA
4013 1901 COMM SQ, TRAVIS AFB, CA
4014 1155 TOS, MC CLELLAN AFB, CA
4015 HQ, CASTLE AFB, CA
4016 1369 PHOTO SQ, VANDENBERG AFB, CA
4017 4126 SUPP SQ, BEALE AFB, CA
4018 552 FMS, MC CLELLAN AFB, CA
4019 HQ CMBT SPT SQ, MARCH AFB, CA
4020 13 AMTS, TRAVIS AFB, CA
4021 HQ 1 STRATRAD, VANDENBERG, CA
4022 3535 CAMS, MATHER AFB, CA
4023 4126 FMS, BEALE AFB, CA
4024 414 CAMS, OXNARD AFB, CA
4025 HQ, NORTON AFB, CA
4026 9 WEA RECON GP, MC CLELLAN AFB, CA
4027 1352 PHOTO GP, LOOKOUT MT AFS, CA
4028 HQ, MC CLELLAN AFB, CA
4029 5 OMS, TRAVIS AFB, CA
4030 1501 GEMS, TRAVIS AFB, CA
4031 2223 INSTRON, MARCH AFB, CA
4032 23 BOMB SQ, TRAVIS AFB, CA
4033 1003 IG, NORTON AFB, CA
4034 146 CAMRON, VAN NUYS, CA

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4035 146 ATW, VAN NUYS, CA
4036 93 FMS, CASTLE AFB, CA
4037 1511 OMS, TRAVIS AFB, CA
4038* 4126 SW, BEALE AFB, CA
4039 3993 OMS, CASTLE AFB, CA
4040 22 FOOD SVC SQ, MARCH AFB, CA
4041 4392 SUPP SQ, VANDENBERG AFB, CA
4042 6511 TEST GP, EL CENTRO, CA
4043 552 OMS, MC CLELLAN AFB, CA
4044 4126 CSG, BEALE AFB, CA
4045 DENVER RES UNIT, DENVER, CO
4046 1352 PHOTO GP, COLO SPRINGS, CO
4047 RESEARCH INST, DENVER CO
4048 HQ, EGLIN AFB, FL
4049 HQ, AFMTC, CAPE CANAVERAL, FL
4050 6555 SP WG, PATRICK AFB, FL
4051 1365 PHOTO SQ, ORLANDO AFB, FL
4052* 4 WEA GP, EGLIN AFB, FL
4053 8 WEA SQ, MAC DILL AFB, FL
4054 APCG, EGLIN AFB, FL
4055 1375 M AND C SQ, TURNER AFB, GA
4056 HQ, TURNER AFB, GA
4057 61 TCS, STEWART AFB, GA
4058* 2000 COMM SQ, STEWART AFB, GA
4059 1371 M AND C SQ, TURNER AFB, GA
4060 1376 CAMRON, TURNER AFB, GA
4061 79 ARS, APO 334
4062 AFTAC EP, HICKAM AFB, HI
4063 50 ATS, HICKAM AFB, HI
4064 6486 ABW, HICKAM AFB, HI
4065 1502 ATW, HICKAM AFB, HI
4066 76 ARS, HICKAM AFB, HI
4067 HQ 1502 ABG, HICKAM AFB, HI
4068 8 AST, HICKAM AFB, HI
4069 HQ PACAF, HICKAM AFB, HI
4070 SMAMA, HICKAM AFB, HI
4071 1957 COMM GP, HICKAM AFB, HI
4072 HQ, MATS, HICKAM AFB, HI
4073 6486 SUPP SQ, HICKAM AFB, HI
4074 4134 OMS, HICKAM AFB, HI
4075 4686 CES, HICKAM AFB, HI
4076 6486 CAMRON, HICKAM AFB, HI
4077 48 ATS, HICKAM AFB, HI
4078 HQ, SCOTT AFB, IL
4079 HQ AWS, SCOTT AFB, IL
4080 1405 ABSQ, SCOTT AFB, IL
4081 3345 ABG, CHANUTE AFB, IL
4082 1915 COMM SQ, BUNKER HILL AFB, IN
4083 9 SUPP SQ, MTN HOME AFB, ID
4084 18 COMM SQ, WESTOVER AFB, MA
4085* AMER SCIENCE, CAMBRIDGE, MA
4086 3245 TG HANSCOM FLD, BEDFORD, MA
4087 HQ AFSC, ANDREWS AFB, MD
4088 1001 ADW, ANDREWS AFB, MD
4089 1298 ATS, ANDREWS AFB, MD
4090 1254 ATW, ANDREWS AFB, MD
4092 HQ, COLUMBUS AFB, MS
4093 117 TACRECON, HUTCHINSON AFB, KS
4094 HQ, CONNEL AFB, KS
4095 4347 CCTW MC CONNEL AFB, KS
4096 343 FTR GP, DULUTH, MN
4097 56 MEDREN, SAWYER, MI
4098* 15 WEARON, OLMSTED AFB, NE
4099 HQ, OFFUTT AFB, NE
4100 3636 FMS, STEAD AFB, NV
4101 HQ 3636, STEAD AFB, NV
4102 3635 FTW, STEAD AFB, NV
4103 3636 M AND S GP, STEAD AFB, NV
4104 HQ, NELLIS AFB, NV
4105 3636 HELISQ, STEAD AFB, NV
4106 3638 FTS HELI, STEAD AFB, NV
4107 HQ, 1211 TEST SQ, KIRTLAND AFB, NM
4108 HQ, AFSWC, KIRTLAND AFB, NM
4109 4900 CAMRON, KIRTLAND AFB, NM
4110 CMBT SPT SQ, WALKER AFB, NM
4111 4925 TST DSCRTRTE, KIRTLAND AFB, NM
4112 6 SS, WALKER AFB, NM
4113 AFTAC, ROSWELL, NM
4114 1094 AVDS, MANZANO, NM
4115 6 BOMB SQ, WALKER AFB, NM
4116 USA SMSA MS, WHITE SANDS, NM
4117 38 ATS, MC GUIRE AFB, NJ
4118 18 ATS, MC GUIRE AFB, NJ
4119 30 ATS, MC GUIRE AFB, NJ
4120 1611 OMS, MC GUIRE AFB, NJ
4121 1612 OMS, MC GUIRE AFB, NJ
4122 4603 CAMRON, STEWARD AFB, NY
4123 ASD, WRIGHT PATTERSON AFB, O
4124 ASTMB, WRIGHT PATTERSON AFB, O
4125 6 WEARON, TINKER AFB, OK
4126 HQ, TINKER AFB, OK
4127 1816 AIRDIV, ALTUS AFB, OK
4128 857 MED GP, CLINTON AFB, OK
4129 4444 RTS, SHAW AFB, SC
4130 314 CAMS, SEWART AFB, TN
4131 HQ, SEWART AFB, TN
4132 3514 FMS, RANDOLPH AFB, TX
4133 3273 SCH SQ, LACKLAND AFB, TX
4134 HQ, SHEPPARD AFB, TX
4135 96 BOMB WG, DYESS AFB, TX
4136 HQ, AMARILLO AFB, TX
4137 SCH OF AEROMED, BROOKS AFB, TX
4138 4130 SQ, BERGSTORM AFB, TX
4139 3700 ABG, LACKLAND AFB, TX
4140 3511 FLM, RANDOLPH AFB, TX
4141 4677 DSES, HILL AFB, UT
4142 191 ATS, SALT LAKE CITY, UT
4143 74 WEARON, HILL AFB, UT
4144 7 TCS, MC CHORD AFB WA
4145 62 TCS, MC CHORD AFB, WA
4146 4 TCS, MC CHORD AFB, WA
4147 44 TCS, MC CHORD AFB, WA
4148 43 ARS, LARSON AFB, WA
4149 HQ, USAF NG AFOTO, WASHINGTON, DC
4150 HQ, USAF AFTAC, WASHINGTON, DC
4151 6488 ABG, APO 105
4152 HQ, TACHIKAWA AFB, APO 323
4154 36 ARS, APO 323
4155 33 ARS, APO 235
4156 1962 COMM SQ, APO 239

4157 HQ, ITAZUKE AFB, APO 929
4158 1 MC GP, CLARK AFB, PI
4160 WRAMA
4161 5 FMS, TRAVIS AFB, CA
4162 1294 ATG, ANDREWS AFB, MD
4163 HQ, CHANUTE AFB, IL
4164 AIR NATIONAL GUARD, NV
4165 HQ, MATS, ROBBINS AFB, GA
4166 MARTIN PLANT, BALTIMORE, MD
4167 52 CAMRON, SUFFOLK AFB, NY
4168 2000 COMM SQ, STEWARD AFB, NY
4169 ARPA OSD, PENTAGON, WASHINGTON, DC
4170 1215 WS DET, MIDDLETOWN, PA
4171 310 BOMB WG, SHILLING AFB, KS
4172 HQ, EDWARDS AFB, CA
4173 HQ, WESTAF, TRAVIS AFB, CA
4174 HQ, HAMILTON AFB, CA
4175 1903 SQ, DAVIS MONTHEN AFB, AZ
4176 DET 1 55 WRS, ZILSON AFB, AK
4177 3500 FLT WG, REESE AFB, TX
4178 SCH OF AEROMED, 7 BROOKS AFB, TX
4179 105 ATS, BERRY F.D, NASHVILLE, TN
4180 155 ATS, MEMPHIS MUN APT, TN
4181 128 ATS, DOBBINS AFB, GA
4182 1070 MED GRP GP, GUNTHER AFB, AL
4200 AF UNIDENTIFIABLE
4202* JTU 8.4.4 TOY TO NAS, BARBERS PT
4209* 9 WEA RECON GP, MC CLELLAN AFB, CA
4230* 128TH ATS (H) GANG, DOBBINS AFB, GA
4231* 105TH ATS (H) TANG, BERRY FLD,TN
4232* 155TH ATS (H) TANG, MEMPHIS MUN APT, TN
4500 6005 AIR PSTL GP, APO 953
4501 1 AIR PSTL SQ, APO 929
4502 389 MSL WG, WARREN AFB
4503 4603 ARG, STEWART APT, NY
4504* 1ST RT AEROSPCE DV, VANDENBERG AFB, CA
4505* HQ, 22 BOMB WG, MARCH AFB, CA
4506 HQ, 343 FTR GP, DULUTH, MN
4507 HQ, 30 AIRDIV SAGE, TRUAX AFB, WI
4508* 3510 FTWG, RANDOLPH AFB, TX
4509 817 CMBT SPT GP, PEASE AFB, NH
4510 HQ, DAVIS MONTHAN AFB, AZ
4511 USAF HOSP, LACKLAND AFB, TX
4512* 544 R TECH GP, OFFUTT AFB, NE
4513 1957 COMM GP, HICKAM AFB, HI
4515 2040 2 COMM SQ, KIRTLAND AFB, NM
4516 2127 COMM SQ, APO 928
4517 2127 1 COMM SQ, APO 994
4518 825 OPNS SQ, LITTLEROCK AFB, AR
4519 6 BOMB WG, WALKER AFB, NM
4520 18 COMM SQ, WESTOVER AFB, MA
4521 1962 COMM SQ, APO 239
4522 1955 COMM SQ, APO 929
4523 1956 COMM SQ, APO 925
4524 2132 COMM SQ, APO 323
4525 1918 COMM SQ, SCOTT AFB, IL
4526 46 COMM SQ, BARKSDALE AFB, LA
4527 1953 COMM SQ, APO 919
4528 4648 SUPP SQ, GUNTHER AFB, AL
4529 688 ACW SQ, AMARILLO, TX
4530 2045 COMM SQ, ANDREWS AFB, MD
4531 96 OPNS SQ, APO 970
4532 4392 ASG, VANDENBERG AFB, CA
4533 815 OPNS SQ, FORBES AFB, KS
4534 4628 SUPP SQ, MC CHORD AFB, WA
4535* 4661 SUPP SQ, HAMILTON AFB, CA
4536 771 RADAR SQ, CAPE CHARLES AFS, VA
4537 745 ACW SQ, DUNCANVILLE, TX
4538 32 COMM SQ, ELKHORN, NE
4539 1001 FMS, ANDREWS AFB, MD
4540 821 RADAR SQ, BAKER, OR
4541 305 AR SQ, MC GUIRE AFB, NJ
4542 2049 COMM GP, MC CLELLAN AFB, CA
4543 11 BOMB WG, ALTUS AFB, OK
4544 4127 STRAT WG, SHERMAN AFB, OK
4545 93 CBS, CASTLE AFB, CA
4546 4141 STRAT WG, GLASGOW, MT
4547 2875 GEEIA SQ, APO 323
4548 30 COMM SQ, OFFUTT AFB, NE
4549 2146 5 COMM GP, APO 64
4550* 554 RADAR SQ, BRUNSWICK, ME
4551 6846 SUPP SQ, HICKAM AFB, HI
4552* 2029 COMM GP, ELLSWORTH AFB, SD
4553 ASD, WRIGHT PATTERSON AFB, OH
4554 1951 COMM GP, APO 953
4555 1909 COMM SQ, ANDREWS AFB, MD
4556 4170 CMBT SPT SQ, LARSON AFB, WA
4557 24 WEAPON, HILL AFB, UT
4558 782 RADAR SQ, ROCKVILLE AFS, IN
4559 6005 AIR PACAF, APO 953
4560 DET 1 PAC, WHEELER AFB, HI
4561 SQ, WURTSMITH AFB, MI
4562 1 ARG, JOHNSON AFB, NC
4563 2869 GEEIA SQ, NORTON AFB, CA
4564 1952 COMM GP, APO 953
4565 2040 COMM SQ, KIRTLAND AFB, NM
4566 2152 COMM GP, APO 235
4567 2867 GEEIA SQ, MC CLELLAN AFB, CA
4568 2146 4 COMM SQ, APO 78
4569 HQ, VANDENBERG AFB, CA
4570 PAC GEEIA RGN, APO 915
4571 6486 ABRON, APO 105
4572 1502 2 ATW, APO 105
4573 1958 COMM GP, APO 324
4574 6 WEAPON, TINKER AFB, OK
4575 3243 ABWG, BEDFORD, MA
4576 6102 ABWG, APO 994
4577 1901 COMM SQ, TRAVIS AFB, CA
4578 2165 COMM SQ, APO 63
4579 3764 SCH SQ, SHEPPARD AFB, TX
4580 6510 ABGP, EDWARDS AFB, CA
4581 6486 ABWG, HICKAM AFB, HI
4582 909 SQ, OKINAWA
4583 1502 FMS, HICKAM AFB, HI
4584 15 WEAPON, MAXWELL AFB, AL
4585 818 OPNS SQ, LINCOLN AFB, NE
4586 751 RADAR SQ, NIAGRA FALLS, NY
4587 42 ABWG, LORING AFB, ME
4588 2016 COMM SQ, DOVER AFB, DE
4589 HQ AFCS, SIOUX CITY, IA

