DNA 6009F

OPERATION
TEAPOT
1955

United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

Prepared by the Defense Nuclear Agency as Executive Agency
for the Department of Defense

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: DNA 6009F	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Operation TEAPOT 1955 Continental Nuclear Weapons Test Series	5. TYPE OF REPORT & PERIOD COVERED: Technical Report
	6. PERFORMING ORG. REPORT NUMBER: JRB Z-816-03-423-00
7. AUTHOR(s): Jean Ponton, Carl Maag, Martha Wilkinson, Robert F. Shepanek	8. CONTRACT OR GRANT NUMBER(s): DNA 001-79-C-0473
9. PERFORMING ORGANIZATION NAME AND ADDRESS: JRB Associates, 8400 Westpark Drive, McLean, Virginia 22102	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Subtask U99QAXMK506 08
11. CONTROLLING OFFICE NAME AND ADDRESS: Director, Defense Nuclear Agency, Washington, D.C. 20305	12. REPORT DATE: 23 November 1981
	13. NUMBER OF PAGES: 274
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This work was sponsored by the Defense Nuclear Agency under RDT&E RMSS Code B350079464 U99QAXMK50608 H2590D. For sale by National Technical Information Service, Springfield, VA 22161.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

TEAPOT
APPLE 2
BEE
Exercise Desert Rock VI
AFSWP
AFSWC
Nevada Test Site
Nuclear Test Personnel Review

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the activities of an estimated 11,000 DOD personnel, both military and civilian, in Operation TEAPOT, the fifth atmospheric nuclear weapons testing series conducted in Nevada from 18 February to 15 May 1955. Activities engaging DOD personnel included Exercise Desert Rock VI observer programs, troop tests, and technical service programs; AEC scientific and diagnostic experiments to evaluate the effects of the nuclear device; DOD operational training programs; and air support.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

18. SUPPLEMENTARY NOTES (Cont.)
The Defense Nuclear Agency Action Officer, Lt. Col. H. L. Reese, USAF, under whom this work was done, wishes to acknowledge the research and editing contribution of nuroerious reviewers in the military services and other organizations in addition to those writers listed in block 7.

Fact Sheet

dna
Defense Nuclear Agency
Public Affairs Office
Washington, D C 20305

Subject: TEAPOT Series

Operation TEAPOT was the fifth series of atmospheric nuclear weapons tests conducted by the Atomic Energy Commission (AEC) within the continental United States. The Series, which consisted of 14 nuclear events and one non-nuclear detonation, was conducted at the Nevada Test Site (NTS) from 18 February to 15 May 1955. As of October 1981, the military services estimate that about 11,000 Department of Defense (DOD) personnel participated in observer programs, tactical maneuvers, and scientific studies. The Series was intended to test nuclear devices for possible inclusion in the weapons arsenal, improve military tactics, equipment, and training, and study civil defense requirements.

Department of Defense Involvement

About 8,000 of the DOD participants at Operation TEAPOT took part in Exercise Desert Rock VI. The remaining DOD personnel assisted in scientific experiments, or administration and support activities for the Joint Test Organization (JTO).

Exercise Desert Rock VI, an Army program involving members of the armed services, included observer activities, troop tests, and technical studies. Observer programs, conducted at Shots WASP, MOTH, TESLA, TURK, BEE, ESS, APPLE 1, and APPLE 2, generally involved instruction on the effects of nuclear weapons, observation of a nuclear detonation, and a subsequent tour of a display of military equipment exposed to the detonation. Troop tests were designed to demonstrate military tactics and doctrine and to train command and staff personnel in all phases of planning and conducting combat operations under the anticipated conditions of nuclear warfare. Troop tests included the maneuvers performed at Shots BEE and APPLE 2. Technical studies were conducted at Shots WASP, MOTH, TESLA, TURK, BEE, ESS, APPLE 1, WASP PRIME, MET, and APPLE 2. These projects were used to train armed services personnel and to study the ability of different types of military equipment and structures to withstand nuclear detonations.

Scientific experiments studying the effects of each nuclear detonation were conducted by the Armed Forces Special Weapons Project (AFSWP) Military Effects Group, Los Alamos Scientific Laboratory Test Group, University of California Radiation Laboratory Test Group, and Federal Civil Defense Administration Civil Effects Test Group. Scientists and technicians from these test groups placed gauges, detectors, and other instruments around the point of detonation in the days and weeks preceding each scheduled nuclear test. After each shot, when the Test Manager had determined that the area was safe for limited access, these participants returned to the test area to recover equipment and gather data.

Support services for both Exercise Desert Rock VI and the JTO included radiological safety, security, transportation, communications, engineering, and logistics. During Operation TEAPOT, approximately 2,000 support troops were assigned to Camp Desert Rock to perform these duties for Exercise Desert Rock VI. The Desert Rock radiological safety section was comprised primarily of members of the 50th Chemical Service Platoon. Some other Desert Rock support elements included the 232nd Signal Company; the 23rd Transportation Truck Company; the 31st Transportation Truck Company; the 2nd Transportation Company; Company A, 505th Military Police Battalion; and the 94th Medical Detachment (Veterinary Food Inspection Service). In addition, the 12th Evacuation Hospital (-)* provided medical and dental care for the military personnel at Camp Desert Rock, and established aid stations for troops in the forward area.

The Air Force Special Weapons Center (AFSWC) provided aircraft and pilots for air drops, security sweeps, cloud sampling, cloud tracking, and aerial radiological surveys for the JTO. These missions were performed by the 4925th Test Group (Atomic), the 4926th Test Squadron (Sampling), the 4935th Air Base Squadron, and the 4900th Air Base Group. AFSWC aircraft staged from Indian Springs Air Force Base and Kirtland Air Force Base.

Radiation Protection Standards and Procedures

Safety criteria were established to minimize the exposure of participants to the effects of nuclear detonations while allowing them to accomplish their missions. Separate criteria were established for participants in Exercise Desert Rock VI, the JTO, and AFSWC. DOD established an exposure limit for Desert Rock troops of 6.0 roentgens of gamma radiation during Operation TEAPOT, with no more than 3.0 roentgens of prompt radiation. The Desert Rock limit was higher than for JTO participants because the Exercise Desert Rock troops, unlike the JTO participants and some AFSWC personnel, were not likely to be exposed to radiation after the Series.

To protect participants from the thermal and blast effects of nuclear detonations, the following additional exposure limits for Desert Rock participants were established:

- Five pounds per square inch of overpressure
- One calorie per square centimeter of thermal radiation.

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*Some subordinate units were not present.

The AEC authorized a maximum exposure for JTO personnel of 3.9 roentgens of gamma radiation during Operation TEAPOT. Since the TEAPOT operational period was approximately 13 weeks, this exposure limit was equivalent to the then-current 0.3 roentgens per week occupational exposure recommended by the National Council on Radiation Protection. AFSWC personnel were limited to the same exposure of 3.9 roentgens of gamma radiation unless otherwise specified.

In some instances, the Test Manager could authorize selected individual gamma radiation exposure limits higher than the standard 3.9 roentgens for JTO participants or 6.0 roentgens for Desert Rock participants. The Test Manager authorized a special exposure limit of 10.0 roentgens of gamma radiation for the ten Desert Rock volunteer officer observers at Shot APPLE 2, who observed the shot at 2,380 meters from ground zero, more than 800 meters closer than the other observers. All volunteer officer observers wore film badges and the average reading was 1.3 roentgens. The Test Manager also authorized a limit of 15 roentgens for the pilots of Military Effects Group Project 2.8b, Manned Penetrations of Atomic Clouds. Two film badge readings for participants in this project exceeded the limit of 15 roentgens. One reading of 21.7 roentgens was for a member of the 4926th Test Squadron, and the other of 21.8 roentgens was for a member of AFSWC headquarters.

Although the Test Manager was responsible for the radiological safety of all participants at TEAPOT, Exercise Desert Rock VI, the JTO, and AFSWC each had responsibility for implementing the radiological safety of its members. The 50th Chemical Service Platoon implemented procedures for Exercise Desert Rock VI. For the safety of all JTO personnel, onsite radiological safety operations were performed for the Test Manager by the Onsite Radiological Safety Organization, headed by the Chief of the Radiological Safety Branch of AFSWP Field Command. The 1st Radiological Safety Support Unit, Fort McClellan, Alabama, provided the main support for the onsite organization and consisted entirely of DOD personnel. Radiological safety procedures for AFSWC personnel at Kirtland Air Force Base were implemented by the 4901st Air Base Wing. For personnel at Indian Springs Air Force Base, AFSWC radiological safety procedures were implemented by the Test Aircraft Branch.

Although the missions of each organization required different types of activities and separate radiation protection plans and staffs, the general procedures were similar:

- Orientation and training - preparing radiological monitors for their work and familiarizing participants with radiological safety procedures

- Personnel dosimetry - issuing, processing, and developing film badges for participants, and analyzing gamma radiation exposures recorded on film badges

- Use of protective equipment - providing anticontamination equipment, including clothing and respirators
- Monitoring - performing radiological surveys and controlling access to all contaminated areas
- Briefing - informing observers and project personnel of radiological hazards and the current status of contamination in the test area
- Decontamination - detecting, removing, and disposing of contaminated material from personnel and equipment.

Summaries of TEAPOT Events

The 15 TEAPOT events are summarized in the accompanying table and the ground zeros are shown in the accompanying map. Eight shots--WASP, TESLA, TURK, BEE, ESS, APPLE 1, MET, and APPLE 2--each included more than 500 DOD participants and are described below.

Shot WASP, an airdropped nuclear device, was detonated at an altitude of 762 feet above Area 7 of Yucca Flat. It had a yield of one kiloton and occurred at 1200 hours on 18 February 1955. Onsite residual radiation greater than 0.01 R/h was confined to a circular area extending about two kilometers from ground zero. As part of Exercise Desert Rock VI, the armed services conducted troop observer and technical service programs involving more than 900 exercise troops, primarily as observers. Troops were scheduled to view the detonation from trenches 4,500 meters south of ground zero, but these trenches were in the predicted path of fallout. Observers therefore viewed the detonation from News Nob, approximately 14 kilometers south of ground zero. Since the equipment display area was also in the path predicted for the fallout, the postshot tour of the display area was canceled.

Shot TESLA, a 300-foot tower detonation, was fired at 0530 hours on 1 March 1955 in Area 9. Although the predicted yield was two kilotons, the nuclear device detonated with a yield of seven kilotons. As at Shot WASP, the armed services conducted troop observer, troop test, and technical service programs as part of Exercise Desert Rock VI. These programs involved almost 600 troops, primarily Camp Desert Rock support troops, observing the shot. The closest troops witnessed the detonation from trenches 2,220 meters southwest of ground zero. Because of high radiation levels, the troops could inspect the display area only up to 900 meters from ground zero. Fallout intensities of up to 10 R/h were detected during the initial survey about 800 meters southwest and south of ground zero.

Shot TURK, a 500-foot tower detonation, was fired with a yield of 43 kilotons at 0520 hours on 7 March 1955 in Area 2. Fallout of up to 10 R/h was detected about 2,100 meters southeast of ground zero during the initial survey, which was conducted from 0630 to 0915 hours. Exercise Desert Rock included observer, troop test, and technical service programs. Most of the 500 Desert Rock troops were support troops observing the shot. Trenches were constructed for TURK troop observers 3,200 meters south of ground zero, but because these trenches were in the expected fallout path, they were not used. Instead, troops occupied the TESLA trenches, located about 5,000 meters southeast of the TURK ground zero. The postshot tour of the display area was postponed until the day after the shot, due to radiation levels in the display area on shot-day.

Shot BEE, a 500-foot tower detonation, was fired with a yield of eight kilotons at 0505 hours on 22 March 1955 in Area 7 of Yucca Flat. Fallout of 10 R/h was detected around ground zero during the initial survey. Fallout between 0.01 R/h and 0.1 R/h extended east of ground zero. At BEE, almost 3,000 personnel performed Exercise Desert Rock troop observer, troop test, and technical service programs. At Shot BEE, about 299 officers and 1,972 enlisted men of the Third Marine Corps Provisional Atomic Exercise Brigade participated in the largest single activity of the TEAPOT Series, the Marine Brigade Exercise. The Marine Brigade was comprised of units from the 1st Marine Division and the 3d Marine Air Wing. Air operations units for the exercise included Marine Helicopter Transport Group 36, Marine Air Support Squadron 363. The Marine Brigade Exercise provided the opportunity for training personnel and for testing the tactics and techniques employed if a nuclear detonation were used in support of an air-ground task force. After the participants observed the shot, some from trenches 3,200 meters southwest of ground zero, they conducted a maneuver, which consisted of an airlift and an assault on the objectives. They then toured the equipment display area. A total of 30 H-19 helicopters took part in the airlift, which began about five minutes after the detonation and was completed almost four hours later. After disembarking from the helicopters, the Marines seized objectives about 15 kilometers west of ground zero. This part of the maneuver ended at 1500 hours, at which time the Marines toured the display area, located from 460 to 2,560 meters southwest of ground zero. Observers had toured this area earlier. At 1730 hours, when the maneuver was completed, the Marines checked in at the decontamination station at Yucca Pass.

Shot ESS, the only subsurface detonation of the TEAPOT Series, was fired with a yield of one kiloton at 1230 hours on 23 March 1955 in Area 10 of Yucca Flat. The ESS event was an operational test of an atomic demolition munition. Fallout greater than 0.01 R/h occurred mainly southeast of ground zero, but extended up to 2,500 meters southwest of ground zero. Because the nuclear device was buried 67 feet underground, tons of earth were blown upward by the detonation, creating a crater 88 meters wide and 96 feet deep. Exercise Desert Rock troop observer, troop test, and technical service programs engaged almost 800 troops during Shot ESS. Approximately 350 of these troops were observers. The closest troops witnessed the detonation in the open 8,230 meters southwest of ground zero. One of the other Exercise Desert Rock projects, Project 40.16, was designed to place and test the ESS demolition munition. Personnel of the 271st Engineer Combat Battalion excavated the shaft and placed the ESS device. Project 40.9, Passive Defense Training, was conducted to train Navy civilian shipyard and laboratory personnel in establishing safe working conditions close to a nuclear detonation. A total of 168 individuals from Navy units all over the country participated in pre- and postshot training, including monitoring techniques and practice rescue operations. Two other projects, Location of Atomic Bursts and Ordnance Vehicular Equipment Test, occupied the remainder of the Exercise Desert Rock participants at Shot ESS.

Shot APPLE 1, a 500-foot tower detonation, was fired with a yield of 14 kilotons at 0455 hours on 29 March 1955 in Area 4. Onsite fallout of up to 10 R/h was detected during the initial survey. Exercise Desert Rock VI troop observer, troop test, and technical service projects engaged more than 600 troops at APPLE 1, primarily Camp Desert Rock support troops observing the shot. Troops witnessed the detonation from trenches 3,200 meters south-southwest of ground zero. After the detonation, they toured the equipment display area, 900 to 2,250 meters southwest of ground zero. In another Exercise Desert Rock project, Sixth Army Passive Defense Training, about 24 persons conducted surveys of the ground zero area on the day after the shot, establishing the 1 and 5 R/h lines to within 100 meters of ground zero.

Shot MET, a 500-foot tower detonation, was fired with a yield of 22 kilotons at 1115 hours on 15 April 1955 in Frenchman Flat. Fallout of up to 10 R/h was detected around ground zero, extending no farther than 1,500 meters southwest of ground zero. Shot MET, an acronym for Military Effects Test, involved the largest number of scientific experiments of any shot in the TEAPOT Series. A total of 38 experiments were conducted by DOD personnel of the Military Effects Group. Because of the extensive preparation required for these experiments beforehand, MET was detonated in Frenchman Flat, away from other shots in the TEAPOT Series, to allow project participants to work throughout the Series unhampered by radioactivity from other shots. Desert Rock programs engaged approximately 260 troops, primarily Camp Desert Rock support troops observing the shot. The troops witnessed the detonation from ten kilometers southwest of ground zero.

Shot APPLE 2, a 500-foot tower detonation, was fired with a yield of 29 kilotons at 0510 hours on 5 May 1955 in Area 1 of Yucca Flat. Onsite fallout occurred northwest of ground zero. Readings of 10 R/h were detected northwest of ground zero almost two hours after the detonation. In addition to troop observer, troop test, and technical service programs conducted as part of Exercise Desert Rock VI, which involved about 800 troops, one special troop test involved about 1,000 troops at Shot APPLE 2. The test of an Armored Task Force, RAZOR, was designed to demonstrate the capability of a reinforced tank battalion to seize an objective immediately after a nuclear detonation. This project was sponsored by the Army Armored School of Fort Knox, Kentucky. Task Force RAZOR was composed of the following armored units:

Camp Irwin, California

- 723rd Tank Battalion

Fort Hood, Texas

- Company C, 510th Armored Infantry Battalion, 4th Armored Division
- Company B, 510th Armored Infantry Battalion, 4th Armored Division
- 1st Platoon, Battery A, 22nd Armored Field Artillery Battalion, 4th Armored Division
- 1st Platoon, Company C, 24th Armored Engineer Battalion, 4th Armored Division
- Provisional Aviation Company, 1st Armored Division.

The armored test involved the following activities:

- A tactical march across open desert terrain from Camp Irwin to the NTS
- Participation in the APPLE 2 event and the armored task force maneuver
- An overland march back to Camp Irwin
- A chemical warfare exercise at Camp Irwin.

Vehicles employed in the maneuver included 55 M48 tanks, two M41 tanks, five M74 tank recovery vehicles, one M75 armored personnel carrier, 25 M59 armored personnel carriers, four M7B2 self-propelled 105 mm howitzers, and about 150 wheeled vehicles.