4590 2045 ACS, ANDREWS AFB, MD
4591 6102 SUPP SQ, APO 328
4592 24 WEARON, LOWRY AFB, CO
4593 1957 AFCS, HICKAM AFB, HI
4594 2009 AAC, RICHARDS AFB
4595 1961 COMM GP, APO 74
4596 4 WEAGP, KANSAS CITY, MO
4597 22 CES SQ, MARCH AFB, CA
4598 1 FMS, SELFRIDGE AFB
4599 CAND E , BEALE AFB, CA
4600 HQ, SAC, BEALE AFB, CA
4601 803 CES, DAVIS MONTHAN AFB, AZ
4602 4661 COMM GP, HAMILTON AFB, CA
4603 HQ, USAF, PAINE FIELD, WI
4604 8 WEAGP, WILLIAMS AFB, AZ
4605 1100 AWSQ, BOLLING AFB, WASH
4606 1861 FLF TACHIKAWA, JAPAN
4607 124TH WEARON, WILLIAMS AFB, AZ
4608 HQ, LOCKBOURNE AFB, OH
4609* WRAIR WRAMC
4610 1502 ATS, HICKAM AFB, HI
4611* 4758 DSRS, BIGGS AFB, TX
4612 FAA, HONOLULU, HI
4613 3380 ARGP, KEESLER AFB, MS
4614 820 OPNS SQ, PLATTSBURG, NY
4615 4645 SUP SQ, DULUTH, MN
4616 551 ARS, OTIS AFB, MA
4617 2040 COMM SQ, CANNON AFB, NM
4618 92 CRS, FAIRCHILD AFB, WA
4619 4900 AR SQ, KIRTLAND AFB, NM
4620 2727 COMM SQ, APO 329
4621 1910 COMM SQ, LOWERY AFB, CO
4622 1958 COMM SQ, APO 334
4623 SMAMA, HICKAM AFB, HI
4624 HQ, AFFTC, EDWARDS AFB, CA
4625 2178 COMM DET, ORLANDO AFB, FL
4626 551 AR SQ, OTIS AFB, MA
4627 28 FMS, ELLSWORTH AFB, CO
4628 AFMEC, HOLLOMAN AFB, NM
4629 2047 AFCS, MAXWELL AFB, AL
4630* 51 MMS, VANDENBERG AFB, CA
4631 HQ, SSD, VANDENBERG AFB, CA
4632 SMAMA, VANDENBERG AFB, CA
4633 HQ, AFSSD, ANDREWS AFB, MD
4634 HQ, STRATAD, VANDENBERG AFB, CA
4635 HQ, RANDOLPH AFB, TX
4636 48 ATS, HICKAM AFB, HI
4637 38 ATS, MC GUIRE AFB, NJ
4638 HQ, AWS, SCOTT AFB, IL
4639 1611 ATW, MC GUIRE AFB, NJ
4640 3RD A & E, APO 328
4641 AIR WEA CEN, OFFUTT AFB, NE
4642 WEA CEN, WESTOVER, MA
4643 1001 AR WG, ANDREWS AFB, CA
4644 6486 ROD, HICKAM AFB, HI
4645* 418 WEA GP, HOWARD AFB, CZ
4647 HQ, PACAF, HICKAM AFB, HI
4648 2 WEA GP, LANGLEY AFB, VA
4649 133 WEA SQ, DULUTH, MN
4650 HQ, AFLC, WRIGHT PATTERSON AFB, OH
4651 26 WEARON, BERGSTROM AFB, TX
4652 WEA CENT, BARKSDALE AFB, LA
4653* HQ, SAC, OFFUTT AFB, NE
4654 WEA CEN, TINKER AFB, OK
4655 HQ, BLYTHEVILLE AFB, AR
4656 9 WEA RCN, MARCH AFB, CA
4657 WEA CEN, HANSCOM FLD, MA
4658 HQ, DYESS AFB, TX
4659 115 AC & W SQ, DOTHAN, AL
4660 6596 INST SQ, VNDENBERG AFB, CA
4661 24WEAPON DET 14 TRAVIS AFB, CA
4662 HQ, AFSWC, KIRTLAND AFB, NM
4663 HQ, USAF, WASH 25, DC
4664 1ST COMBT EVAL, BARKSDALE AFB, LA
4665* 45 STRAT MSL WG, LOWRY AFB, CO
4667 2415 MS S GP, LOWRY AFB, CO
4668 HQ, ROBBINS AFB, GA
4669 3345 AB GP, CHANUTE AFB, IL
4670 AWS, ANDREWS AFB, MD
4671 HQ, LACKLAND AFB, TX
4672 WEA CEN, WALKER AFB, NM
4673 WEA CEN, BEALE AFB, CA
4674 6595 AEROSPCE TST, SUNNYVALE, CA
4675 6560 OPNS GP, PATRICK AFB, FL
4676 HQ, ORLANDO, FL
4677 1090 SRW, SANDIA BASE, NM
4678 6580 AR GP, HALLOMAN AFB, NM
4679 AFSC ENG OFF, BROOKLEY AFB, AL
4680 AFCRL, HANSCOM FIELD, BEDFORD, MA
4681 3225 DRONE SQ, HALLOMAN AFB, NM
4682 728 ACW SQ, CANNON AFB, NM
4683 6515 AE MAINT, EDWARDS AFB, CA
4684 HQ, 18 TFW, APO 239
4685 6512 TEST GP, EDWARDS AFB, CA
4686 1369 PINTO SQ, VANDENBERG AFB, CA
4687 ASD, EDWARDS AFB, CA
4688 1095 SUP SQ, BOSSIER AFB, LA
4689 728 ACW SQ, NELLIS AFB, NV
4690 4728 DET, CANNON AFB, NM
4691 1369 PHOTO SQ, VANDENBERG AFB, CA
4692 HQ, ORLANDO AFB, FL
4693 6550 OPNS GP, PATRICK AFB, FL
4694* 129 ACW SQ, DOBBINS AFB, GA
4695 3206 DRONE SQ, ELGIN AFB, FL
4696 1365 PHOTO SQ, WESTOVER AFB, MA
4697 1352 PHOTO GP, LOOKOUT MTN, CA
4698 6515 FMS, EDWARDS AFB, CA
4699 APOC, ELGIN AFB, FL
4700* HQ, KIRTLAND AFB, NM
4701 HQ, LACKLAND AFB, TX8
4702 6313 AB WG, APO 239
4703 AIR UNV, MAXWELL AFB, AL
4704 CMBT DEF SQ, C SHERMAN AFB, OK
4705 56 WRS, APO 328
4706 DET 6 9 WRS, MALMSTROM AFB, MT
4707 HQ, BIGGS AFB, TX
4708 4080 SW, LAUGHLIN AFB, TX
4709 4780 SUP SQ, PERRIN AFB, TX
4710 HQ, ENT AFB, CO
4711 HQ, CARSWELL AFB, TX

4712 HQ, ITAZUKE AFB, JAPAN
4713* CAFB, LA
4714* HQ, TYNDALL AFB, FL
4715 HQ, RICHARDS GEBAUER AFB, MO
4716* HQ, LITTLEROCK AFB, AR
8000 HQ, JTF 8, BARTON HALL, WASHINGTON, DC
8001 VIPS
8002 UNITED KINGDOM
8004 HQ, DASA, WASHINGTON, DC
8005 USPHS, WASHINGTON, DC
8006 FLD COMD, DASA, SANDIA BASE, NM
8007 HQ, AFSWC, KIRTLAND AFB, NM
8008 FCWET, SANDIA BASE, NM
8009 OSD ARPA, PENTAGON, WASHINGTON, DC
8010* OCE DA, WASHINGTON, DC
8110 LOS ALAMOS
8120 LRL
8130 FCWET DASA
8140 SANDIA
8150 SSD
8160 RG&G
8200 USA CMLC RADL UNIT, DUGWAY, UT
8201 HQ, USA CMLCTNGCOM, FT MC CLELLAN, AL
8202 USASRDL, FT MONMOUTH, NJ
8203 497 ENG CO PC, FT BELVOIR, VA
8204* HQ, USARJ, APO 34
8205 USA TRIPLER GEN HOSP, APO 438
8206 524 MP CO, APO 958
8207* 4 MP CO, FT MEYER, VA
8208 USA DENTAL CLINIC, APO 957
8209 HQ, 14 INF, APO 25
8210 25 AVN CO., APO 25
8211 81 TRANS CO, APO 25
8212 HAW ARMY AIRFORCE EX, APO 958
8213* DET 6 USACA, FT LEAVENWORTH, KS
8214 UNITED SERVICE ORGANIZATION
8215 STARCOM, APO 958
8216 USACA, FT DETRICK, MD
8217 125 SIG BN, APO 25
8218 27 INF BG, APO 25
8219 USAIS PRESIDIO OF MONTERRY, CA
8220 MADIGEN GEN HOSP, TACOMA, WA
8221 HQ, CO JCA, FT RITCHIE, MD
8222 MTL DISP OFF, CAMP ZAMA, APO 343
8223 USAG, FT SHAFTER, APO HAWAII
8224 USAG, SCHOFIELD BKS, APO 25
8225 HQ 6 USA, PRESIDIO, CA
8226 USAG, FT LEWIS, WA
8227 WHITE SANDS MISSILE RANGE, NM
8228 USAH, FT ORD, CA
8229 USASCSA, ARLINGTON, VA
8230 USASCC, FT DETRICK, MD
8231 USA DATA ANLYSIS GP, WASHINGTON, DC
8232 2 ENG BN, FT BELVOIR, VA
8233 HQ, USAITCT, FT BENNING, GA
8234 106 GEN HOSP, EL PASO, TX
8235 WALTER REED GEN HOSP, WASHINGTON, DC
8236 HQ, USARPAC, FT SHAFTER, HI
8237* 545 TRANS DET, APO 25
8238 595 SIG CO, FT MONMOUTH, NJ
8239 USAMS FE, APO 67
8240 USA CHAPLAIN BO, FT MEADE, MD
8241 518 ENG DET, FT BELVOIR, VA
8242 PMGS, FT, GORDON, GA
8243* 922 TRANS CO, APO 25
8244 51 SIG BN, APO 358
8245* 25 MED BN, APO 25
8246 43 MED GP, FT LEWIS, WA
8247 HQ 4 USA, FT SAM HOUSTON, TX
8248 HQ, USARHAW, APO 25
8249 USARS, FT BELVOIR, VA
8250 HQ, FT BLISS, TX
8251 USAG, FT LEWIS, WA
8252 HQ, 4 TNG BRGT, FT DIX, NJ
8253 725 ORD BN, APO 25
8254 STR, FT GORDON, GA
8255 52 ARTY, FT BLISS, TX
8256 HQ, USARSLRSA, REDSTONE, AL
8257 USA CML CENTER, MD
8258 200 ORD DET, FT BLISS, TX
8259 901 CIC DET, SANDIA BASE, NM
8260 HQ, 5 TNG BRGT, FT DIX, NJ
8261 791 MP CO, REDSTONE ARS, AL
8262 HQ, PICTINNY ARSENAL, NJ
8263 TAGSUSA, FT BENJAMIN HARRISON, IN
8264 USAACG, WASHINGTON, DC
8265 USASCG, FT BRAGG, SC
8266 USAG, APO 105
8267 USARJ
8268 OAKLAND ARMY TERMINAL, CA
8269 USAG, FT BELVOIR, VA
8270 USASCG, FT MEYER, VA
8271 3 RECON, APO 25
8272 HQ, FT, DIX, NJ
8273 2 MSL BN, FT BLISS, TX
8274 65 ENG BN, APO 25
8275 USCC, WEST POINT, NY
8276 SUP MAIN CEN, APO 958
8277 STAFF AND FAC, FT SILL, OK
8278 HQ, SPTRPS, FT MONMOUTH, NJ
8279* FAC CO, FT DIX, NJ
8280 HQ 82 ABN DIV, FT BRAGG, NM
8281 1 TRNG BRGT, FT JACKSON, SC
8282 79 ENG BN, FT BELVOIR, VA
8283 151 ENG GP, FT BENNING, GA
8284 USASRPA, FT MONMOUTH, NJ
8285 USAG, SANDIA BASE, NM
8286 HQ, ABERDEEN PVG GD, MD
8287 999 SIG CO, OKINAWA
8288 HQ, KILLEEN BASE, TX
8289 PUEBLO ORD DEP, PUEBLO, CO
8290 HQ 3 USA, FT MC PHERSON, GA
8291 999 SIG SPT CO, APO 25
8292 20 ARTY, APO 24
8300 HEADQUARTERS, TG 8.3
8301 ACR 1 DIVISION, DET Z
8302 1CU DIVISION 13, DET 8
8303 USNS PVT F J PETRARCA T AK 250
8304 JTF 8.3.9.7
8305 USS CONSERVER ARS 39

8306 USS HALSEY POWELL DD 686
8307 USS MUNCIE ATF 107
8308 ARC 1 USNAB CORONADO, CA
8309 USS CARTILHO LSD 16
8310 USS MARSHALL DD 676
8311 USS POWHATOULA AO 148
8312 VP 872
8313 USS MOCTORI ATF 105
8314 USS NORTON SOUND AVM 1
8315 USS ARIKARA ATF 98
8316 USS YORKTOWN CVS 10
8317 USS SIOUX ATF 75
8318 USS RAZORBACK SS 394
8319 USS MOLALA ATF 106
8320 VAP 62 DET 35
8321 USS CREE ATF 84
8322 VR 46 NAS NORIS
8323 USS RAUSEL DD 845
8324 COMMANDER DESTROYER SQDN 7
8325 USS POLK COUNTY LST 1084
8326 USS PAGE COUNTY LST 1076
8327 USNS ALATNA T ADG 81
8328 USS JEROME COUNTY
8329 USNOL WHITE OAK SILVR SPRGS MD
8330 NRDL ARC
8331 USS RICHARD B ANDERSON DD 786
8332 USS HOPEWELL DD 681
8333 USS ALGRIMOM DD 826
8334 USC & GSS PIONEER OSS 31
8335 USS GANNET MSC 290
8336 USS CARRONERO SS 337
8337 USS IWO JIMA LPH 2
8338 USS SAMUEL N MOORE DD 747
8339 USS MADDOX DD 731
8340 USS BRUSH DD 745
8341 USS PRESTON DD 795
8342 USS CHIPPUNG AO 30
8343 USS FORT MARION LSD 22
8344 USS AMERICAN MARINER
8345 USS HASCAYAMPA AO 145
8346* CTF 8.3.7.2
8347 8.3.9.6
8348 USS FINCH DER 328
8349 USS TAKELMA ATF 113
8350 USS RECLAIMER ARS 42
8351 USS TOLOVANA
8352 USS FORSTER DER 334
8353 USS SOUTHERLAND DD 743
8354 USS SNOHOMISH COUNTY LST 1126
8355 USS MONTICELLO LSD 35
8356 USS GRAPPLE ARS 7
8357 USS LOYALTY MSO 457
8358 USS MATACO ATF 86
8359 USS OAK HILL LSD 7
8360 USS DD HANNAN DDR 450
8361 COMMANDER FLWRT AIR WING 2
8362 CTU 8.3 9
3363 USS LIPAN ATF 85
8364 HMM 364
8365 VP 26 NAVY 14
8366 USS JOHN S. MC CAIN DL 3
8367 ARMD SQDN PACIFIC NAVY 14
8368 USS TAWAKONI ATF 114
8369 USS MENDRIGAL SS 480
8370 USS MEWELL DER 322
8371 USS FALGOUT DER 324
8372 USS CHICKASAW ATF 83
8373 USS ROWAN DD 782
8374 USS CHIPOLA AO 63
8375 USS PRINCETON LPH 5
8376 USS SUMMIT CTY LST 1146
8377* VP 17
8378 USS LANSING DER 388
8379 USS HITCHITI ATF 103
8380 HARRIS CTY LST 822
8381 USS SAFEGUARD
8382 PT BARROW TAKD 1
8383 IMPERVIOUS MSO 499
8384 ENGAGE MSO 433
8385 FORTIFY MSO 446
8386 TAYLOR DD 468
8387 HENRY CTY LST 824
8388* USNS SUNNYVALE
8389* USNS LONG VIEW
8390 CMDG OFF VP 9
8391 USS WALKER DDG517 FPO, S FRAN, CA
8392 TUSCUMBIA YTR 762
8393 USS ARNAKI ATF 96
8394 USNS RANGE TRACKER
8395 VP 6
8396 USS GURKE DD 783
8397* USS GRAY?
8398* USS JENKINS
8399* USS DURANT
8500 HOLMES & NARVER
8590 SCRIPPS
8591* WESTERN ELECTRIC, SAN LEANDRO, CA
8592* WESTINGHOUSE
8593* UNIVERSITY OF WASHINGTON
8594* BUREAU OF COMMERCIAL FISHERIES, HI
8600 USCG LORAN STA, JOHNSTON ISLAND
8601 PRO AERONUTRONIC, NEWPORT BEACH, CA
8602 DOUG ACFT CO, SANTA MONICA, CA
8603 CUBIC CORP, SAN DIEGO, CA
8604* FINTEL CO
8605 LTL, GREENSBORO, SC
8606 IBM, HONOLULU, HI
8607 GEN ELEC CO, PHILADELPHIA, PA
8608 RCA CORP, CHERRYHILL, NJ
8609 SID ELEC CORP, PT HUENEME, CA
8610 BELL TEL LAB, NJ
8611 MILGO ELEC, MIAMI, FL
8612 VITRON CORP, MINNEAPOLIS, MN
8613 SYLVANIA CORP, BUFFALO, NY
8614 BENDIX RADIO, BALTIMORE, MD
8615 ROCKETDYNE, LOS ANGELES, CA
8616 AC SPARK PLUG, MILWAUKEE, WI
8617* T H DAVIES CO, HONOLULU, HI
8618 COLLINS RADIO, DALLAS, TX
8619 U S CUSTOMS, HONOLULU, HI

8620 TRLR SIG CO, HICKSVILLE, NY
8621 PHILCO CORP, PHILADELPHIA, PA
8622 ONAN STUDEBAKER CO
8623 STANFORD RES INST, MENLO PARK, CA
8624 KRELINE INST CORP, SANTE FE, NM
8625 U S WEA BUR, WASHINGTON, DC
8626 WESTINGHOUSE ELEC, LOS ANGELES, CA
8627 VARIAN ASSOC, PALO ALTO, CA
8628 SWEINHART ELEC CO
8629 RAYTHEON CORP, FALMOUTH, MA
8630* STATE HLTH DEPT, HONOLULU, HI
8631 AEROSPACE RES, NEWTON, MA
8632 MIT LINCOLN LAB, LEXINGTON, MA
8633 MARQUARDT
8634 ELECTRO OPT SYS, PASADENA, CA
8635 AEROJET GEN, AZUSA, CA
8636 AMER SCI AND ENG, CAMBRIDGE, MA
8637 NMSU PSL, UNIVERSITY PARK, NM
8638 CCA, BOSTON, MA
8639 TECHOPS, BURLINGTON, MA
8640 ATLANTIC RES CORP, EL MONTE, CA
8641 RDI, MT VIEW, CA
8642 CONT EQP CORP APCRL, BEDFORD, MA
8643 HUGHES ACFT CO, CULVER CITY, CA
8644 AERO LAB, PASADENA, CA
8645 THE MITRE CORP, BEDFORD, MA
8646 BELL AND HOWELL, PASADENA, CA
8647 GEOPHYSICS CORP, BEDFORD, MA
8648 UNIV OF UTAH, SALT LAKE CITY, UT
8649 AVCO CORP, WILMINGTON, MA
8650 ELEC ASSOC INC, SAN JOSE, CA
8651 NORTHRUP VENTURA, VAN NUYS, CA
8652 NBS ERPL, BOULDER, CO
8653 SCHIMMELMAN ENG CO, SANTA ANA, CA
8654 ZIMMKY CORP, MONROVIA, CA
8655 POLYTECHNIC ENG CO, SLVR SPNGS, MD
8656 ARACON LABS, CONCORD, MA
8657 ALLIED RES ASSO, BOSTON, MA
8658 KAMAN NUC, COLORADO SPRINGS, CO
8659* TECHNICLO
8660 GENERAL DYNAMICS, SAN DIEGO, CA
8661 ELEC COMM INC, ST PETERSBURG, FL
8662 ADCOLE CORP, CAMBRIDGE, MA
8663 COHO ELEC, SAN DIEGO, CA
8664 ARMOUR RESEARCH, CHICAGO, IL
8665 MATRIX R D CORP, NASHAU, NH
8666 COLUMBIA UNIV, NEW YORK, NY
8667 COOK ELEC CO, MORTON GROVE, IL
8668 WENTWORTH INST, BOSTON, MA
8669 COMSTOCK WESCOTT, CAMBRIDGE, MA
8670 GT SCHJELDAHL CO, NORTHFIELD, MN
8671 UNIV OF WASH, SEATTLE, WA
8672 US BUR COMM FISHERIES, WASHINGTON, DC
8673 SCRIPPS INST, LA JOLLA, CA
8674 WESTERN ELEC CO, 220 CHURCH, NY ,NY
8675 APCRL OKLA STATE UNIV, OKLA
8676 UNIV OF DAYTON, OH
8677 UNIVAC, SAN DIEGO, CA
8678 ARL, CUMBERLAND, MD
8679 A & M CORP, HONOLULU, HI
8680 BARNES ENG CO, STANFORD, CT
8681* MATHIASEN TANKER, PHILADELPHIA, PP
8682* HAW TESTING CO, HONOLULU, HI
8683* STROMBERG CARLSON
8900 UNIDENTIFIABLE
9000 GILBERT & ELLIS IS COL GOV & XMAS PLANT

APPENDIX C

TERMS, ABBREVIATIONS, ACRONYMS, AND UNITS

Many of the definitions in this glossary relating to nuclear device and radiation phenomena have been quoted or extracted from The Effects of Nuclear Weapons (3rd edition), S. Glasstone and P.J. Dolan, 1977.

AACS. Airways and Air Communication Service (Air Force).

AAU. Administrative Area Unit (Army).

ACC. Army Chemical Center, Edgewood Arsenal, Maryland.

accelerometer. An instrument for determining the acceleration of the system with which it moves.

AD. Destroyer tender (Navy).

AEC. Atomic Energy Commission, Washington, D.C. Independent agency of the federal government with statutory responsibilities for atomic energy matters. No longer exists; its functions have been assumed by the Department of Energy and the Nuclear Regulatory Commission.

AF. Store ship (Navy); also Air Force.

AFB. Air Force Base.

AFCRC. Air Force Cambridge Research Center.

AFDL. Small floating dry dock.

AFSWC. Air Force Special Weapons Center, Kirtland AFB, New Mexico.

AFSWP. Armed Forces Special Weapons Project.

AGC. Amphibious force flagship, later LCC (Navy).

airburst. The detonation of a nuclear device in the air at a height such that the expanding fireball does not touch the Earth's surface when the luminosity (emission of light) is at a maximum.

air particle trajectory. The direction, velocity, and rate of descent of windblown radioactive particles.

AK. Cargo ship.

AKA. Attack cargo ship, later LKA (Navy).

allowable dose. See MPL.

alpha emitter. A radionuclide that undergoes transformation by alpha-particle emission.

alpha particle. A charged particle emitted spontaneously from the nuclei of some radioactive elements. It is identical with a helium nucleus, having a mass of 4 units and an electric charge of 2 positive units. See also radioactivity.

alpha rays. A stream of alpha particles. Loosely, a synonym for alpha particles.

AMN. Airman; enlisted Air Force personnel.

AMS. Army Map Service, Washington, D.C.

AN/PDR-39. An ion-chamber-type survey meter; this was the standard radsafe meter. Others in use included the Navy version, the AN/PDR-T1B, the AN/PDR-18A and -18B, and lower-range Geiger-Mueller instruments (AN/PDR-27, Beckman MX-5, and Nuclear Corporation 2610). Other radiac devices were also used.

AO. Oiler (Navy).

AOC. Air Operations Center.

AOG. Gasoline tanker (Navy).

AP. Transport ship (Navy).

APO. Army Post Office.

APD. High-speed transport ship (Navy).

APG. Aberdeen Proving Ground, Maryland.

ARA. Allied Research Associates, Boston, Massachusetts.

arming. The changing of a nuclear device from a safe condition (that is, a condition in which it cannot be accidentally detonated) to a state of readiness for detonation.

ARS. Salvage ship (Navy); also Air Rescue Service (Air Force).

ARSD. Salvage lifting ship (Navy).

ASA. Army Security Agency.

ATA. Auxiliary ocean tug (Navy).

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ATF. Fleet ocean tug (Navy).

atoll. A ring of coral reefs, usually with small islets, that surrounds a lagoon. Most are isolated reefs rising from the deep sea that have built up on submerged volcanoes. They vary considerably in size; the largest atoll, Kwajalein in the Marshall Islands, has an irregular shape that extends for 84 miles (135 km). See also coral reef.

atomic bomb (or weapon). A term sometimes applied to a nuclear weapon utilizing fission energy only. See also fission, nuclear device.

atomic explosion. See nuclear explosion.

attenuation. The process by which radiation is reduced in intensity when passing through some material. It is due to absorption or scattering or both, but it excludes the decrease of intensity with distance from the source (inverse square law, which see).

AU. Army Unit.

AV. Seaplane tender (Navy).

AVR. Aircraft rescue vessel (Navy).

AW. Distilling ship (Navy).

B-29. A 4-engine, propeller-driven bomber developed by Boeing, used for weather reconnaissance, cloud tracking, aerial sampling and photography, and aerial refueling at the EPG. These versions designated PB-29, WB-29, and KB-29.

B-50. A 4-engine bomber developed by Boeing, with some features like those of the B-29, but having a taller tail fin and larger engines and nacelles.

B-52. Eight-engine English Electric Canberra bomber used as cloud-sampling aircraft.

B-57. U.S. version of English Electric Canberra bomber used as cloud-sampling aircraft.

background radiation. The radiation of man's natural environment, consisting of that which comes from cosmic rays and from the naturally radioactive elements of the Earth, including that from within man's body. The term may also mean radiation extraneous to an experiment.

base surge. The particulate dust cloud that rolls out from the bottom of the cloud column produced by the detonation of a nuclear device. For underwater bursts, the base surge is a cloud of water droplets, and the flowing properties are those of a homogeneous liquid.

bathythermograph. A device for obtaining a record of temperature with depth in the upper 1,000 feet (300 meters) of the ocean, from a ship underway.

becquerel (Bq). See curie.

beta burns. Beta particles that come into contact with the skin and remain for an appreciable time can cause a form of radiation injury sometimes referred to as "beta burn." In an area of extensive early fallout, the whole surface of the body may be exposed to beta particles.

beta emitter. A radionuclide that disintegrates by beta particle emission. All beta-active elements existing in nature expel negative particles, i.e., electrons or, more exactly, negatrons. Beta-emitting particles are harmful if inhaled or ingested or remain on the skin.

beta particle (ray). A charged particle of very small mass emitted spontaneously from the nuclei of certain radioactive elements. Most, if not all, of the direct fission products emit negative beta particles (negatrons). Physically, the beta particle is identical to an electron moving at high velocity.

bhangmeter. A device that measures bomb yield based on light generated by the explosion.

blast. The detonation of a nuclear device, like the detonation of a high explosive such as TNT, results in the sudden formation of a pressure or shock wave, called a blast wave in the air and a shock wave when the energy is imparted to water or earth.

blast wave. An air pulse in which the pressure increases sharply at the front followed by winds propagated from an explosion.

blast yield. That portion of the total energy of a nuclear explosion that manifests itself as blast and shock waves.

bomb debris. See weapon debris.

BRL. Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland (Army).

BuAer. Bureau of Aeronautics (Navy).

BuMed. Bureau of Medicine and Surgery (Navy).

burst. Explosion; or detonation. See also airburst, high-altitude burst, surface burst.

BuShips. Bureau of Ships (Navy).

C-47. A twin-engine transport aircraft manufactured by Douglas Aircraft Company (Air Force version of the DC-3).

C-54. A 4-engine military cargo and personnel transport manufactured by Douglas Aircraft Company (Air Force version of the DC-4).

cab. The shelter that covers a nuclear device being prepared for test. May be located on a tower, on the Earth's surface, or on a barge.

Canberra. An RAF twin-turbojet, all-weather, tactical bomber developed by English Electric. Also built in the United States and used by the Air Force as the B-57.

cathode-ray tube. A vacuum tube in which cathode rays (electrons) are beamed upon a fluorescent screen to produce a luminous image. The character of this image is related to, and controlled by, one or more electrical signals applied to the cathode-ray beam as input information. The tubes are used in measuring instruments such as oscilloscopes and in radar and television displays.

cave. A heavily shielded enclosure in which radioactive materials can be remotely manipulated to avoid radiation exposure of personnel.

CDC. Center for Disease Control.

Ci; c. Abbreviation for curie, which see. Ci is preferred now but c was the abbreviation used in the 1960s.

CIC. Counter-Intelligence Corps (Army). Combat Information Center (Navy).

CINCPAC. Commander-in-Chief, Pacific.