The four-day overland march from Camp Irwin began 18 April 1955 and ended 21 April 1955. From 21 April to 4 May, the task force rehearsed the maneuver in the forward area of the NTS. Three times during this period, the task force camped in Yucca Flat in preparation for the shot, but in each instance, the shot was postponed due to poor weather. On 4 May 1955, the day before detonation, the task force vehicles were positioned northbound, from three to five kilometers south of ground zero. At the time of the shot, all tank turrets were rotated to the rear, all sight apertures were sealed with opaque tape, and all hatches were closed and secured. All personnel took protective measures appropriate to their distance from the shot. The detonation caused no significant damage to the task force, although most of the engine and fan access panels were dislodged from the M59 personnel carriers. They were repositioned for the maneuver, which began upon clearance by the Test Director.

About eight minutes after the shot, all units were mobilized and moving toward ground zero, maintaining radio contact with the Task Force Commander. About 20 monitors from the 50th Chemical Service Platoon were provided to check radiation levels during the assault. When the tanks closest to ground zero obtained an inside reading of 1 R/h, about 890 meters from ground zero, the Task Force Commander ordered the formation to execute a partial left turn away from ground zero. Two M59s in the rear of the formation temporarily lost contact and moved to within 820 meters of ground zero before they recovered and joined the rest of the task force a few minutes later. After passing through a defile at Syncline Ridge, the task force attained its objective, about 6.4 kilometers from the preshot position, about 90 minutes after detonation. To bring realism to the maneuver, tank guns and coaxial machine-guns fired blanks in the final stages of the assault. After the maneuver, task force members were brushed with brooms to remove dust and debris, even though monitoring of both personnel and vehicles showed no significant contamination.

Radiation Exposures at TEAPOT

As of November 1981, the military services had identified 7,930 participants by name for Operation TEAPOT. Film badge data are available for 4,504 of these participants, as shown in the "Summarv of Dosimetry for Operation TEAPOT" table. It is estimated that the total number of participants in Operation TEAPOT was approximately 11,000 personnel. Using this estimate, 72 percent have been identified by name and film badge data has been located for 41 percent. The table also includes information, listed by service or affiliation, on the number of personnel in various dose ranges, the number of personnel with zero gamma exposure, the average gamma exposure and the maximum gamma exposure.

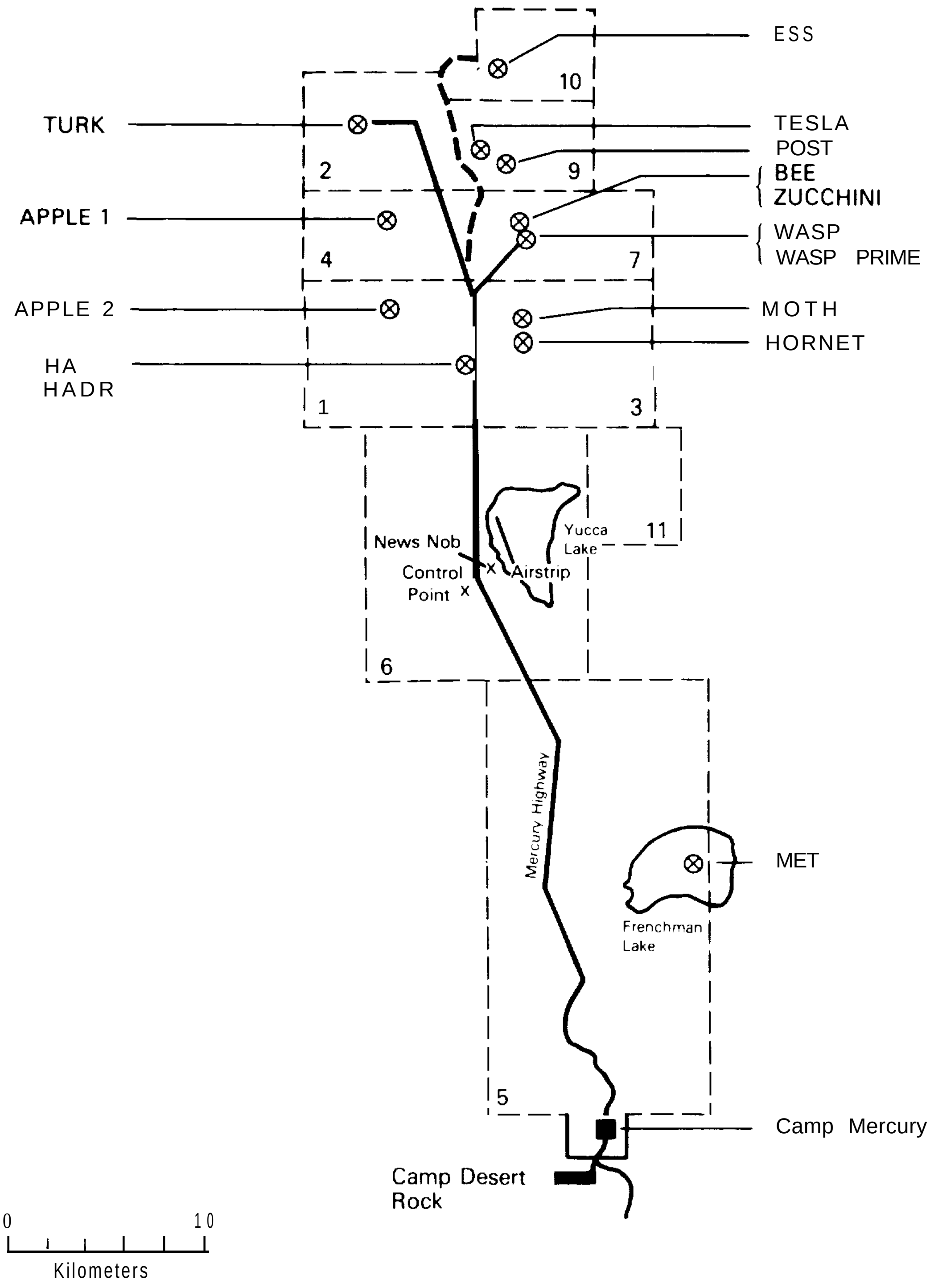
Film badge data are generally unavailable for Desert Rock VI participants. Therefore, most Army participants identified by name and film badge in the table were probably associated with JTO activites. However, some aggregate exposure data for Desert Rock VI participants is available in the Final Report of Operations, Desert Rock VI. It states that, for Desert Rock personnel:

- 97 individuals received over 3.0 but less than 6.0 roentgens of exposure
- 15 individuals received between 6.0 and 20.0 roentgens of exposure
- Two individuals received over 20.0 roentgens of exposure.

SUMMARY OF OPERATION TEAPOT EVENTS (1955)

Shot	WASP	MOTH	TESLA	TURK	HORNET	BEE	ESS	HADR	APPLE 1	WASP PRIME	HA	POST	MET	APPLE 2	ZUCCHINI
Sponsor	LASL	LASL	UCRL	UCRL	LASL	LASL	DOD	DOD	LASL	LASL	DOD	UCRL	LASL/ DOD	LASL	LASL
Planned Date	18 Feb	22 Feb	25 Feb	15 Feb	8 March	18 March	15 March	1 March	18 March	20 March	4 March	1 March	1 March	26 April	1 April
Actual Date	18 Feb	22 Feb	1 March	7 March	12 March	22 March	23 March	25 March	29 March	29 March	6 April	9 April	15 April	5 May	15 May
Local Time	1200	0545	0530	0520	0520	0505	1230	0900	0455	1000	1000	0430	1115	0510	0500
NTS Location	Area 7	Area 3	Area 9	Area 2	Area 3	Area 7	Area 10	Above Area 1	Area 4	Area 7	Above Area 1	Area 9	Area 5	Area 1	Area 7
Type of Detonation	Airdrop	Tower	Tower	Tower	Tower	Tower	Shaft	Airdrop	Tower	Airdrop	Airdrop	Tower	Tower	Tower	Tower
Height of Burst (Feet)	762	300	300	500	300	500	-67	38,000*	500	737	36.620"	300	400	500	500
Actual Yield (kt.)	1	2	7	43	4	8	1	(non-nuclear)	14	3	3	2	22	29	28

* Mean sea level



NEVADA TEST SITE SHOWING LOCATIONS OF SHOT GROUND ZEROS IN TEAPOT SERIES

SUMMARY OF DOSIMETRY FOR OPERATION TEAPOT
AS OF NOVEMBER 1981

Service	Personnel Identified By Name	Personnel Identified By Name and By Film Badge	Gamma Exposure (Roentgens)					Number of Personnel with Zero Gamma Exposure*	Average Gamma Exposure (Roentgens)	Maximum Gamma Exposure (Roentgens)
			< .1	.1-1.0	1.0-3.0	3.0-5.0	5.0+			
Army	2,144	761	400	121	126	96	18	352	1.083	19.3
Navy	407	160	61	48	31	16	4	11	1.121	12.4
Air Force	603	603	290	154	97	53	9	1	.879	21.8
Marine Corps	2,305	510	117	391	2	0	0	67	.317	1.2
Scientific Personnel, Contractors, and Affiliates	123	122	74	28	18	2	0	27	.437	4.1
Service Unknown**	2,348	2,348	1,449	681	196	22	0	873	.282	3.8
TOTAL	7,930	4,504	2,391	1.423	470	189	31	1,331	.535	

* The number of personnel in this column is also represented in the < .1 Gamma Exposure column.
** Film badge data are available, but service affiliation is not.

PREFACE

Between 1945 and 1962, the United States Government, through the Manhattan Engineer District and its successor agency, the Atomic Energy Commission (AEC), conducted 235 atmospheric nuclear weapons tests at sites in the southwestern U.S. and in the Pacific and Atlantic Oceans. In all, an estimated 220,000 Department of Defense (DOD) participants, both military and civilian, were present at the tests. Approximately 90,000 of these participants were present at the nuclear weapons tests conducted at the Nevada Test Site (NTS),* northwest of Las Vegas, Nevada.

In 1977, 15 years after the last above-ground nuclear weapons test, the Center for Disease Control+ noted a possible leukemia cluster among a small group of soidiers present at Shot SMOKY, one weapons related test of Operation PLUMBBOB, the series of nuclear weapons tests conducted in 1957. Since that initial report by the Center for Disease Control, the Veterans Administration 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 weapons tests.

In late 1977, the DOD began a study that provided data to both the Center for Disease Control and the Veterans Administration on possible exposures to ionizing radiation among its military and civilian personnel who participated in the

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*The Nevada Proving Ground was renamed the Nevada Test Site during the TEAPOT Series.

+The Center for Disease Control is part of the U.S. Department of Health and Human Services (formerly the U.S. Department of Health, Education, and Welfare).

atmospheric nuclear weapons tests. The DOD organized an effort to:

- Identify DOD personnel who had taken part in the atmospheric nuclear weapons 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 weapons tests.

This report on Operation TEAPOT is based on the historical and technical documents associated with each of the atmospheric nuclear weapons tests conducted during the Series. The reports provide a public record of the activities and possible radiation exposure for use in ongoing public health research and policy analysis.

METHODS AND SOURCES USED TO PREPARE THIS VOLUME

The Defense Nuclear Agency compiled information for this volume by examining available documents that record the military operations and scientific activities performed during Operation TEAPOT, the series of nuclear weapons tests conducted in 1955. These records, most of which were developed by individuals and organizations participating in the TEAPOT Series, are kept in over three dozen document repositories throughout the United States.

In compiling information for this report, teams of historians, health physicists, radiation specialists, and information analysts canvassed document repositories known to contain materials on the nuclear weapons tests conducted in the southwestern U.S. These repositories include armed services libraries, Government agency archives and libraries, Federal repositories, and libraries of scientific and technical laboratories. The teams examined classified and unclassified documents containing information on DOD participation in Operation TEAPOT. Researchers recorded relevant information concerning the activities of DOD personnel during TEAPOT, and catalogued the data sources.

Gathering data for this study presented a variety of challenges. Many different military and civilian organizations were involved in developing and storing records related to Operation TEAPOT. Each branch of the armed services and each civilian organization had its own system of recording information. Much material was not preserved, because it was not considered important at the time. In addition, some records have been lost or destroyed over the years. Other records have been transferred from one repository to another, and accounts of the transfer of documents are not always available.

An important example of such discrepancies is the documentation dealing with air operations at Operation TEAPOT. Several postshot and post-series documents were analyzed to determine the nature and extent of these air activities, including Parsons' Operational Summary (WT-1158) and Fackler's Technical Air Operations (WT-1206). The Operational Summary provides an overview of all activities conducted during the testing, primarily those of AFSWP. Technical Air Operations, however, is a more specific document, chronicling in detail the air operations of DOD personnel. Discrepancies as to numbers of aircraft actually participating in any single event exist between these two documents and other TEAPOT documents. When possible, these discrepancies were resolved through additional research. In those cases for which further research failed to resolve the problem, the Technical Air Operations report, WT-1206, was used because it deals specifically with air operations at TEAPOT and therefore is considered the more reliable document for determining the extent and nature of air operations.

Commonly, the surviving historical documentation of activities conducted during Operation TEAPOT addresses test specifications and technical information, rather than personnel data. Moreover, instances have arisen in which available historical documentation has revealed inconsistencies in vital factual data, such as the number of DOD participants in a certain project at a given shot or their locations and assignments at a given time. These inconsistencies in data usually occur between two or more documents, but occasionally appear within the same document. Efforts have been made to resolve these data inconsistencies wherever possible, or to otherwise bring them to the attention of the reader.

For several of the Desert Rock VI and Joint Test Organization (JTO) projects discussed in the TEAPOT volumes, the only available documents describing personnel activities are the Sixth Army's Desert Rock VI Operations Orders and the Test Director's schedule of events from "Operation Order l-55." These sources detail the plans developed by DOD and AEC personnel prior to the TEAPOT Series; they do not necessarily describe the projects as conducted at the NTS. After-action documents, such as the Final Report of Operations for Exercise Desert Rock VI and the Weapons Tests Reports for the Armed Forces Special Weapons Project (AFSWP), summarize the projects performed during the TEAPOT Series, but do not always supply shot-specific information about personnel-related activities. Therefore, it is not known if all of the projects addressed in the planning documents and discussed in the volume were conducted exactly as planned.

ORGANIZATION OF TEAPOT REPORTS

This volume details participation by DOD personnel in Operation TEAPOT, the fifth nuclear weapons testing series conducted at the NTS. Four other publications address DOD activities during the TEAPOT Series:

- Shot Volume: Shots WASP through HORNET, the Early TEAPOT Tests

* Shot Volume: Shot BEE
* Shot Volume : Shot APPLE 2
* Shot Volume: Shots ESS through MET and Shot ZUCCHINI, the Final TEAPOT Tests

The volumes addressing the test events of Operation TEAPOT have been designed for use with one another. The Series volume contains information that applies to those dimensions of Operation TEAPOT that transcend specific events, such as historical background, organizational relationships, and radiological safety procedures. In addition, this volume contains a bibliography of all works consulted in the preparation of all five Operation TEAPOT reports. The two single-shot volumes describe DOD participation in Shots BEE and APPLE 2, respectively. These two events have been bound separately because they included significant Exercise Desert Rock maneuvers involving large numbers of DOD people. Each multi-shot volume combines shot-specific descriptions for several nuclear events. The shot and multi-shot volumes contain bibliographies only of the sources referenced in each text. Descriptions of activities concerning any particular shot in the TEAPOT Series, whether the shot is addressed in a single-shot volume or in a multi-shot volume, should be supplemented by the general organizational and radiological safety information contained in this volume.

The information in these reports is supplemented by the Reference Manual: Background Materials for the CONUS Volumes. This document summarizes information on radiation physics, radiation health concepts, exposure criteria, and measurement techniques, as well as a list of acronyms and a glossary of terms used in the DOD reports addressing test events in the continental U.S.

This volume is divided into six chapters. Chapter 1 provides background information about Operation TEAPOT, including an explanation of the historical context of the Series, a description of the NTS, a summary and comparison of the 15 events in the Series, and a summary of DOD participants.

Chapter 2 describes the two groups with major DOD participation at Operation TEAPOT, the Joint Test Organization (JTO) and Exercise Desert Rock VI. This chapter defines the responsibilities of each group and its components in planning, administering, and supporting the tests of the nuclear device and in conducting other activities in conjunction with those tests.

Chapter 3 describes the Exercise Desert Rock VI military activities conducted during Operation TEAPOT, while chapter 4 describes various training activities, military effects and diagnostic experiments, and support missions conducted by DOD personnel. These chapters define objectives of the activities, describe the planned and actual procedures, and indicate at which shots the programs occurred.

Chapter 5 describes the radiological safety criteria and procedures in effect during Operation TEAPOT.

Chapter 6 is a study of the results of the radiation protection program during Operation TEAPOT, including an analysis of film badge readings for DOD personnel.