CJTF 8. Commander, Joint Task Force 8.

cloud chamber effect. See Wilson cloud.

cloud column (funnel). The visible column of weapon debris (and possibly dust or water droplets) extending upward from the point of a nuclear burst.

cloud phenomena. See fallout, fireball, radioactive cloud.

CNO. Chief of Naval Operations.

collimate. To align nuclear weapon radiant outputs within an assigned solid angle through the use of baffles in order to enhance measurements.

Co. Chemical symbol for cobalt.

cobalt. Metallic element with radionuclide ^{60}Co used as calibration source for gamma instruments.

ComAirPac. Commander Naval Air Force Pacific (Navy).

ComServPac. Commander Service Forces Pacific (Navy).

Condition "Purple". See Purple conditions.

Consolidated List. Consolidated List of Radiological Exposures. The list that covers all recorded individual radiological exposures for joint task force participants.

contamination. The deposit of radioactive material on the surfaces of structures, areas, objects, and personnel following a nuclear detonation. This material generally consists of fallout in which fission products and other device debris have become incorporated with particles of dust, vaporized components of device platforms, etc. Contamination can also arise from the radioactivity induced in certain substances by the action of neutrons from a nuclear explosion. See also decontamination, fallout, weapon debris.

coracle. A small circular craft that was moored and instrumented to measure gamma radiation from the underwater shot, SWORDFISH.

coral reef. A complex ecological association of bottom-living and attached shelled marine animal fossils that form fringing reefs, barrier reefs, and atolls. The lagoons of barrier reefs and atolls are important places for the deposition of fine-grained calcium carbonate mud.

CPM. Counts per minute, a measure of radioactive material disintegration.

crater. The depression formed in the surface of the Earth by a surface or underground explosion. Crater formation can occur by vaporization of the surface material, by the scouring effect of airblast, by throwout of disturbed material, or by subsidence.

CRL. Chemical Research Laboratory (Army).

Cs. Chemical symbol for cesium.

C/S. Chief of Staff.

CTG. Commander Task Group.

curie (Ci). A unit of radioactivity; it is the activity of a quantity or any radioactive species in which 3.700×10^{10} (37 billion) nuclear disintegrations occur per second (approximately the radioactivity of 1 gram of radium). The gamma curie is sometimes defined correspondingly as the activity of material in which this number of gamma-ray photons is emitted per second. This unit is being replaced by the becquerel (Bq), which is equal to one disintegration per second.

cutie pie. The CP-30M portable beta-gamma survey meter using an ionization chamber as the detector volume to measure radiation exposure. Usually used at higher radiation levels for both detecting and measuring ionizing radiation. A removable end-cap acts as a shield for the detector, allowing the instrument to indicate combined beta and gamma radiation when the cap is removed, or gamma radiation only when the cap is in place.

CVE. Escort aircraft carrier (Navy).

CW net. Carrier wave network. An organization of stations capable of direct radio communications on a common channel or frequency.

dan buoy. A floating temporary marker buoy such as one used in minesweeping and antisubmarine warfare operations.

D-day. The term used to designate the unnamed day on which a test takes place. The equivalent

rule applies to H-hour. Time in plans is indicated by a letter that shows the unit of time employed in figures, with a minus or plus sign to indicate the amount of time before or after the reference event, e.g., D+7 means 7 days after D-day, H+2 means 2 hours after H-hour.

DDE. Escort destroyer (Navy).

DE. Destroyer escort (Navy).

debris (radioactive). See weapon debris.

decay (radioactive). The decrease in activity of any radioactive material with the passage of time due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, sometimes accompanied by gamma radiation, or by gamma photons alone. Every decay process has a definite half-life.

decontamination. The reduction or removal of contaminating radioactive material from a structure, area, object, or person. Decontamination may be accomplished by (1) treating the surface to remove or decrease the contamination; (2) letting the material stand so that the radioactivity is decreased as a result of natural decay; and (3) covering the contamination in order to attenuate the radiation emitted.

device. Nuclear fission and fusion materials, together with their arming, fuzing, firing, chemical-explosive components, that have not reached the development status of an operational weapon.

diagnostic measurements or experiments. Experiments whose purpose is to study the explosive disassembly of a nuclear detonation (as opposed to effects measurements, which see).

DM. Minelayer destroyer (Navy). Converted destroyers designed to conduct high-speed minelaying operations.

DMA. The Division of Military Applications of the Atomic Energy Commission.

DOD. Department of Defense. The Federal executive agency responsible for the defense of the United States. Includes the four services and special joint defense agencies. Reports to the President through the Secretary of Defense.

DOFL. Diamond Ordnance Fuze Laboratory (Army). Later, the U.S. Army Harry Diamond Laboratory.

dose. A general term denoting the quantity of ionizing radiation absorbed. The unit of absorbed dose is the rad (which see). In soft body tissue the absorbed dose in rads is essentially equal to the exposure in roentgens. The biological dose (also called the RBE dose) in rems is a measure of biological effectiveness of the absorbed radiation. Dosage is ... in older literature as well as exposure do and simply exposure, and care should be exercised in their use. See also exposure.

dose rate. As a general rule, the amount of ionizing (or nuclear) radiation that an individual or material would receive per unit of time. It is usually expressed as rads (or rems) per hour or multiples or divisions of these units such as millirads per hour. The dose rate is commonly used to indicate the level of radioactivity in a contaminated area. See survey meter.

dosimeter. An instrument for measuring and registering the total accumulated dose of (or exposure to) ionizing radiation. Instruments worn or carried by individuals are called personnel dosimeters.

dosimetry. The measurement and recording of radiation doses and dose rates. It is concerned with the use of various types of radiation instruments with which measurements are made. See also dosimeter, survey meter.

DPM Disintegrations per minute, a measure of radioactivity, literally atoms disintegrating per minute. Difficult to directly compare with roentgens per hour for mixtures of radionuclides.

droque. A sea anchor or similar drag device used to pull out a parachute.

DTMB. David Taylor Model Basin, Carderock, Maryland (Navy).

DUKW. Two-and-one-half-ton amphibious truck.

dynamic pressure. Air pressure that results from the mass air flow (or wind) behind the shock front of a blast wave.

effects measurements or experiments. Experiments whose purpose is to study what a nuclear explosion does to materials, equipment, and systems. Includes also measurement of the changes in the environment caused by the detonation, such as increased air pressures (blast), thermal and nuclear radiation, cratering, water waves, etc.

EG&G. Edgerton, Germeshausen & Grier, Boston, Massachusetts (now EG&G, Inc.). An AEC contractor. Provided timing and firing electronics and technical film coverage.

electromagnetic radiation. Electromagnetic radiations range from X-rays and gamma rays of short wavelength (high frequency), through the ultraviolet, visible, and infrared regions, to radar and radio waves of relatively long wavelength.

electron. A particle of very small mass and electrically charged. As usually defined, the electron's charge is negative. The term negatron is also used for the negative electron and the positively charged form is called a positron. See also beta particles.

EODU. Explosive Ordnance Disposal Unit (Navy).

ETA. Estimated time of arrival.

ETD. Estimated time of departure.

exposure. A measure expressed in roentgens of the ionization produced by gamma rays (or X-rays) in air. The exposure rate is the exposure per unit time (e.g., roentgens per hour). See dose, dose rate, roentgen.

exposure rate contours. Lines joining points that have the same radiation intensity to define a fallout pattern, represented in terms of roentgens per hour.

fallout. The process or phenomenon of the descent to the Earth's surface of particles contaminated with radioactive material from the radioactive cloud. The term is also applied in a collective sense to the contaminated particulate matter itself. The early (or local) fallout is defined, somewhat arbitrarily, as particles reaching the Earth within 24 hours after a nuclear explosion. The delayed (or worldwide) fallout consists of the smaller particles, which ascend into the upper troposphere and stratosphere and are carried by winds to all parts of the Earth. The delayed fallout is brought to Earth, mainly by rain and snow, over extended periods ranging from months to years.

fathometer. A depth-sounding instrument. The depth of water is measured by noting the time the echo of a sound takes to return from the bottom.

FEAF. Far East Air Forces.

film badges. Used for the indirect measurement of ionizing radiation. Generally contain two or three pieces of film of different radiation sensitivities. They are wrapped in paper (or other thin material) that blocks light but is readily penetrated by gamma rays. The films are developed and the degree of fogging (or blackening) observed is a measure of the gamma-ray exposure, from which the absorbed dose is calculated. Film badges can also measure beta and neutron radiation.

fireball. The luminous sphere of hot gases that forms a few millionths of a second after a nuclear explosion as the result of the absorption by the surrounding medium of the thermal X-rays emitted by the extremely hot (several tens of millions of degrees) device residues. The exterior of the fireball in air is initially sharply defined by the luminous shock front and later by the limits of the hot gases themselves.

fission. The process of the nucleus of a particular heavy element splitting into two nuclei of lighter elements, with the release of substantial amounts of energy. The most important fissionable materials are uranium-235 and plutonium-239; fission is caused by the absorption of neutrons.

fission detectors. Radiation pulse detector of the proportional counter type in which a foil or film of fissionable materials is incorporated to make it respond to neutrons.

fission products. A general term for the complex mixture of substances produced as a result of nuclear fission. A distinction should be made between these and the direct fission products or fission fragments that are formed by the actual splitting of the heavy-element nuclei into nuclei of medium atomic weight. Approximately 80 different fission fragments result from roughly 40 different modes of fission of a given nuclear species (e.g., uranium-235 or plutonium-239). The fission fragments, being radioactive, immediately begin to decay, forming additional (daughter) products, with the result that the complex mixture of fission products so formed contains over 300 different radionuclides of 36 elements.

fixed alpha. Alpha radioactivity that cannot be easily removed as evidenced by no measured change in a swipe of a 100-cm^2 area.

fluorescence. The emission of light (electromagnetic radiation) by a material as a result of the absorption of energy from radiation. The term may refer to the radiation emitted, as well as to the emission process.

FPO. Fleet Post Office (Navy).

fusion. The combination of two light nuclei to form a heavier nucleus, with the release of the difference of the nuclear binding energy of the fusion products and the sum of the binding energies of the two light nuclei.

gamma rays. Electromagnetic radiations of high photon energy originating in atomic nuclei and accompanying many nuclear reactions (e.g., fission, radioactivity, and neutron capture). Physically, gamma rays are identical with X-rays of high energy; the only essential difference is that X-rays do not originate from atomic nuclei of high energy. Gamma rays can travel great distances through air and can penetrate considerable thickness of material, although they can neither be seen nor felt by human beings except at very high intensities, which causes an itching and tingling sensation of the skin. They can produce harmful effects even at a long distance from their source (The Effects of Nuclear Weapons, 3rd edition).

Geiger-Mueller (GM) counter. A gas discharge pulse counter for ionizing radiation. See also AN/PDR-39 and ion-chamber-type survey meter.

GMT. Greenwich Mean Time.

gray (Gy). A recently introduced ICRP term; 1 Gy equals 100 rad.

ground zero. See surface zero.

gunk. A viscous commercial preparation that is soluble both in water and petroleum de ivatives. It acts as a wetting agent in removing

grease and particulate matter from metal and other nonporous surfaces.

H-21. Large utility helicopter.

H-hour. Time zero, or time of detonation. When used in connection with planning operations it is the specific hour on which the operation event commences. See D-day.

half-life. The time required for a radioactive material to lose half of its radioactivity due to decay. Each radionuclide has a unique half-life.

HE. High explosive.

HF. High-frequency radio communications. The HF band is from 3 to 30 kHz.

high-altitude burst. Defined, somewhat arbitrarily, as a detonation in or above the stratosphere. The distribution of the energy of the explosion between blast and thermal radiation changes appreciably with increasing altitude.

HMR. Marine Helicopter Transport Squadron.

hodograph. A common hodograph in meteorology represents the speed and direction of winds at different altitude increments.

HO. Navy Hydrographic Office.

hot; hot spot. Commonly used colloquial term meaning a spot or area relatively more radioactive than some adjacent area.

HRS-2. Transport helicopter manufactured by Sikorsky Aircraft Company.

IBDA. Indirect Bomb Damage Assessment. A revised target analysis based on new data such as actual weapon yield, burst height, and surface zero obtained by means other than direct assessment.

ICRP. International Commission on Radiological Protection.

initial radiation. Electromagnetic radiations of high energy emitted from both the fireball and the radioactive cloud within the first minute after a detonation. It includes neutrons and gamma rays given off almost instantaneously, as well as the gamma rays emitted by the fission products and other radioactive species in the rising cloud. Initial radiations from ground or near-ground bursts activate both earth materials and device debris to create contamination.

inverse square law. The decrease in radiation intensity with distance from a single-point source is in proportion to the square of the distance removed.

ion-chamber-type survey meter. A device for measuring the amount of ionizing radiation. Consists of a gas-filled chamber containing two electrodes (one of which may be the chamber wall) between which a potential difference is maintained. The radiation ionizes gas in the chamber and an instrument connected to one electrode measures the ionization current produced.

ionization. The process of adding electrons to, or knocking electrons from, atoms or molecules, thereby creating ions. High temperatures, electrical discharges, and nuclear radiation can cause ionization.

ionizing radiation. Any particulate or electromagnetic radiation capable of producing ions, directly or indirectly, in its passage through matter. Alpha and beta particles produce ion pairs directly, while gamma rays and X-rays liberate electrons as they traverse matter, which in turn produce ionization in their paths.

ionosphere. The region of the atmosphere, extending from roughly 40 to 250 miles (64 to 400 km) above the Earth, in which there is appreciable ionization. The presence of charged particles in this region profoundly affects the propagation of radio and radar waves.

irradiation. Exposure of matter to radiation.

isodose lines. Dose or dose-rate contours. In fallout, contours plotted on a radiation field within which the dose rate or the total accumulated dose is the same.

isotope. Atoms with the same atomic number (same chemical element) but different atomic weight; i.e., the nuclei have the same number of protons but a different number of neutrons.

JCS. Joint Chiefs of Staff.

JTF 8. Joint Task Force 8 was a combined force of personnel of the Department of Defense (Air Force, Army, Marine Corps, Navy), the AEC, and their contractors. JTF 8 was responsible for all aspects of nuclear weapon tests in the Pacific testing area during 1962.

kiloton convention. Relates nuclear explosion energy to TNT explosion energy by using the approximate energy release of 1,000 tons of TNT as the measuring unit.

kinetic energy. Energy associated with the motion of matter.

LASL. Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

LCM. Mechanized landing craft (Navy).

LCP(L). Personnel landing craft, large (Navy).

LCP(R). Personnel landing craft, ramp (Navy).

LCT. Tank landing craft (Navy).

LCU. Utility landing craft (Navy).

LML. Lookout Mountain Laboratory, Hollywood, California (Air Force).

LRL. Livermore Radiation Laboratory of the Unisity of California.

Loran. Long-range aid to navigation system. Loran stations were maintained by the U.S. Coast Guard Station on Enewetak Island and Johnston Atoll.

LSD. Landing ship, duck.

LSIL. Landing ship, infantry (large).

LST. Landing ship, tank.

magnetometer. An instrument for measuring changes in the geomagnetic field.

MATS. Military Air Transport Service; later, Military Airlift.

megaton (energy). Approximately the amount of energy that would be released by the explosion of one million tons of TNT.

microcurie. One-millionth of a curie.

micron. One-millionth of a meter (i.e., 10^{-6} meter or 10^{-4} centimeter); it is roughly four one-hundred-thousandths (4×10^{-5}) of an inch.

milliroentgen. One-thousandth of a roentgen.

MPL. Maximum Permissible Limit. That amount of radioactive material in air, water, foodstuffs, etc. that is established by authorities as the maximum that would not create undue risk to human health.

mR; mr. Abbreviation for milliroentgen

MSTS. Military Sea Transportation Service, (Navy).

mushroom cap. Top of the cloud formed from the fireball of a nuclear detonation.

MV. Motor vessel.

MWB. Motor whale boat.

NAS. Naval Air Station.

NBS. National Bureau of Standards.

NCO. Noncommissioned officer.

NCRP. National Committee on Radiation Protection and Measurements. Before 1956 simply the National Committee on Radiation Protection.

NEL. Naval Electronics Laboratory.

neutron. A neutral elementary particle (i.e., with neutral electrical charge) of approximately unit mass (i.e., the mass of a proton) that is present in all atomic nuclei, except those of ordinary (light) hydrogen. Neutrons are required to initiate the fission process, and large numbers of neutrons are produced by both fission and fusion reactions in nuclear explosions.

neutron flux. The intensity of neutron radiation. It is expressed as the number of neutrons passing through 1 cm^2 in 1 second.

nmi. Nautical miles.

NPG. Nevada Proving Ground, now the Nevada Test Site (NTS).

NRDL. Naval Radiological Defense Laboratory.

NRL. Naval Research Laboratory.

NSC, TI. Naval Schools Command, Treasure Island, California.

NTPR. Nuclear Test Personnel Review.

NTS. Nevada Test Site.

nuclear cloud. See radioactive cloud.

nuclear device (or weapon or bomb). Any device in which the explosion results from the energy released by reactions involving atomic nuclei, either fission or fusion, or both. Thus, the A- (or atomic) bomb and the H- (or hydrogen) bomb are both nuclear weapons. It would be equally true to call them atomic weapons, since the energy of atomic nuclei is involved in each case. However, it has become more or less customary, although it is not strictly accurate, to refer to weapons in which all the energy results from fission as A-bombs. In order to make a distinction, those weapons in which part of the energy results from thermonuclear (fusion) reactions of the isotopes of hydrogen have been called H-bombs or hydrogen bombs.

nuclear explosion. Explosive release of energy due to the splitting, or joining, of atoms. The explosion is observable by a violent emission of ultraviolet, visible, and infrared (heat) radiation, gamma rays, neutrons, and other particles. This is accompanied by the formation of a fireball. A large part of the energy from the explosion is emitted as blast and shock waves when detonated at the Earth's surface or in the atmosphere. The fireball produces a mushroom-shaped mass of hot gases and debris, the top of which rises rapidly. See also radiation, gamma rays, fireball, nuclear weapon, fission, fusion, blast.

nuclear fusion. See thermonuclear fusion.

nuclear radiation. Particulate and electromagnetic radiation emitted from atomic nuclei in various nuclear processes. The important nuclear radiations, from the weapons standpoint, are alpha and beta particles, gamma rays, and neutrons. All nuclear radiations are ionizing

radiations, but the reverse is not true; X-rays, for example, are included among ionizing radiations, but they are not nuclear radiations since they do not originate from atomic nuclei.

nuclear tests. Tests carried out to supply information required for the design and improvement of nuclear weapons and to study the phenomena and effects associated with nuclear explosions.

nuclide. Any species of atom that exists for a measurable length of time. The term nuclide is used to describe any atomic species distinguished by the composition of its nucleus; i.e., by the number of protons and the number of neutrons. Isotopes of a given element are nuclides having the normal number of protons but different numbers of neutrons in this nuclei. A radionuclide is a radioactive nuclide.

NYKOPO. New York Operations Office (Atomic Energy Commission).

off-scale. Radiation (or other physical phenomena) greater than the capacity of a measuring device to measure.

ONR. Office of Naval Research, Washington, D.C.

ORNL. Oak Ridge National Laboratory, Tennessee.

oscilloscope. The name generally applied to a cathode-ray device.

overpressure. The transient pressure, usually expressed in pounds per square inch, exceeding the ambient pressure, manifested in the shock (or blast) wave from an explosion.

P2V. Twin-engine patrol bomber used for maritime patrol and antisubmarine warfare. Developed by Lockheed for the U.S. Navy. Used in nuclear tests as controller and transient ship search.

PC. Patrol craft (Navy).

peak overpressure. The maximum value of the overpressure (which see) at a given location.

permissible dose. That dose of ionizing radiation that is not expected to cause appreciable bodily injury to a person at any time during his lifetime.

phantom. A volume of material closely approximating the density and effective atomic number of tissue. The phantom absorbs ionizing radiation in the same manner as tissue, thus radiation dose measurements made within the phantom provide a means of approximating the radiation dose within a human or animal body under similar exposure conditions. Materials commonly used for phantoms are water, masonite, pressed wood, plexiglas, and beeswax.

pibal. Pilot balloon observation. A method of winds-aloft observation done by recording the elevation and azimuth of a rising pilot balloon. This tracking is visual using a theodolite.

pig. A heavily shielded container (usually lead) used to ship or store radioactive materials.

POL. Petroleum, oil, and lubricants. The storage area for these products is referred to as a POL farm.

prompt radiation. Neutrons and gamma rays emitted almost instantaneously following a nuclear fission or fusion.

proton. A particle carrying a positive charge and physically identical to the nucleus of the ordinary hydrogen atom.

Purple conditions. A shipboard warning system used in radiological defense. Various numbered conditions were sounded when radioactive fallout was encountered. Responses to the sounded warnings included closing of various hatches and fittings, turning off parts of the ventilation system, and removing personnel from a ship's open decks. The higher the Purple condition number, the more severe the radiological situation.

"Q"-clearance. A security clearance granted by the Atomic Energy Commission, based upon a background investigation.

R; r. Symbol for roentgen.

R5D. Four-engine propeller transport manufactured by the Douglas Aircraft Company for the Navy and the Air Force, where it was designated C-54. Commercial versions were designated DC-4.

Ra. Chemical symbol for radium.

rad. Radiation absorbed dose. A unit of absorbed dose of radiation; it represents the absorption of 100 ergs of ionizing radiation per gram (or 0.01 J/kg) of absorbing material, such as body tissue. This unit is presently being replaced in scientific literature by the Gray (Gy), numerically equal to the absorption of 1 joule of energy per kilogram of matter.

RadDefense. Radiological defense. Defense against the effects of radioactivity from atomic weapons. It includes the detection and measurement of radioactivity, the protection of persons from radioactivity, and decontamination of areas, places, and equipment. See also radsafe.

radex area. Radiological exclusion area. Following each detonation there were areas of surface radiological contamination and areas of air radiological contamination. These areas were designated as radex areas. Radex areas were used to chart actual or predicted fallout and also used for control of entry and exit.

radiac. Radiation detection, indication, and computation.

radiation. The emission of any rays, electromagnetic waves, or particles (e.g., gamma rays, alpha particles, beta particles, neutrons) from a source.

radiation decay. See decay (radioactive).

radiation detectors. Any of a wide variety of materials or instruments that provide a signal when stimulated by the passage of ionizing radiation; the sensitive element in radiation detection instruments. The most widely used media for the detection of ionizing radiation are photographic film and ionization of gases in detectors (e.g., Geiger counters), followed by materials in which radiation induces scintillation.

radiation exposure. Exposure to radiation may be described and modified by a number of terms. The type of radiation is important: alpha and beta particles, neutrons, gamma rays and X-rays, and cosmic radiation. Radiation exposure may be from an external radiation source, such as gamma rays, X-rays, or neutrons, or it may be from radionuclides retained within the body emitting alpha, beta, or gamma radiation. The exposure may result from penetrating or nonpenetrating radiation in relation to its ability to enter and pass through matter -- alpha and beta particles being considered as nonpenetrating and other types of radiation as penetrating. Exposure may be related to a part of the body or to the whole body. See also whole-body irradiation.

radiation intensity. Degree of radiation. Measured and reported in roentgens (R), rads, rems, and rep, multiples and divisions of these units, and multiples and divisions of these units as a function of exposure rate (per hour, day, etc.).

radioactive (or nuclear) cloud. An all-inclusive term for the cloud of hot gases, smoke, dust, and other particulate matter from the weapon itself and from the environment, which is carried aloft in conjunction with the rising fireball produced by the detonation of a nuclear weapon.

radioactive nuclide. See radionuclide.

radioactive particles. See radioactivity.

radioactive pool. A disk-like pool of radioactive water near the surface formed by a water-surface or subsurface detonation. The pool gradually expands into an annular form, then reverts to a larger irregular disk shape at later times with a corresponding attenuation of radioactivity.

radioactivity. The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the nuclei of an (unstable) nuclide. As a result of this emission the radioactive nuclide is converted (decays) into the isotope of a different (daughter) element, which may (or may not) also be radioactive. Ultimately, as a result of one or more stages of radioactive decay, a stable (nonradioactive) end product is formed.

radiological survey. The directed effort to determine the distribution and dose rate of radiation in an area.

radionuclide. A radioactive nuclide (or radioactive atomic species).

radiosonde. A balloon-borne instrument for the simultaneous measurement and transmission of meteorological data, consisting of transducers for the measurement of pressure, temperature, and humidity; a modulator for the conversion of the output of the transducers to a quantity that controls a property of the radiofrequency signal; a selector switch, which determines the sequence in which the parameters are to be transmitted; and a transmitter, which generates the radiofrequency carrier.

radiosonde balloon. A balloon used to carry a radiosonde aloft. These balloons have daytime bursting altitudes of about 80,000 feet (25 km) above sea level. The balloon measures about 5 feet (1.5 meters) in diameter when first inflated and may expand to 20 feet (6 meters) or more before bursting at high altitude.

radium. An intensely radioactive metallic element with the atomic. In nature, radium is found associated with uranium, which decays to radium by a series of alpha and beta emissions. Radium is used as a radiation source for instrument calibration.

radsafe. Radiological safety. General term used to cover the training, operations, and equipment used to protect personnel from potential overexposures to nuclear radiation during nuclear tests.

rainout. Removal of radioactive particles from a nuclear cloud by rain.

rawin. Radar wind sounding tests that determine the winds aloft patterns by radar observation of a balloon.

rawinsonde. Radar wind sounding and radiosonde (combined).

RB-29. Reconnaissance version of the B-29.

RBE. Relative biological effectiveness. A factor used to compare the biological effectiveness of absorbed radiation (i.e., rads) due to different types of radiation. For radiation protection the term has been superseded by Quality Factor.

rem. A special unit of biological radiation dose equivalent; the name is derived from the initial letters of the term "roentgen equivalent man (or mammal)." The number of rems of radiation is equal to the number of rads absorbed

multiplied by the RBE of the given radiation (for a specified effect). The rem is also the unit of dose equivalent, which is equal to the product of the number of rads absorbed multiplied by the Quality Factor and the distribution factor for the radiation. The unit is presently being replaced by the sievert (Sv).

rep. An obsolete special unit of absorbed dose.

residual nuclear radiation. Nuclear radiation, chiefly beta particles and gamma rays, that persists for a time following a nuclear explosion. The radiation is emitted mainly by the fission products and other bomb residues in the fallout, and to some extent by Earth and water constituents, and other materials, in which radioactivity has been induced by the capture of neutrons.

R-hour. Reentry hour.

riometer. Relative ionospheric opacity meter. A device that measures the intensity of cosmic (radiofrequency) noise.

rollup. The process for orderly dismantling of facilities no longer required for nuclear test operations and their transfer to other areas.

roentgen (R; r). A special unit of exposure to gamma (or X-) radiation. It is defined precisely as the quantity of gamma (or X-) rays that will produce electrons (in ion pairs) with a total charge of 2.58×10^{-4} coulomb in 1 kilogram of dry air under standard conditions. An exposure of 1 roentgen results in the deposition of about 94 ergs of energy in 1 gram of soft body tissue. Hence, an exposure of 1 roentgen is approximately equivalent to an absorbed dose of 1 rad in soft tissue.

RSSU. Radiological Safety Support Unit (Army).

SA-16. Air Force general-purpose amphibian for air-sea rescue work. Manufactured by Grumman Aircraft Engineering Corporation, New York. Redesignated UY-16.

SAC. Strategic Air Command (Air Force).

sampler aircraft. Aircraft used for collection of gaseous and particulate samples from nuclear clouds to determine the level of radioactivity or the presence of radioactive substances.

SAR. Search and rescue operations.

SC. Sandia Corporation, Albuquerque, New Mexico.

scattering. The diversion of radiation (thermal, electromagnetic, and nuclear) from its original path as a result of interactions (or collisions) with atoms, molecules, or larger particles in the atmosphere or other media between the source of the radiations (e.g., a nuclear explosion) and a point some distance away. As a result of scattering, radiations (especially gamma rays and neutrons) will be received at such a point from many directions instead of only from the direction of the source. See also skyshine.

SCEL. Signal Corps Engineering Laboratories, Ft. Monmouth, New Jersey (Army).

scintillation. A flash of light produced by ionizing radiation in a fluor or a phosphor, which may be crystal, plastic, gas, or liquid.

seamount. A submarine mountain rising above the deep sea floor, commonly from 3,000 to 10,000 feet (1 to 3 km) and having the summit 1,000 to 6,000 feet (0.3 to 1.8 km) below sea level.

SEL. Signal Engineering Laboratory (Army).

shear (wind). Refers to differences in direction (directional shear) of wind at different altitudes.

shielding. Any material or obstruction that absorbs (or attenuates) radiation and thus tends to protect personnel or equipment from the effects of a nuclear explosion. A moderately thick layer of any opaque material will provide satisfactory shielding from thermal radiation, but a considerable thickness of material of high density may be needed for gamma radiation shielding. See also attenuation.

shock. Term used to describe a destructive force moving in air, water, or Earth caused by detonation of a nuclear detonation.

shock wave. A continuously propagated pressure pulse (or wave) in the surrounding medium, which may be air, water, or earth, initiated by the expansion of the hot gases produced in an explosion.

sievert (Sv). A recently introduced ICRP measure of "dose equivalent" that takes into account the Quality Factor of different sources of ionizing radiation. One sievert equals 100 rem.