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LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used in this volume:

AEC	Atomic Energy Commission
AFB	Air Force Base
AFSWC	Air Force Special Weapons Center
AFSWP	Armed Forces Special Weapons Project
BJY	BUSTER-JANGLE "Y"
CETG	Civil Effects Test Group
CONUS	Continental United States
DOD	Department of Defense
DWET	Directorate Weapons Effects Tests
EG and G	Edgerton, Germeshausen, and Grier
FCDA	Federal Civil Defense Administration
GZ	Ground Zero
JTO	Joint Test Organization
LASL	Los Alamos Scientific Laboratory
MEG	Military Effects Group
NTS	Nevada Test Site
OCAFF	Office, Chief of Army Field Forces
REECo	Reynolds Electrical and Engineering Company
R/h	Roentgen per hour
UCRL	University of California Radiation Laboratory
USAF	United States Air Force
UTM	Universal Transverse Mercator
VFIS	Veterinary Food Inspection Service

CHAPTER 1

INTRODUCTION TO OPERATION TEAPOT

Operation TEAPOT, the fifth series of nuclear weapons tests conducted at the Nevada Test Site (NTS), consisted of 14 nuclear detonations and one non-nuclear test. The TEAPOT Series lasted from 18 February 1955 to 15 May 1955, and involved an estimated 11,000 DOD personnel participating in observer programs, tactical maneuvers, and military effects and scientific studies. The series was intended to test nuclear weapons for possible inclusion in the defense arsenal, to improve military tactics, equipment, and training, and to enhance the understanding of civil defense requirements (47)*.

This volume summarizes information on organizations, procedures, and activities in the TEAPOT Series. The background information in this chapter includes:

- A discussion of the international and domestic situation which existed in 1955 when the TEAPOT tests were conducted
- A description of the NTS
- A synopsis of the 15 individual events
- An overview of DOD participation at Operation TEAPOT.

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*All sources cited in the text are listed alphabetically and numbered in the Reference List, appended at the back of this volume. The number given within the citation in the text is the number of the source document in the Reference List.

This information provides a basis for understanding the nature and extent of DOD participation discussed in more detail in this volume and the four shot and multi-shot volumes which constitute the TEAPOT reports.

1.1 INTERNATIONAL AND DOMESTIC CONDITIONS INFLUENCING OPERATION TEAPOT

Operation TEAPOT was planned and conducted to enhance a defense policy that increasingly relied on nuclear weapons.

The role of nuclear weapons in the United States defense policy evolved as a result of a series of events occurring in the late 1940s and early 1950s. These events included the testing by the Soviet Union of an atomic bomb in 1949 and the commitment of U.S. ground forces on the Korean peninsula. To reduce the necessity of a large standing army and minimize the likelihood of a surprise attack by the Soviet Union, the United States deployed a strategic nuclear arsenal capable of inflicting massive destruction on critical targets throughout the USSR. This policy led to the development of strategic nuclear weapons for arming international ballistic missiles and aircraft for the USAF Strategic Air Command. It also led to exploring the potential for tactical battlefield use of smaller nuclear devices (290; 304).

The Chairman of the Atomic Energy Commission (AEC) strongly advocated the development of nuclear devices for tactical purposes. Describing the prospects for new types of nuclear weapons, the AEC Chairman stated in 1951:

> What we are working toward here is a situation where we will have atomic weapons in almost as complete a variety as conventional ones.... This would include artillery shells, guided missiles, torpedoes, rockets and bombs for ground-support aircraft....We could use an atomic bomb today in a tactical way against enemy

> troops in the field, against military concentrations near battle areas and against other vital military targets without risk to our own troops. We are steadily increasing, through our technological and production progress, the number of situations in which atomic weapons can be effectively employed in battle areas (304).

Consequently, should tactical nuclear weapons be used in land combat, the military forces of the United States needed to be trained to react effectively.

Operation TEAPOT, authorized by President Eisenhower on 30 August 1954, was intended to address both the tactical and strategic considerations (26; 27). As a result, the 1955 Series had two major objectives:

- To improve the nuclear weapons used for strategic bomber delivery and missile'delivery and those used for tactical battlefield situations
- To establish military doctrine and tactics for the use of ground forces on a nuclear battlefield.

To attain the first objective, the AEC had planned to conduct scientific experiments during Operation TEAPOT to:

- Prove the adequacy of nuclear devices as warheads before they entered the country's nuclear weapons stockpile
- Test model nuclear devices for development as practical stockpile weapons
- Explore phenomena which could affect the efficiency and performance of nuclear weapons, but which could not be analyzed theoretically
- Determine the validity of recommendations to improve the efficiency of nuclear weapons
- Observe detonations and obtain new information pertinent to weapons development
- Accelerate the development cycle by substituting tests for lengthy laboratory programs
- Obtain basic scientific information (1).

To achieve the second objective, that of preparing for the tactical battlefield use of nuclear weapons, the Department of Defense conducted Exercise Desert Rock VI. The significant advantage in firepower which the new weapons gave ground units would not eliminate the need to follow established principles of movement and position. It was essential that military units become familiar with the new weapons and their special characteristics. The best way to accomplish this was through realistic field exercises, a prominent feature of Exercise Desert Rock VI, which also included observation and training programs, military maneuvers, and tests of equipment and tactics (32; 133).

Although the NTS was isolated from major population centers, domestic concern over radioactive fallout resulting from continental atmospheric testing was an important planning consideration during the preparations for Operation TEAPOT. Weather conditions were critical in assessing the direction and extent of possible fallout. Although a schedule of events was prepared for Operation TEAPOT, the schedule was adjusted as necessary. A Department of Army memorandum to the Chief, Army Field Forces, Fort Monroe, Virginia, reflected the AEC's revised weather policy:

> In the past year the AEC has been confronted with a considerable number of complaints from civilian sources because of the fallout of radioactive material near or on inhabited areas. To eliminate or drastically reduce this type of problem in TEAPOT and future tests it has been learned that the AEC will fire test shots only when the weather conditions are just right. It can be anticipated that this policy will tend to increase the possibility of last minute delays of all shots (109).

As a result the planned schedule for Operation TEAPOT was continually revised, as reflected in table l-l.* The delay of one shot often resulted in postponing subsequent shots, regardless of weather conditions. The many schedule changes caused, altogether, a six-week extension of Operation TEAPOT from 1 April to 15 May (47; 265).

1.2 THE NEVADA TEST SITE

Operation TEAPOT, like RANGER, BUSTER-JANGLE, TUMBLER-SNAPPER, and UPSHOT-KNOTHOLE, was conducted at the NTS, originally established as the Nevada Proving Ground by the AEC in December 1950. The area is located in the southeastern part of Nevada, 100 kilometers (62 miles)+ northwest of Las Vegas, as shown in figure l-l.

IN 1955 the NTS, as depicted in figure 1-2, encompassed approximately 1,600 square kilometers in Nye County. On its eastern, northern, and western boundaries, the NTS adjoined the Nellis AFB Bombing and Gunnery Range, of which it was a part before December 1950. The NTS, an area of high desert and

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*As listed in table l-l, Universal Transverse Mercator (UTM) coordinates are used in this report. The first three digits refer to a point on an east-west axis, and the second three digits refer to a point on a north-south axis. The point so designated is the southwest corner of an area 100 meters square. Since both Shots HADR and HA were detonated at high altitude, UTM coordinates are unavailable for their surface-zero locations. Their approximate location within Area 1 of the NTS is shown on figure l-2.

+Throughout this report, surface distances are given in metric units rounded up to the nearest whole number. The metric conversion factors include: 1 meter = 3.28 feet; 1 meter = 1.09 yards; 1 kilometer = 0.62 miles. Altitudes and other vertical distances are given in feet.

Table I-I: SUMMARY OF OPERATION TEAPOT EVENTS (1955)

Shot	WASP	MOTH	TESLA	TURK	HORNET	BEE	ESS	HADR	APPLE 1	WASP PRIME	HA	POST	MET	APPLE 2	ZUCCHINI
sponsor	LASL	LASL	UCAL	UCRL	LASL	LASL	DOD	DOD	LASL	LASL	DOD	UCRL	LASL DOD	LASL	LASL
Planned Date	18 Feb	22 Feb	25 Feb	15 Feb	8 March	18 March	15 March	1 March	18 March	20 March	4 March	1 March	1 March	26 April	1' April
Actual Date	18 Feb	22 Feb	1 March	7 March	12 March	22 March	23 March	25 March	29 March	29 March	6 April	9 April	15 April	5 May	15 May
Local Time	1200	0545	0530	0520	0520	0505	1230	0900	0455	1000	1000	0430	1115	0510	0500
NTS Location	Area 7	Area 3	Area 9	Area 2	Area 3	Area 7	Area 10	Above Area 1	Area 4	Area 7	Above Area 1	Area 9	Area 5	Area 1	Area 7
UTM Coordinates	869047	871004	844090	784104	8679%	667056	849138		797056	869047		860086	956728	798009	967056
Type of Detonation	Airdrop	Tower	Tower	Tower	Tower	Tower	Shaft	Airdrop	Tower	Airdrop	Airdrop	Tower	Tower	Tower	Tower
Height of Burst (Feet)	762	300	300	500	300	500	67	38,000*	500	737	36.620'	300	400	500	500
Actual Yield (kt)	1	2	7	43	4	8	1	non nuclear)	14	3	3	2	22	29	28

* Mean sea level

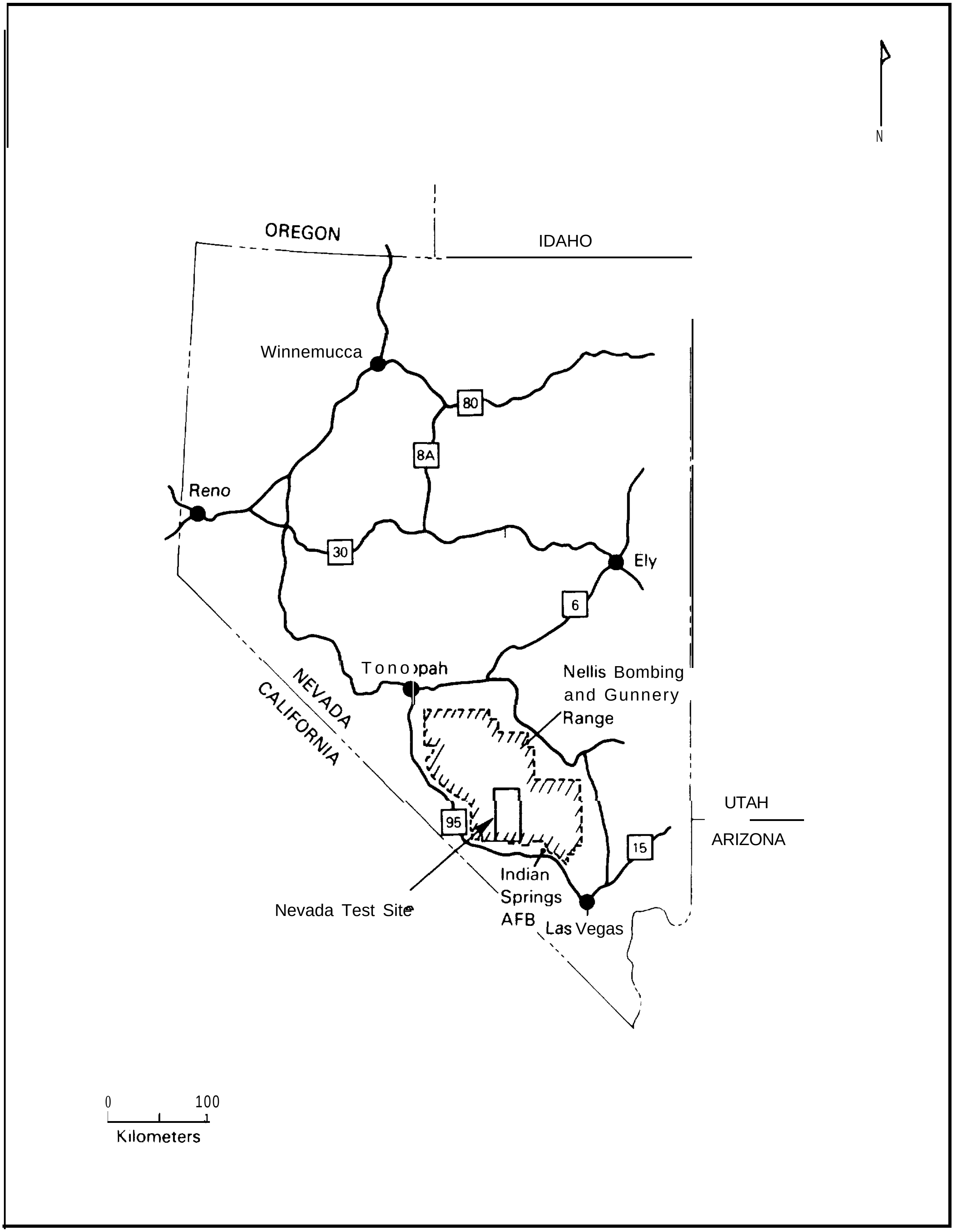

Figure I-I: LOCATION OF NEVADA TEST SITE

mountain terrain, was the location for most of the atmospheric nuclear weapons tests conducted within the continental U.S. from 1951 to 1962.

The nuclear weapons tests of Operation TEAPOT were conducted either in Yucca Flat or in Frenchman Flat. Yucca Flat is a 320-square-kilometer desert valley surrounded by mountains. Located in the north-central part of the NTS, Yucca Flat was the location of 13 of the 14 TEAPOT nuclear tests. The area boundaries outlined in figure l-2 approximate the Yucca Flat testing area. Frenchman Flat, which includes a 22-square-kilometer dry-lake basin, is located in the southeastern part of the NTS. Only one TEAPOT event, Shot MET, was conducted in this area. Yucca Flat and Frenchman Flat are linked by Mercury Highway, which extends north and south through Yucca Pass. Yucca Pass was the site of News Nob, a major observation point, and the Control Point. The Control Point, which consisted of nine permanent buildings, is situated on the west side of Yucca Pass. Detonation of all tower shots and the one subsurface shot, ESS, was controlled from Building 1 at the Control Point. The location permitted visual observation into the test areas of both Frenchman Flat to the southeast and Yucca Flat to the north. The Control Point also had decontamiantion facilities for personnel and vehicles returning from the testing areas.

Camp Mercury, situated at the southern boundary of the NTS, provided office and living quarters, as well as laboratory facilities and warehouses, for the temporary and permanent civilian personnel participating in the JTO test activities.

Camp Desert Rock, headquarters of the Desert Rock exercises, was just outside the NTS, three kilometers (about two miles) southwest of Camp Mercury. Camp Desert Rock consisted of temporary structures supplemented by trailers and tents as

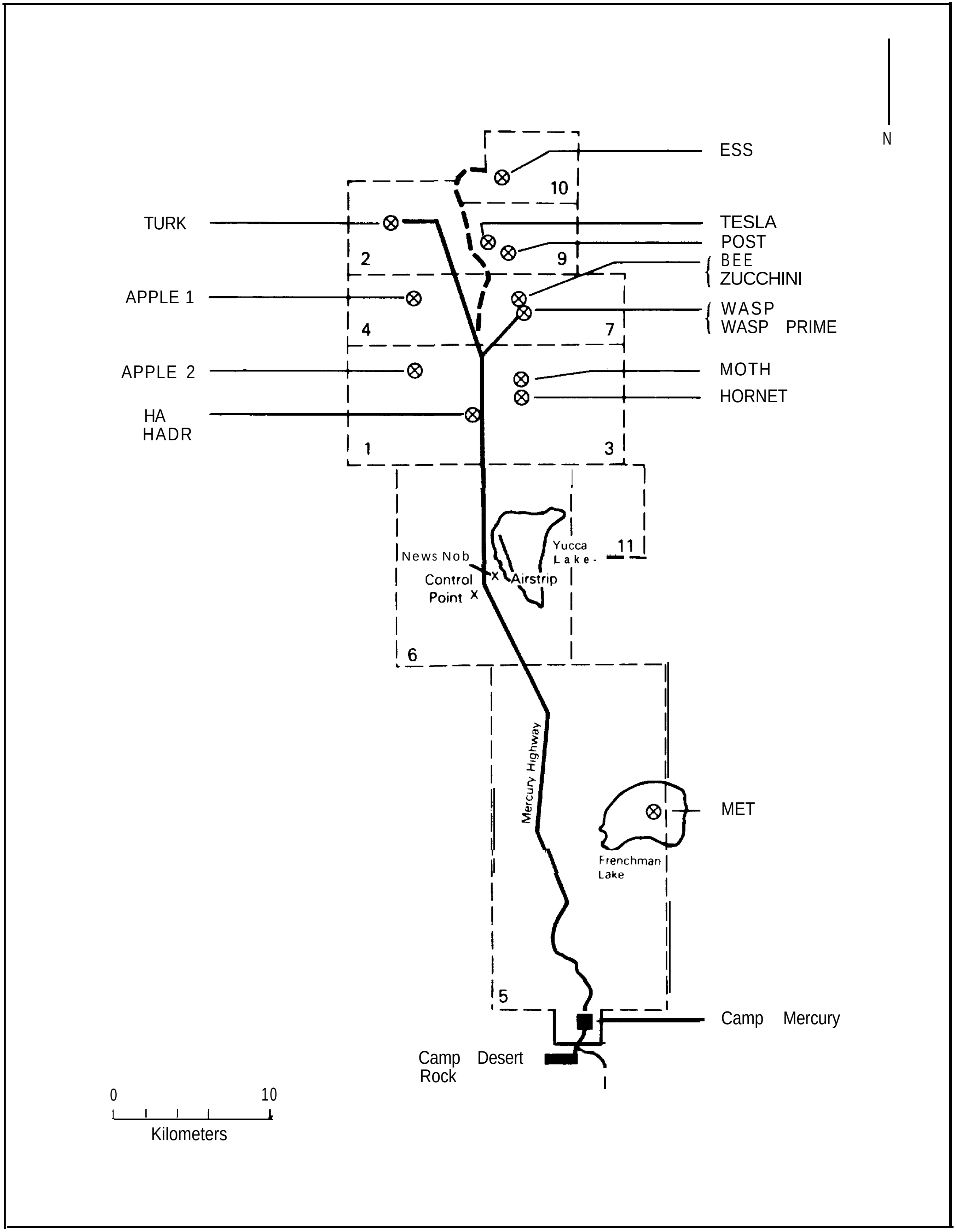

Figure 1-2: NEVADA TEST SITE SHOWING LOCATIONS OF SHOT GROUND ZEROS IN TEAPOT SERIES

necessary. The camp's population varied considerably, depending on the schedule of weapons' tests and associated troop maneuvers. When test operations were not being conducted, the camp would be maintained by fewer than 100 people. During test operation periods, however, Camp Desert Rock often housed several thousand DOD personnel on temporary assignment to participate in the nuclear weapons tests (245).