SIO. Scripps Institution of Oceanography, La Jolla, California.

skyshine. Radiation, particularly gamma rays from a nuclear detonation, reaching a target from many directions as a result of scattering by the oxygen and nitrogen in the intervening atmosphere.

slant range. The straight-line distance of an aircraft at any altitude from surface zero or the distance from an airburst to a location on the ground.

SRI. Stanford Research Institute, Stanford, California.

stratosphere. Upper portion of the atmosphere, approximately 7 to 40 miles (11 to 64 km) above the Earth's surface, in which temperature changes but little with altitude and cloud formations are rare.

streamline. In meteorology, the direction of the wind at any given time.

surface burst. A nuclear explosion on the land surface, an island surface or reef, or on a barge.

surface zero. The point on the surface of land or water at, or vertically below or above, the center of the burst of a nuclear weapon.

survey meters. Portable radiation detection instruments especially adapted for surveying or inspecting an area to establish the existence and amount of radiation present, usually from the standpoint of radiological protection. Survey instruments are customarily powered by self-contained batteries and are designed to respond quickly and to indicate directly the exposure rate conditions at the point of interest. See AN/PDR-39, Geiger-Mueller counter, and ion-chamber-type survey meter.

survey, radiation. Evaluation of the radiation hazards associated with radioactive materials.

T-AP. Personnel transport (Military Sea Transportion Service).

TAU. Test Aircraft Unit.

TBU. Test Base Unit.

TDY. Temporary duty assignment.

TG. Task Group.

TE. Task Element.

thermal radiation. Electromagnetic radiation emitted in two pulses from a surface or airburst from the fireball as a consequence of its very high temperature; it consists essentially of ultraviolet, visible, and infrared radiation. In the first pulse, when the temperature of the fireball is extremely high, ultraviolet radiation predominates; in the second pulse, the temperatures are lower and most of the thermal radiation lies in the visible and infrared regions of the spectrum.

thermonuclear fusion. Refers to the processes in which very high temperatures are used to bring about the fusion of light nuclei, such as those of the hydrogen isotopes (deuterium and tritium), with the accompanying liberation of energy. The high temperatures required to initiate the fusion reaction are obtained by means of a fission explosion. See also fusion.

TNT equivalent. A measure of the energy released as the result of the detonation of a nuclear device or weapon, expressed in terms of the mass of TNT that would release the same amount of energy when exploded. The TNT equivalent is usually stated in kilotons (thousands of tons) or megatons (millions of tons). The basis of the TNT equivalence is that the explosion of 1 ton of TNT is assumed to release 1 billion calories of energy. See also megaton, yield.

trapped radiation. Electrically charged particles moving back and forth in spirals along the north-south orientation of the Earth's magnetic field between mirror points, called conjugate points. Negatively charged particles drift eastward as they bounce between northern and southern conjugate points and positively charged particles drift westward, thus forming shells or belts of radiation above the Earth. The source of the charged particles may be natural, from solar activity (often called Van Allen belts), or artifical, resulting from high-altitude nuclear detonations.

troposphere. The boundary dividing the stratosphere from the lower part of the atmosphere, the troposphere. The tropopause normally occurs at an altitude of about 25,000 to 45,000 feet (7.6 to 13.7 km) in polar and temperate zones, and at 55,000 feet (16.8 km) in the tropics. See also stratosphere, troposphere.

troposphere. The region of the atmosphere, immediately above the Earth's surface and up to the tropopause, in which the temperature falls fairly regularly with increasing altitude, clouds form, convection is active, and mixing is continuous and more or less complete.

TU. Task Unit.

TSU. Test Services Unit.

TSUP. Test Support Unit (Provisional).

type commander. The officer or agency having cognizance over all Navy ships of a given type. This is in addition to the particular ship's assignment in a task force, fleet, or other tactical subdivision.

UCLA. University of California, Los Angeles.

Uf-1. The Navy designation for the SA-16A.

UHF. Ultra-high frequency.

ultraviolet. Electromagnetic radiation of wavelengths between the shortest visible violet (about 3,650 angstroms) and soft X-rays (about 100 angstroms).

USNS. United States Navy Ship; vessels of this designation are manned by civilian crews.

VA. Veterans' Administration.

VC. Fleet composite squadron, formerly VU (Navy).

versene. A detergent.

VHF. Very-high-frequency radio communications. The VHF band is from 30 to 300 kHz.

VP. Aviation patrol squadron (Navy).

VR. Air transport squadron (Navy).

WADC. Wright Air Development Center, Wright-Patterson AFB, Ohio (Air Force).

warhead. The portion of the missile or bomb containing the nuclear device.

WASP. Five-inch shells fired to spread radar-trackable material (window) to study high-altitude winds.

WB-29. Weather reconnaissance version of B-29 used for cloud tracking and sampling.

weapon debris. The radioactive residue of a nuclear device after it has been detonated, consisting of fission products, various products of neutron capture, weapon casing and other components, and uranium or plutonium that has escaped fission.

WES. Waterways Experiment Station (Army).

whole-body irradiation. Exposure of the body to ionizing radiation from external radiation sources. Critical organs for the whole body are the lens of the eye, the gonads, and the red-blood-forming marrow. As little as only 1 cm^3 of bone marrow constitutes a whole-body exposure. Thus, the entire body need not be exposed to be classed as a whole-body exposure.

Wilson cloud. A mist or fog of minute water droplets that temporarily surrounds a fireball following a nuclear detonation in a humid atmosphere. This is caused by a sudden lowering of the pressure (and temperature) after the passing of the shock wave (cloud chamber effect) and quickly dissipates as temperatures and pressures return to normal.

window. See WASP.

worldwide fallout. Consists of the smaller radioactive nuclear detonation particles that ascend into the upper troposphere and the stratosphere and are carried by winds to all parts of the Earth. The delayed (or worldwide) fallout is brought to Earth, mainly by rain and snow, over extended periods ranging from months to years.

WT. Prefix of Weapon Test (WT) report identification numbers. These reports were prepared to record the results of scientific experiments.

YAG. Miscellaneous auxiliary ship (Navy).

YC. Open lighter, non-self-propelled (Navy).

YCV. Aircraft transportation lighter, non-self-propelled (Navy).

YFN. Covered lighter, non-self-propelled (Navy).

YFNB. Large covered lighter (Navy).

yield. The total effective energy released in a nuclear detonation. It is usually expressed in terms of the equivalent tonnage of TNT required to produce the same energy release in an explosion. The total energy yield is manifested as nuclear radiation (including residual radiation), thermal radiation, and blast and shock energy, the actual distribution depending upon the medium in which the explosion occurs and also upon the type of weapon. See TNT equivalent

yield (blast). That portion of the total energy of a nuclear detonation that is identified as the blast or shock wave.

yield (fission). That portion of the total explosive yield attributable to nuclear fission, as opposed to fusion. The interest in fission yield stems from the interest in fission product formation and its relationship to radioactive fallout.

YO. Fuel oil barge, self-propelled (Navy).

YOG. Gasoline barge, self-propelled (Navy).

YOGN. Gasoline barge, non-self-propelled (Navy).

YON. Oil storage barge, non-self-propelled (Navy).

ZI. Zone of Interior (conterminous United States).

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Defense Nuclear Agency
ATTN: FCTT, W. Summa
ATTN: FCLS, D. Norton
ATTN: FCTT, G. Ganong
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ATTN: FCTXF

Interservice Nuclear Weapons School
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National Defense University
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DEPARTMENT OF THE ARMY

Army Library
ATTN: Military Documents Sect

Army Nuclear Test Personnel Review
2 cy ATTN: DAAG-AMR, P. Tago

U.S. Army Center of Military History
ATTN: DAMH-HSO

U.S. Army Chemical School
ATTN: ATZN-CM-AL
ATTN: ATZN-CM-CS

U.S. Army Comd & General Staff College
ATTN: Library

U.S. Army Nuclear & Chemical Agency
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U.S. Army War College
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U.S. Military Academy
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DEPARTMENT OF THE NAVY

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Bureau of Medicine and Surgery
ATTN: Asst. for Medical Surgery

James Carson Breckinridge Lib
ATTN: Library Div

Marine Corps Base
ATTN: Document Custodian

Marine Corps Dev & Education Command
ATTN: J. C. Breckinridge Lib

Marine Corps Historical Center
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Marine Corps Nuc Test Personnel Review
ATTN: Code MSRB-60

Merchant Marine Academy
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Naval Historical Center
ATTN: Operational Archives Branch

Naval Hospital Corps School
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Naval Ocean Systems Center
ATTN: Library

Naval Oceanographic Office
ATTN: Code 025, Historian

Naval Postgraduate School
ATTN: Code 1424, Library

Naval Research Laboratory
ATTN: Library

Naval School
ATTN: Librarian

Naval Sea Systems Command
ATTN: Nuclear Technology Div

Naval Surface Weapons Center
ATTN: Library

Naval War College
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Naval Weapons Center
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Naval Weapons Evaluation Facility
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DEPARTMENT OF THE NAVY (Continued)

Navy Department Library
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Navy Nuclear Power School
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Navy Nuclear Test Personnel Review
2 cy ATTN: W. Loeffler

Nimitz Library
ATTN: Documents & Reports Dept

Office of the Judge Adv Gen
ATTN: Code 73

U.S. Merchant Marine Academy
ATTN: Librarian

U.S. Naval Air Station Library
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DEPARTMENT OF THE AIR FORCE

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Air Force Communications Command
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Air Force Logistics Command
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Air Force Nuclear Test Personnel Review
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Air Force Systems Command
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Air Force Technical Applications Ctr
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Air Force Weapons Laboratory
ATTN: Tech Library

Air National Guard
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Air Training Command
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Air University Library
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Military Airlift Command
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Pacific Air Forces
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Strategic Air Command
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DEPARTMENT OF THE AIR FORCE (Continued)

Tactical Air Command
ATTN: Historian

U.S. Air Force Academy Library
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USAF School of Aerospace Medicine
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Nevada Operations Office
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2 cy ATTN: R. Nutley

Human Health & Assessments Div
ATTN: Librarian

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ATTN: JNATDR, Mr Greene

Lawrence Livermore National Lab
ATTN: Technical Info Dept Library

Los Alamos National Laboratory
ATTN: M. Walz, ADLA MS A183
ATTN: D. Cobb, ESS MSS 0466
2 cy ATTN: Library
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Reynolds Electrical & Engr Co, Inc
ATTN: CIC
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Sandia National Lab
ATTN: Central Library
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ATTN: G. Caldwell

Central Intelligence Agency
ATTN: Office of Medical Services

Dept of Health & Human Svcs
ATTN: Office of General Counsel

Exec Ofc of the President
Management & Budget Ofc Lib
ATTN: Librarian

Library of Congress
ATTN: Library Service Division
ATTN: Science & Technology Div
ATTN: Serial & Govt Publication

OTHER GOVERNMENT AGENCIES (Continued)

National Archives
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National Atomic Museum
ATTN: Historian

Department of Commerce
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Occupational Safety & Health Admin
ATTN: Library

Office of Health & Disability
ATTN: R. Copela

Office of Workers Compensation Pgrm
ATTN: R. Larson

U.S. Coast Guard Academy Library
ATTN: Librarian

U.S. House of Representatives
2 cy ATTN: Committee on Armed Services

U.S. House of Representatives
ATTN: Subcommittee on Health & Envir

U.S. Senate
ATTN: Committee on Veterans Affairs

U.S. Senate
ATTN: Committee on Veterans Affairs

Veterans Administration - RO
Providence, RI
ATTN: Director

Veterans Administration
Washington, D.C.
ATTN: Board of Veteran Appeal

Veterans Administration - Ofc Central
Washington, D.C.
ATTN: Dept Veterans Benefit, Central Ofc
ATTN: Director

Veterans Administration - RO
Montgomery, AL
ATTN: Director

Veterans Administration - RO
Anchorage, AK
ATTN: Director

Veterans Administration - RO
Phoenix, AZ
ATTN: Director

Veterans Administration - RO
Little Rock, AR
ATTN: Director

Veterans Administration -RO
Los Angeles, CA
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration - RO
San Francisco, CA
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Veterans Administration - RO
Denver, CO
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Veterans Administration - RO
Hartford, CT
ATTN: Director

Veterans Administration - RO
Wilmington, DE
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Veterans Administration - RO
St. Petersburg, FL
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Veterans Administration - RO
Atlanta, GA
ATTN: Director

Veterans Administration - RO
Honolulu, HI
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Veterans Administration - RO
Chicago, IL
ATTN: Director

Veterans Administration - RO
Seattle, WA
ATTN: Director

Veterans Administration - RO
Indianapolis, IN
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Veterans Administration - RO
Des Moines, IA
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Veterans Administration - RO
Wichita, KS
ATTN: Director

Veterans Administration - RO
Louisville, KY
ATTN: Director

Veterans Administration - RO
New Orleans, LA
ATTN: Director

Veterans Administration - RO
Togus, ME
ATTN: Director

Veterans Administration - RO
Baltimore, MD
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Veterans Administration - RO
Boston, MA
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OTHER GOVERNMENT AGENCIES (Continued)

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St. Paul, MN
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Veterans Administration - RO
Jackson, MS
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Veterans Administration - RO
Huntington, WV
ATTN: Director

Veterans Administration - RO
St. Louis, MO
ATTN: Director

Veterans Administration - RO
Fort Harrison, MT
ATTN: Director

Veterans Administration - RO
Lincoln, NE
ATTN: Director

Veterans Administration - RO
Reno, NV
ATTN: Director

Veterans Administration - RO
Manchester, NH
ATTN: Director

Veterans Administration - RO
Newark, NJ
ATTN: Director

Veterans Administration - RO
Milwaukee, WI
ATTN: Director

Veterans Administration - RO
Albuquerque, NM
ATTN: Director

Veterans Administration - RO
Buffalo, NY
ATTN: Director

Veterans Administration -RO
New York, NY
ATTN: Director

Veterans Administration -RO
Winston Salem, NC
ATTN: Director

Veterans Administration - RO
Fargo, ND
ATTN: Director

Veterans Administration - RO
Cleveland, OH
ATTN: Director

Veterans Administration - RO
Muskogee, OK
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

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Portland, OR
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Veterans Administration - RO
Pittsburgh, PA
ATTN: Director