1.3 SUMMARY OF OPERATION TEAPOT EVENTS

During the planning for Operation TEAPOT, the AEC directed the Los Alamos Scientific Laboratory (LASL), the University of California Radiation Laboratory (UCRL), and the DOD to delineate experimental requirements that could be addressed during the 1955 test series (81). These proposals, when analyzed and evaluated, resulted in the scheduling of the events listed in table l-l.

The Operation TEAPOT events were designed to promote scientific and diagnostic research, and, on a basis of noninterference, to provide an opportunity for military testing, training, and maneuvers. The USAF Strategic Air Command, for example, used both Shot WASP and Shot WASP PRIME to test airdrop delivery techniques. Shot HADR (High Altitude Dress Rehearsal) was the only non-nuclear test conducted during Operation TEAPOT. This high-explosive device was detonated at 38,000 feet on 25 March 1955, so that the delivery and technical equipment to be used at the nuclear HA (High Altitude) event on 6 April could be calibrated prior to that detonation. Shot ESS, a prototype nuclear demolition munition and the only subsurface test during Operation TEAPOT, was detonated in Area 10 in a shaft 67 feet deep. All remaining shots in the TEAPOT Series were detonated from towers, which ranged in height from 300 feet to 500 feet. Tower shots, particularly BEE and APPLE 2, involved the largest number of DOD participants (87; 106; 107; 111).

1.4 DEPARTMENT OF DEFENSE PARTICIPANTS AND ACTIVITIES

Estimates provided by the military services indicate that approxmiately 11,000 Department of Defense personnel, both military and civilian, participated in various activities at Operation TEAPOT. These Department of Defense personnel participated in the following activities:

- JTO administration and support
- Test Group military effects and diagnostic activities
- DOD operational training projects
- Exercise Desert Rock VI support
- Exercise Desert Rock VI troop maneuvers, technical service projects, and observation programs
- Air support.

Approximately 8,000 participants at Operation TEAPOT took part in Exercise Desert Rock VI, the Army training and test program (133; 243). These participants included both Desert Rock troops and exercise troops. The exercise troops performed troop test maneuvers and technical service projects, or observed the detonations. The Desert Rock troops performed support services for Desert Rock activities and camp functions. Most of these troops observed at least one detonation in trenches or open areas along with exercise troop observers.

The remaining DOD personnel assisted in the administration of Operation TEAPOT or took part in the scientific, diagnostic, and operational training programs. These activities were conducted by various elements of the JTO, which was established for planning, coordinating, and conducting the TEAPOT nuclear weapons tests.

CHAPTER 2

RESPONSIBILITIES OF THE ADMINISTRATIVE ORGANIZATIONS DURING OPERATION TEAPOT

The Joint Test Organization (JTO) and Exercise Desert Rock VI were responsible for the activities conducted during Operation TEAPOT. This chapter describes how these groups were organized to plan, manage, and conduct the 15 weapons tests and the military effects, diagnostic, technical, and training projects that constituted Operation TEAPOT.

The JTO included representatives from the U.S. Atomic Energy Commission (AEC), the Department of Defense (DOD), the Federal Civil Defense Administration (FCDA) and the U.S. Public Health Service. Primary responsibilities of the JTO were to schedule and detonate the nuclear devices and to evaluate the results of each detonation. The Test Manager and his staff performed these functions, with assistance from the Test Director and his staff.

Exercise Desert Rock VI was staffed and administered by the Army and included personnel from the armed services. Exercise Desert Rock VI functioned separately from the JTO, with a liaison established between the two groups to ensure that Exercise Desert Rock VI technical and training programs did not interfere with the military effects and diagnostic programs of the JTO. Armed service personnel of Exercise Desert Rock VI were either support troops or exercise troops, as described in section 2.2. Desert Rock support troops resided at Camp Desert Rock throughout Operation TEAPOT and provided a number of services to the exercise troops, including security and law enforcement, radiological safety, medical care, transportation, engineering, mess, and laundry. Exercise troops were assigned to Camp Desert Rock for periods of a few days to a few weeks to participate in a particular program.

Other participants at TEAPOT included Federal Government agencies, research laboratories, and private firms under contract to the Government. Department of Defense personnel participated in the activities of many of these organizations, as well.

2.1 THE JOINT TEST ORGANIZATION

The AEC and the DOD shared responsibility for planning and implementing the nuclear weapons test program. The AEC was responsible for exploring and developing new areas of nuclear weapons technology, while the DOD was responsible for incorporating the weapons into the country's military defense program.

Congress established the AEC in 1946 with passage of the Atomic Energy Act. The AEC was organized into four divisions (5; 6; 8):

- Research
- Production
- Engineering
- Military Application.

The Director of the Division of Military Application supervised nuclear test operations from AEC Headquarters in Washington, D.C. A member of the Armed Forces, he delegated onsite responsibility for test preparations to the Manager of the AEC Santa Fe Operations Office. Before Operation TEAPOT, he authorized the Manager of the Santa Fe Operations Office to appoint a Test Manager to preside over the JTO at the NTS. Figure 2-1 shows the lines of authority from the President through both the AEC and DOD to the Test Manager and the JTO.

The principal DOD agency responsible for developing nuclear weaponry was the Armed Forces Special Weapons Project (AFSWP), created by Congress in 1947 (14). The Commander, Field Command, AFSWP, assisted the Test Manager in coordinating DOD participation, by appointing a Deputy for Military Operations to serve on