Veterans Administration - RO
Philadelphia, PA
ATTN: Director

Veterans Administration - RO
APO San Francisco
ATTN: Director

Veterans Administration - RO
San Juan, Puerto Rico
ATTN: Director

Veterans Administration - RO
Columbia, SC
ATTN: Director

Veterans Administration - RO
Sioux Falls, SD
ATTN: Director

Veterans Administration - RO
Houston, TX
ATTN: Director

Veterans Administration - RO
Waco, TX
ATTN: Director

Veterans Administration - RO
Salt Lake City, UT
ATTN: Director

Veterans Administration - RO
White River Junction, VT
ATTN: Director

Veterans Administration - RO
Roanoke, VA
ATTN: Director

Veterans Administration - RO
Cheyenne, WY
ATTN: Director

Veterans Administration - RO
San Diego, CA
ATTN: Director

Veterans Administration - RO
Boise, ID
ATTN: Director

Veterans Administration - RO
Detroit, MI
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans administration - RO
Nashville, TN
ATTN: Director

The White House
ATTN: Domestic Policy Staff

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JAYCOR
ATTN: A. Nelson
10 cy ATTN: Health & Environment Div

Kaman Tempo
6 cy ATTN: E. Martin
ATTN: DASIAC

Kaman Tempo
ATTN: R. Miller

Kaman Tempo
10 cy ATTN: C. Jones
ATTN: DASIAC

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ATTN: Medical Follow-up Agency
ATTN: National Materials Advisory Board

Pacific-Sierra Research Corp
ATTN: H. Brode, Chairman SAGE

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ATTN: P. Haas

Rand Corp
ATTN: P. Davis

Rand Corp
ATTN: B. Bennett

Science Applications, Inc
ATTN: Tech Library

Science Applications, Inc
10 cy ATTN: L. Novotney

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Adams State College
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Akron Public Library
ATTN: Govt Publication Librarian

Alabama St Dept of Archives & History
ATTN: Military Records Division

University of Alabama
ATTN: Reference Dept/Documents

OTHER (Continued)

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Alexander City State Jr College
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Allegheny College
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Allen County Public Library
ATTN: Librarian

Altoona Area Public Library
ATTN: Librarian

American Statistics Index
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Anaheim Public Library
ATTN: Librarian

Andrews Library, College of Wooster
ATTN: Government Documents

Angelo State University Library
ATTN: Librarian

Angelo Iacoboni Pub Lib
ATTN: Librarian

Anoka County Library
ATTN: Librarian

Appalachian State University
ATTN: Library Documents

Arizona State University Library
ATTN: Librarian

University of Arizona
ATTN: Gov Doc Dept, C. Bower

Arkansas College Library
ATTN: Library

Arkansas Library Comm
ATTN: Library

Arkansas State University
ATTN: Library

University of Arkansas
ATTN: Government Documents Div

Austin College
Arthur Hopkins Library
ATTN: Librarian

Atlanta Public Library
ATTN: Ivan Allen Dept

Atlanta University Center
ATTN: Librarian

OTHER (Continued)

Auburn Univ at Montgomery Lib
ATTN: Librarian

B. Davis Schwartz Mem Lib
ATTN: Librarian

Bangor Public Library
ATTN: Librarian

Bates College Library
ATTN: Librarian

Baylor University Library
ATTN: Docs Dept

Beloit College Libraries
ATTN: Serials Docs Dept

Bemidji State College
ATTN: Library

Benjamin F. Feinberg Library
State University College
ATTN: Government Documents

Bierce Library, Akron University
ATTN: Government Documents

Boston Public Library
ATTN: Documents Department

Bowdoin College
ATTN: Librarian

Bowling Green State Univ
ATTN: Govt Docs Services

Bradley University
ATTN: Govt Publication Librarian

Brandeis University Lib
ATTN: Documents Section

Brigham Young University
ATTN: Librarian

Brigham Young University
ATTN: Documents Collection

Brookhaven National Laboratory
ATTN: Technical Library

Brooklyn College
ATTN: Documents Division

Broward County Library Sys
ATTN: Librarian

Brown University
ATTN: Librarian

Bucknell University
ATTN: Reference Dept

OTHER (Continued)

Buffalo & Erie Co Pub Lib
ATTN: Librarian

Burlington Library
ATTN: Librarian

California at Fresno State Univ Lib
ATTN: Library

California at San Diego University
ATTN: Documents Department

California at Stanislavs St Clg Lib
ATTN: Library

California St Polytechnic Univ Lib
ATTN: Librarian

California St Univ at Northridge
ATTN: Gov Doc

California State Library
ATTN: Librarian

California State Univ at Long Beach Lib
ATTN: Librarian

California State University
ATTN: Librarian

California State University
ATTN: Librarian

California Univ Library
ATTN: Govt Publications Dept

California Univ Library
ATTN: Librarian

California University Library
ATTN: Govt Documents Dept

California University Library
ATTN: Documents Sec

California University
ATTN: Government Documents Dept

Calvin College Library
ATTN: Librarian

Calvin T. Ryan Library
Kearney State College
ATTN: Govt Documents Dept

Carleton College Library
ATTN: Librarian

Carnegie Library of Pittsburgh
ATTN: Librarian

Carnegie Mellon University
ATTN: Director of Libraries

OTHER (Continued)

Carson Regional Library
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Case Western Reserve University
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University of Central Florida
ATTN: Library Docs Dept

Central Michigan University
ATTN: Library Documents Section

Central Missouri State Univ
ATTN: Government Documents

Central State University
ATTN: Library Documents Dept

Central Washington University
ATTN: Library Docs Section

Central Wyoming College Library
ATTN: Librarian

Charleston County Library
ATTN: Librarian

Charlotte & Mechlenburg County Pub Lib
ATTN: E. Correll

Chattanooga Hamilton Co
ATTN: Librarian

Chesapeake Pub Lib System
ATTN: Librarian

Chicago Public Library
ATTN: Governments Publications Dept

State University of Chicago
ATTN: Librarian

Chicago University Library
ATTN: Director of Libraries
ATTN: Documents Processing

Cincinnati University Library
ATTN: Librarian

Claremont Colleges Libs
ATTN: Doc Collection

Clemson University
ATTN: Director of Libraries

Cleveland Public Library
ATTN: Documents Collection

Cleveland State Univ Lib
ATTN: Librarian

Coe Library
ATTN: Documents Division

OTHER (Continued)

Colgate Univ Library
ATTN: Reference Library

Colorado State Univ Libs
ATTN: Librarian

Colorado University Libraries
ATTN: Director of Libraries

Columbia University Library
ATTN: Documents Service Center

Columbus & Franklin Cty Public Lib
ATTN: Gen Rec Div

Compton Library
ATTN: Librarian

Connecticut State Library
ATTN: Librarian

University of Connecticut
ATTN: Govt of Connecticut

Connecticut University
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Cornell University Lib
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Corpus Christi State University Lib
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Culver City Library
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Curry College Library
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Dallas County Public Library
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Dallas Public Library
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Dalton Jr College Library
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Dartmouth College
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Davenport Public Library
ATTN: Librarian

Davidson College
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Dayton & Montgomery City Pub Lib
ATTN: Librarian

University of Dayton
ATTN: Librarian

OTHER (Continued

Decatur Public Library
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Dekalb Comm Coll So Cpus
ATTN: Librarian

Delaware Pauw University
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University of Delaware
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Delta College Library
ATTN: Librarian

Delta State University
ATTN: Librarian

Denison Univ Library
ATTN: Librarian

Denver Public Library
ATTN: Documents Div

Dept of Lib & Archives
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Detroit Public Library
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Dickinson State College
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Drake Memorial Learning Resource Ctr
ATTN: Librarian

Drake University
ATTN: Cowles Library

Drew University
ATTN: Librarian

Duke University
ATTN: Public Docs Dept

Duluth Public Library
ATTN: Documents Section

Earlham College
ATTN: Librarian

East Carolina University
ATTN: Library Docs Dept

East Central University
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East Islip Public Library
ATTN: Librarian

East Orange Public Lib
ATTN: Librarian

East Tennessee State Univ Sherrod Lib
ATTN: Documents Dept

OTHER (Continued)

East Texas State University
ATTN: Library

Eastern Branch
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Eastern Illinois University
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Eastern Kentucky University
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Eastern Michigan University Lib
ATTN: Documents Libn

Eastern Montana College Library
ATTN: Documents Dept

Eastern New Mexico Univ
ATTN: Librarian

Eastern Oregon College Library
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Eastern Washington Univ
ATTN: Librarian

El Paso Public Library
ATTN: Documents & Geneology Dept

Elko County Library
ATTN: Librarian

Elmira College
ATTN: Librarian

Elon College Library
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Enoch Pratt Free Library
ATTN: Documents Office

Emory University
ATTN: Librarian

Evansville & Vanderburgh County Pub Lib
ATTN: Librarian

Everett Public Library
ATTN: Librarian

Fairleigh Dickinson Univ
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Florida A & M Univ
ATTN: Librarian

Florida Atlantic Univ Lib
ATTN: Div of Public Documents

Florida Institute of Tech Lib
ATTN: Federal Documents Dept

Florida Intl Univ Library
ATTN: Docs Section

OTHER (Continued)

Florida State Library
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Florida State University
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Fort Hays State University
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Fort Worth Public Library
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Free Pub Lib of Elizabeth
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Free Public Library
ATTN: Librarian

Freeport Public Library
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Fresno County Free Library
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Gadsden Public Library
ATTN: Librarian

Garden Public Library
ATTN: Librarian

Gardner Webb College
ATTN: Documents Librn

Gary Public Library
ATTN: Librarian

Georgetown Univ Library
ATTN: Govt Docs Room

Georgia Inst of Tech
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Georgia Southern College
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Georgia Southwestern College
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Georgia State Univ Lib
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University of Georgia
ATTN: Dir of Libraries

Glassboro State College
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Gleeson Library
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OTHER (Continued)

Government Publications Library-M
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Graceland College
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Grand Forks Public City-County Library
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Grand Rapids Public Library
ATTN: Director of Libraries

Greenville County Library
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Guam RFK Memorial University Lib
ATTN: Fed Depository Collection

University of Guam
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Gustavus Adolphus College
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Hardin-Simmons University Library
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Hartford Public Library
ATTN: Librarian

Harvard College Library
ATTN: Director of Libraries

Harvard College Library
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University of Hawaii
ATTN: Government Docs Collection

Hawaii State Library
ATTN: Federal Documents Unit

University of Hawaii at Monoa
ATTN: Director of Libraries

University of Hawaii
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Haydon Burns Library
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Henry Ford Comm College Lib
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Herbert H. Lehman College
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Hofstra Univ Library
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Hollins College
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Hoover Institution
ATTN: J. Bingham

OTHER (Continued)

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University of Houston, Library
ATTN: Documents Div

Houston Public Library
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Hoyt Public Library
ATTN: Librarian

Humboldt State College Library
ATTN: Documents Dept

Huntington Park Library
ATTN: Librarian

Hutchinson Public Library
ATTN: Librarian

Idaho Public Lib & Info Center
ATTN: Librarian

Idaho State Library
ATTN: Librarian

Idaho State University Library
ATTN: Documents Dept

University of Idaho
ATTN: Documents Sect
ATTN: Dir of Libraries

University of Illinois, Library
ATTN: Documents Section

Illinois State Library
ATTN: Government Documents Branch

Illinois Univ at Urbana Champaign
ATTN: P. Watson, Documents Library

Illinois Valley Comm Coll
ATTN: Library

Indiana State Library
ATTN: Serial Section

Indiana State University
ATTN: Documents Libraries

Indiana University Library
ATTN: Documents Department

Indianapolis Marion Cty Pub Library
ATTN: Social Science Div

Iowa State University Library
ATTN: Govt Documents Dept

Iowa University Library
ATTN: Government Documents Dept

OTHER (Continued)

Butler University, Irwin Library
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Isaac Delchdo College
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James Madison University
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Jefferson County Public Lib
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Jersey City State College
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Johns Hopkins University
ATTN: Documents Library

John J. Wright Library, La Roche College
ATTN: Librarian

Johnson Free Public Lib
ATTN: Librarian

Kahului Library
ATTN: Librarian

Kalamazoo Public Library
ATTN: Librarian

Kansas City Public Library
ATTN: Documents Div

Kansas State Library
ATTN: Librarian

Kansas State Univ Library
ATTN: Documents Dept

University of Kansas
ATTN: Director of Libraries

Kent State University Library
ATTN: Documents Div

Kentucky Dept of Library & Archives
ATTN: Documents Section

University of Kentucky
ATTN: Governments Publication Dept
ATTN: Director of Libraries

Kenyon College Library
ATTN: Librarian

Lake Forest College
ATTN: Librarian

Lake Sumter Comm Coll Lib
ATTN: Librarian

Lakeland Public Library
ATTN: Librarian

OTHER (Continued)

Lancaster Regional Library
ATTN: Librarian

Lawrence University
ATTN: Documents Dept

Lee Library, Brigham Young University
ATTN: Documents & Map Section

Library & Statutory Distribution & Svc
2 cy ATTN: Librarian

Little Rock Public Library
ATTN: Librarian

Long Beach Publ Library
ATTN: Librarian

Los Angeles Public Library
ATTN: Serials Div U.S. Documents

Louisiana State University
ATTN: Government Doc Dept
ATTN: Director of Libraries

Louisville Free Pub Lib
ATTN: Librarian

Louisville Univ Library
ATTN: Librarian

Lyndon B. Johnson Sch of Pub Affairs Lib
ATTN: Librarian

Maine Maritime Academy
ATTN: Librarian

Maine University at Oreno
ATTN: Librarian

Uni rsity of Maine
ATTN: Librarian

Manchester City Library
ATTN: Librarian

Mankato State College
ATTN: Govt Publications

Mantor Library
Univ of Maine at Farmington
ATTN: Director of Libraries

Marathon County Public Library
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Marshall Brooks Library
ATTN: Librarian

University of Maryland
ATTN: McKeldin Libr Docs Div

University of Maryland
ATTN: Librarian

OTHER (Continued)

University of Massachusetts
ATTN: Government Docs College

McNeese State Univ
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Memphis Shelby County Pub Lib & Info Ctr
ATTN: Librarian

Memphis State University
ATTN: Librarian

Mercer University
ATTN: Librarian

Mesa County Public Library
ATTN: Librarian

University of Miami, Library
ATTN: Government Publications

Miami Public Library
ATTN: Documents Division

Miami Univ Library
ATTN: Documents Dept

Michel Orradre Library
University of Santa Clara
ATTN: Documents Div

Michigan State Library
ATTN: Librarian

Michigan State University Library
ATTN: Librarian

Michigan Tech University
ATTN: Library Documents Dept

University of Michigan
ATTN: Acq Sec Documents Unit

Middlebury College Library
ATTN: Librarian

Millersville State Coll
ATTN: Librarian

Mil[illegible] Library
State University of New York
ATTN: Docs Libm

Milwaukee Pub Lib
ATTN: Librarian

Minneapolis Public Lib
ATTN: Librarian

Minnesota Div of Emergency Svcs
ATTN: Librarian

Minot State College
ATTN: Librarian

Mississippi State University
ATTN: Librarian

OTHER (Continued)

University of Mississippi
ATTN: Director of Libraries

Missouri Univ at Kansas City Gen
ATTN: Librarian

Missouri University Library
ATTN: Government Documents

M.I.T. Libraries
ATTN: Librarian

Mobile Public Library
ATTN: Governmental Info Division

Moffett Library
ATTN: Librarian

Montana State Library
ATTN: Librarian

Montana State University, Library
ATTN: Librarian

University of Montana
ATTN: Documents Div

Moorhead State College
ATTN: Library

Mt Prospect Public Lib
ATTN: Librarian

Murray State Univ Lib
ATTN: Library

Nassau Library System
ATTN: Librarian

Natrona County Public Library
ATTN: Librarian

Nebraska Library Comm
ATTN: Librarian

Univ of Nebraska at Omaha
ATTN: Librarian

Nebraska Western College Library
ATTN: Librarian

Univ of Nebraska at Lincoln
ATTN: Director of Libraries

Univ of Nevada at Reno
ATTN: Governments Pub Dept

Univ of Nevada at Las Vegas
ATTN: Director of Libraries

New Hampshire University Lib
ATTN: Librarian

New Hanover County Public Library
ATTN: Librarian

Nebraska University Library
ATTN: Acq Dept

OTHER (Continued)

New Mexico State Library
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New Mexico State University
ATTN: Lib Documents Div

University of New Mexico
ATTN: Director of Libraries

University of New Orleans Library
ATTN: Govt Documents Div

New Orleans Public Lib
ATTN: Library

New York Public Library
ATTN: Librarian

New York State Library
ATTN: Doc Control, Cultural Ed Ctr

New York State Univ at Stony Brook
ATTN: Main Lib Doc Sect

New York State Univ Col at Cortland
ATTN: Librarian

State Univ of New York
ATTN: Library Documents Sec

State Univ of New York
ATTN: Librarian

New York State University
ATTN: Documents Center

State University of New York
ATTN: Documents Dept

New York University Library
ATTN: Documents Dept

Newark Free Library
ATTN: Librarian

Newark Public Library
ATTN: Librarian

Niagara Falls Pub Lib
ATTN: Librarian

Nicholls State Univ Library
ATTN: Docs Div

Nieves M. Flores Memorial Lib
ATTN: Librarian

Norfolk Public Library
ATTN: R. Parker

North Carolina Agri & Tech State Univ
ATTN: Librarian

Univ of North Carolina at Charlotte
ATTN: Atkins Library Documents Dept

Univ of North Carolina at Greensboro, Library
ATTN: Librarian

OTHER (Continued)

North Carolina Central University
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North Carolina State University
ATTN: Librarian

North Carolina University at Wilmington
ATTN: Librarian

University of North Carolina
ATTN: BA SS Division Documents

North Dakota State University Lib
ATTN: Docs Librarian

University of North Dakota
ATTN: Librarian

North Georgia College
ATTN: Librarian

North Texas State University Library
ATTN: Librarian

Northeast Missouri State University
ATTN: Librarian

Northeastern Illinois University
ATTN: Library

Northeastern Oklahoma State Univ
ATTN: Librarian

Northeastern University
ATTN: Dodge Library

Northern Arizona University Lib
ATTN: Government Documents Dept

Northern Illinois University
ATTN: Librarian

Northern Iowa University
ATTN: Library

Northern Michigan Univ
ATTN: Documents

Northern Montana College Library
ATTN: Librarian

Northwestern Michigan College
ATTN: Librarian

Northwestern State Univ
ATTN: Librarian

Northwestern State Univ Library
ATTN: Librarian

Northwestern University Library
ATTN: Govt Publications Dept

Norwalk Public Library
ATTN: Librarian

OTHER (Continued)

University of Notre Dame
ATTN: Document Center

Oakland Comm College
ATTN: Librarian

Oakland Public Library
ATTN: Librarian

Oberlin College Library
ATTN: Librarian

Ocean County College
ATTN: Librarian

Ohio State Library
ATTN: Librarian

Ohio State University
ATTN: Libraries Documents Division

Ohio University Library
ATTN: Docs Dept

Oklahoma City University Library
ATTN: Librarian

Oklahoma City University Library
ATTN: Librarian

Oklahoma Dept of Libraries
ATTN: U.S. Govt Documents

University of Oklahoma
ATTN: Documents Div

Old Dominion University
ATTN: Doc Dept Univ Library

Olivet College Library
ATTN: Librarian

Omaha Pub Lib Clark Branch
ATTN: Librarian

Oregon State Library
ATTN: Librarian

University of Oregon
ATTN: Documents Section

Ouachita Baptist University
ATTN: Librarian

Pan American University Library
ATTN: Librarian

Passaic Public Library
ATTN: Librarian

Paul Klapper Library
ATTN: Documents Dept

Pennsylvania State Library
ATTN: Government Publications Section

OTHER (Continued)

Pennsylvania State University
ATTN: Library Document Sec

University of Pennsylvania
ATTN: Director of Libraries

Penrose Library
University of Denver
ATTN: Penrose Library

Peoria Public Library
ATTN: Business, Science & Tech Dept

Free Library of Philadelphia
ATTN: Govt Publications Dept

Philipsburg Free Public Library
ATTN: Library

Phoenix Public Library
ATTN: Librarian

University of Pittsburg
ATTN: Documents Office G 8

Plainfield Public Library
ATTN: Librarian

Popular Creek Public Lib District
ATTN: Librarian

Association of Portland Lib
ATTN: Librarian

Portland Public Library
ATTN: Librarian

Portland State University Library
ATTN: Librarian

Prescott Memorial Lib
Louisiana Tech Univ
ATTN: Librarian

Princeton University Library
ATTN: Documents Division

Providence College
ATTN: Physics Dept

Providence Public Library
ATTN: Librarian

Cincinnati & Hamilton County Public Library
ATTN: Librarian

Public Library of Nashville and Davidson County
ATTN: Library

University of Puerto Rico
ATTN: Doc & Maps Room

Purdue University Library
ATTN: Librarian

OTHER (Continued)

Quinebaug Valley Community Col
ATTN: Librarian

Ralph Brown Draughon Lib
Auburn University
ATTN: Microforms & Documents Dept

Rapid City Public Library
ATTN: Librarian

Reading Public Library
ATTN: Librarian

Reed College Library
ATTN: Librarian

Reese Library
Augusta College
ATTN: Librarian

University of Rhode Island Library
ATTN: Govt Publications Office

University of Rhode Island
ATTN: Director of Libraries

Rice University
ATTN: Director of Libraries

Richard W. Norton Mem Lib
Louisiana College
ATTN: Librarian

Richland County Pub Lib
ATTN: Librarian

University of Richmond
ATTN: Library

Riverside Public Library
ATTN: Librarian

University of Rochester Library
ATTN: Documents Section

Rutgers University, Camden Library
ATTN: Librarian

Rutgers State University
ATTN: Librarian

Rutgers University
ATTN: Govt Docs Dept

Rutgers University Law Library
ATTN: Federal Documents Dept

Salem College Library
ATTN: Librarian

Samford University
ATTN: Librarian

San Antonio Public Library
ATTN: Bus Science & Tech Dept

OTHER (Continued)

San Diego County Library
ATTN: C. Jones, Acquisitions

San Diego Public Library
ATTN: Librarian

San Diego State University Library
ATTN: Govt Pubs Dept

San Francisco Public Library
ATTN: Govt Documents Dept

San Francisco State College
ATTN: Govt Pub Collection

San Jose State College Library
ATTN: Documents Dept

San Luis Obispo City-County Library
ATTN: Librarian

Savannah Pub & Effingham Libty Reg Lib
ATTN: Librarian

Scottsbluff Public Library
ATTN: Librarian

Scranton Public Library
ATTN: Librarian

Seattle Public Library
ATTN: Ref Doc Asst

Selby Public Library
ATTN: Librarian

Shawnee Library System
ATTN: Librarian

Shreve Memorial Library
ATTN: Librarian

Silas Bronson Public Library
ATTN: Librarian

Simon Schwob Mem Lib
Columbus College
ATTN: Librarian

Sioux City Public Library
ATTN. Librarian

Skidmore College
ATTN: Librarian

Slippery Rock State College Library
ATTN: Librarian

South Carolina State Library
ATTN: Librarian

University of South Carolina
ATTN: Librarian

OTHER (Continued)

University of South Carolina
ATTN: Government Documents

South Dakota Sch of Mines & Tech
ATTN: Librarian

South Dakota State Library
ATTN: Federal Documents Department

University of South Dakota
ATTN: Documents Librarian

South Florida University Library
ATTN: Librarian

Southdale-Hennepin Area Library
ATTN: Government Documents

Southeast Missouri State University
ATTN: Librarian

Southeastern Massachusetts University Library
ATTN: Documents Sec

University of Southern Alabama
ATTN: Librarian

Southern California University Library
ATTN: Documents Dept

Southern Connecticut State College
ATTN: Library

Southern Illinois University
ATTN: Librarian

Southern Illinois University
ATTN: Documents Ctr

Southern Methodist University
ATTN: Librarian

University of Southern Mississippi
ATTN: Library

Southern Oregon College
ATTN: Library

Southern University in New Orleans, Library
ATTN: Librarian

Southern Utah State College Library
ATTN: Documents Department

Southwest Missouri State College
ATTN: Library

Southwestern University of Louisiana, Libraries
ATTN: Librarian

Southwestern University School of Law Library
ATTN: Librarian

OTHER (Continued)

Spokane Public Library
ATTN: Reference Dept

Springfield City Library
ATTN: Documents Section

St. Bonaventure University
ATTN: Librarian

St. Joseph Public Library
ATTN: Librarian

St. Lawrence University
ATTN: Librarian

St. Louis Public Library
ATTN: Librarian

St. Paul Public Library
ATTN: Librarian

Stanford University Library
ATTN: Govt Documents Dept

State Historical Soc Lib
ATTN: Docs Serials Section

State Library of Massachusetts
ATTN: Librarian

State University of New York
ATTN: Librarian

Stetson Univ
ATTN: Librarian

University of Steubenville
ATTN: Librarian

Stockton & San Joaquin Public Lib
ATTN: Librarian

Stockton State College Library
ATTN: Librarian

Superior Public Library
ATTN: Librarian

Swarthmore College Lib
ATTN: Reference Dept

Syracuse University Library
ATTN: Documents Div

Tacoma Public Library
ATTN: Librarian

Tampa, Hillsborough County Public Lib
ATTN: Librarian

Temple University
ATTN: Librarian

Tennessee Technological University
ATTN: Librarian

OTHER (Continued)

University of Tennessee
ATTN: Dir of Libraries

Terteling Library
College of Idaho
ATTN: Librarian

Texas A & M University Library
ATTN: Librarian

University of Texas at Arlington
ATTN: Library Documents

University of Texas at San Antonio
ATTN: Library

Texas Christian University
ATTN: Librarian

Texas State Library
ATTN: U.S. Documents Sect

Texas Tech University Library
ATTN: Govt Docs Dept

Texas University at Austin
ATTN: Documents Coll

Texas University at El Paso
ATTN: Documents and Maps Lib

University of Toledo Library
ATTN: Librarian

Toledo Public Library
ATTN: Social Science Dept

Torrance Civic Center Library
ATTN: Librarian

Traverse City Public Library
ATTN: Librarian

Trenton Free Public Library
ATTN: Librarian

Trinity College Library
ATTN: Librarian

Trinity University Library
ATTN: Documents Collection

Tufts University Library
ATTN: Documents Dept

Tulane University
ATTN: Documents Dept

University of Tulsa
ATTN: Librarian

UCLA Research Library
ATTN: Public Affairs Svc/US Docs

OTHER (Continued)

Uniformed Svcs Univ of the Hlth Sci
ATTN: LRC Library

University Libraries
ATTN: Dir of Libraries

Upper Iowa College
ATTN: Documents Collection

Utah State University
ATTN: Librarian

University of Utah
ATTN: Special Collections

University of Utah
ATTN: Dept of Pharmacology
ATTN: Director of Libraries

Valencia Library
ATTN: Librarian

Vanderbilt University Library
ATTN: Govt Docs Sect

University of Vermont
ATTN: Director of Libraries

Virginia Commonwealth University
ATTN: Librarian

Virginia Military Institute
ATTN: Librarian

Virginia Polytechnic Inst Lib
ATTN: Docs Dept

Virginia State Library
ATTN: Serials Section

University of Virginia
ATTN: Public Documents

Volusia County Public Libraries
ATTN: Librarian

Washington State Library
ATTN: Documents Section

Washington State University
ATTN: Lib Documents Section

Washington University Libraries
ATTN: Dir of Libraries

University of Washington
ATTN: Documents Div

Wayne State University Library
ATTN: Librarian

Wayne State University Law Library
ATTN: Documents Dept

Weber State College Library
ATTN: Librarian

Wagner College
ATTN: Librarian

OTHER (Continued)

Wesleyan University
ATTN: Documents Librarian

West Chester State Coll
ATTN: Documents Dept

West Covina Library
ATTN: Librarian

University of West Florida
ATTN: Librarian

West Hills Community Coll
ATTN: Library

West Texas State University
ATTN: Library

West Virginia Coll of Grad Studies Lib
ATTN: Librarian

University of West Virginia
ATTN: Dir of Libraries

Westerly Public Library
ATTN: Librarian

Western Carolina University
ATTN: Librarian

Western Illinois University Lib
ATTN: Librarian

Western Washington Univ
ATTN: Librarian

Western Wyoming Community College Lib
ATTN: Librarian

Westmoreland Cty Comm Coll
ATTN: Learning Resource Ctr

Whitman College
ATTN: Librarian

Wichita State Univ Library
ATTN: Librarian

William & Mary College
ATTN: Docs Dept

William Allen White Library
Emporia Kansas State College
ATTN: Govt Documents Div

William College Library
ATTN: Librarian

Willimantic Public Library
ATTN: Librarian

Winthrop College
ATTN: Documents Dept

University of Wisconsin at Whitewater
ATTN: Governments Documents Library

OTHER (Continued)

Wisconsin Milwaukee University
ATTN: Librarian

Wisconsin Oshkosh University
ATTN: Librarian

Wisconsin Platteville University
ATTN: Librarian

Wisconsin University at Stevens Point
ATTN: Docs Section

University of Wisconsin
ATTN: Govt Pubs Dept

University of Wisconsin
ATTN: Acquisitions Dept

Worcester Public Library
ATTN: Librarian

OTHER (Continued)

Yale University
ATTN: Director of Libraries

Yeshiva University
ATTN: Librarian

Yuma City County Library
ATTN: Librarian

Wright State Univ Library
ATTN: Govts Documents Dept

Wyoming State Library
ATTN: Librarian

University of Wyoming
ATTN: Documents Div

University of Alaska
ATTN: Govt Publication Librarian