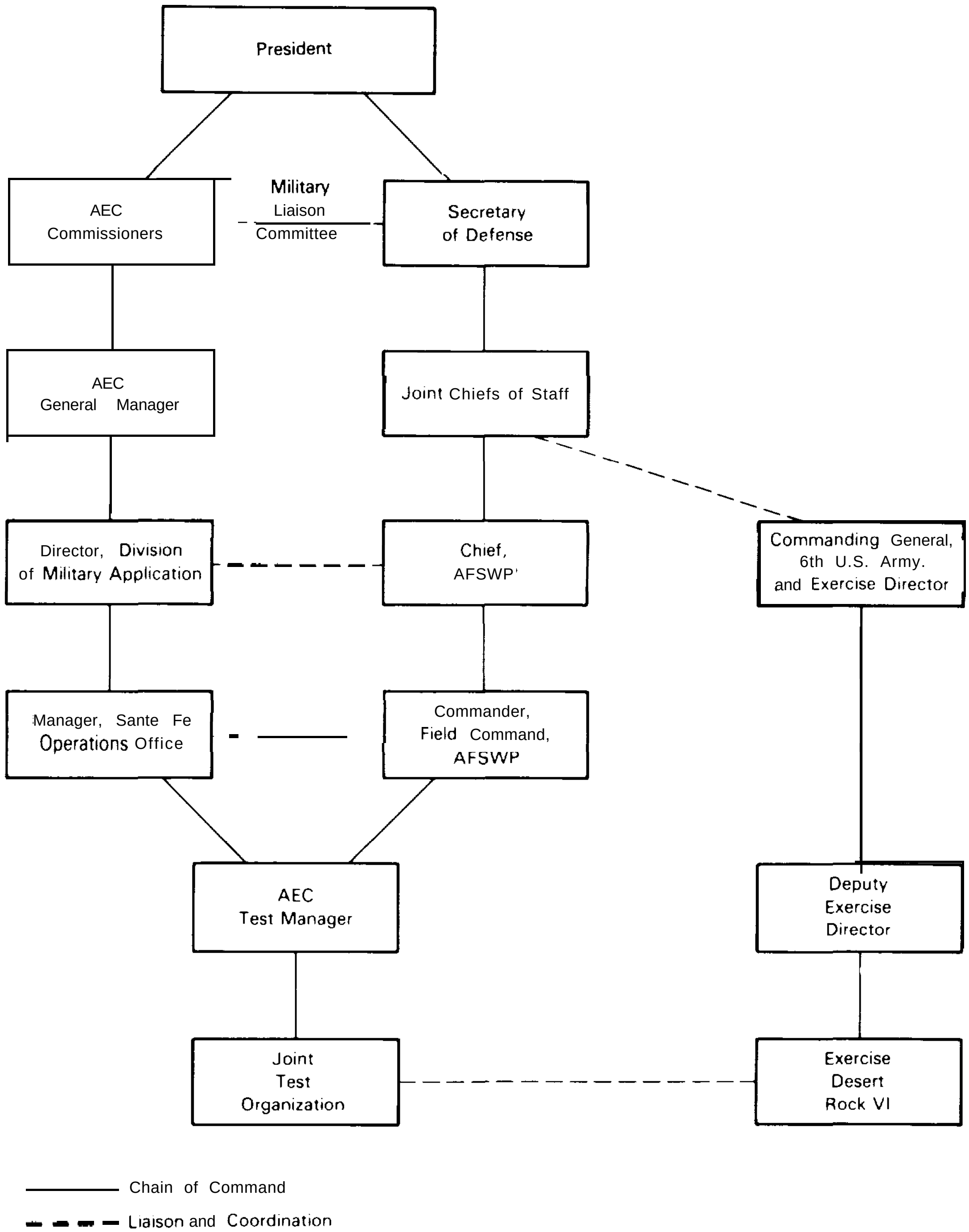

Figure 2-1: JOINT TEST ORGANIZATION/EXERCISE DESERT ROCK VI STRUCTURE WITHIN FEDERAL GOVERNMENT

the Test Manager's staff. The deputy and the DOD Operations Coordinator were responsible for coordinating DOD activities at the NTS with those of other test groups. The DOD activities included the weapons effects programs of the Field Command Military Effects Group; the DOD operational training program; the troop maneuvers, training programs, and technical tests that comprised Exercise Desert Rock VI; and the air support provided by the Air Force Special Weapons Center (AFSWC).

At the operational level, the relationship of the AEC with the DOD was formalized in a memorandum signed by the field officers of both the Santa Fe Operations Office and AFSWP Field Command. Dated 16 February 1953, the memorandum stated that, in matters relating to DOD participation at the NTS, the Test Manager was responsible to the Commander, Field Command, AFSWP. In matters not relating to DOD participation, however, the Test Manager reported to his superior at AEC headquarters, the Director of Military Application. This agreement was confirmed in a letter from the AEC to the Assistant to the Secretary of Defense for Atomic Energy (281).

The activities of troops involved in Exercise Desert Rock VI had to be coordinated with the programs of the JTO. During the planning and implementation phases of Operation TEAPOT, the Joint Chiefs of Staff coordinated the activities of Exercise Desert Rock VI through liaison with the Commanding General of the Sixth U.S. Army, the Exercise Director for Desert Rock VI. At the operational level, the AFSWP representative to the JTO, the Deputy for Military Operations, coordinated Exercise Desert Rock VI activities with those of the JTO.

Operational planning for the JTO began in June 1954. During the planning phases, the Test Manager worked with members of AFSWP Field Command to develop the Operation TEAPOT test schedule and to plan the JTO scientific, diagnostic, and support activities.

When Operation TEAPOT began in February 1955, the Test Manager was also assisted by the Scientific Advisor, the Deputy for Military Operations, and the Test Director, who was a scientist from the Los Alamos Scientific Laboratory (LASL). In order to staff the Joint Test Organization, personnel were drawn from the AEC Santa Fe Operations Office, AEC contractors, various DOD agencies, the Federal Civil Defense Administration, and other Federal agencies, including the U.S. Public Health Service and the U.S. Weather Bureau (23; 47).

2.1.1 Test Manager's Organization

The Test Manager was responsible for the overall direction of the TEAPOT Series. His responsibilities included deciding whether or not to proceed with a shot as planned, coordinating the agencies involved in the weapons development and weapons effects projects, supervising the staff units that performed support functions for the test participants, and securing the safety of DOD and non-DOD personnel working for the JTO (23; 33; 34; 225; 226).

To fulfill these duties, the Test Manager required the large and diversified staff shown in figure 2-2. The scientists included the Scientific Advisor, the Advisory Panel, and the Technical Staff Operations Group (265). The Scientific Advisor worked closely with the Technical Staff Operations Group. The Advisory Panel, chaired by the Scientific Advisor, was staffed by military representatives of AFSWP Field Command, and scientists of two AEC nuclear weapons development laboratories, LASL and the University of California Radiation Laboratory (UCHL). This panel assessed information presented by the Technical Staff Operations Group and briefed the Test Manager accordingly.

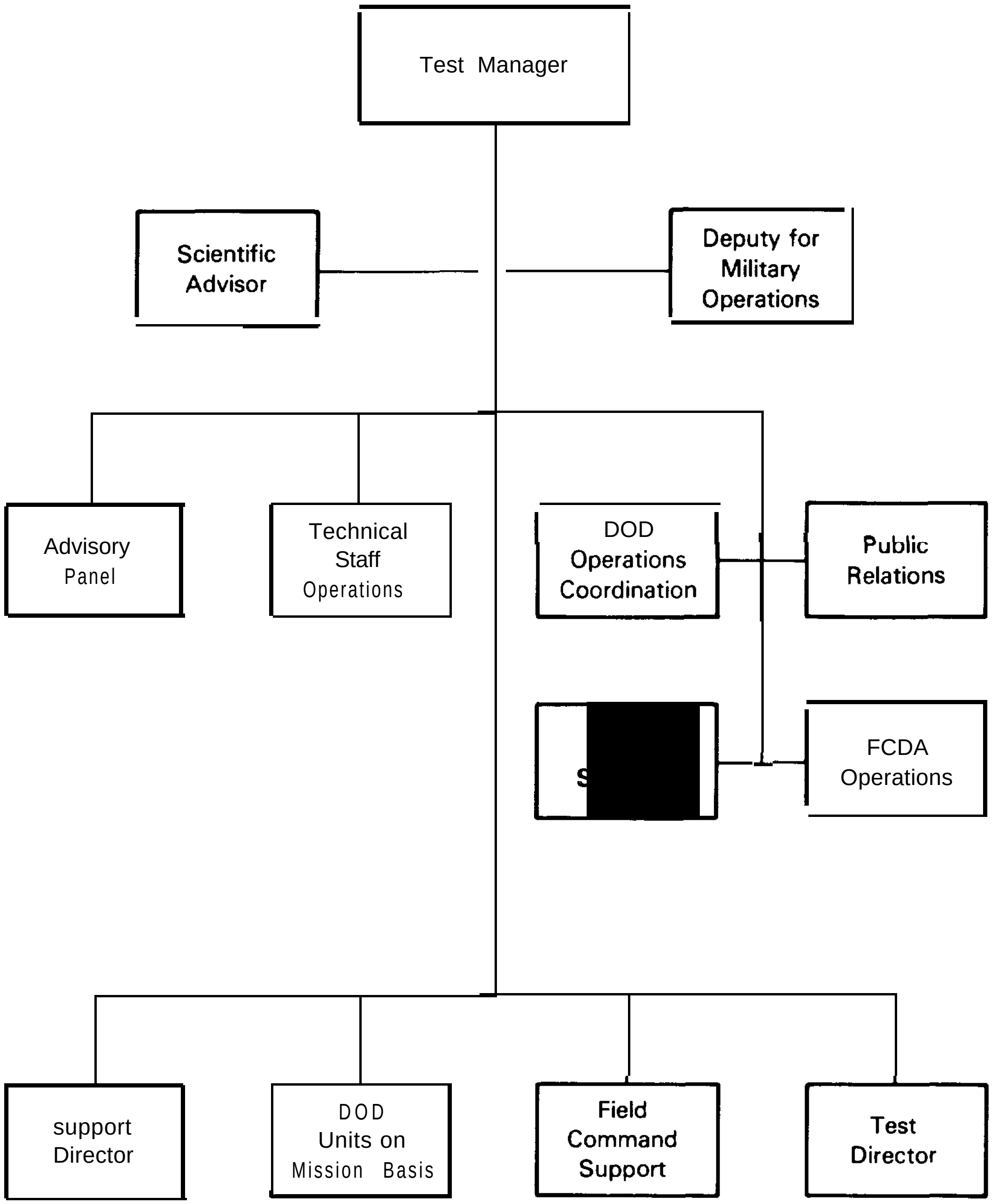

Figure 2-2: JOINT TEST ORGANIZATION

The Technical Staff Operations Group maintained detailed, current information on the possible effects of each scheduled detonation. Information was based upon the predicted weather conditions in the area related to the expected maximum yield capabilities of the nuclear device to be tested. This group consisted of the Weather Prediction Unit, the Fallout Prediction Unit, and the Blast Prediction Unit (265).

The Weather Prediction Unit, staffed by personnel from USAF Air Weather Service, furnished weather forecasts for the Nevada Test Site (NTS) and surrounding areas. In addition, selected U.S. Weather Bureau stations and offsite military weather stations provided meteorological observations on a scheduled basis. The six person Fallout Prediction Unit, operated by members of the U.S. Weather Bureau, LASL, and UCRL, forecasted fallout patterns and nuclear-cloud heights. The Sandia Laboratory operated the Blast Prediction Unit. Its staff members estimated the maximum anticipated strength of the blast that would be produced by each nuclear detonation (265).

The Test Manager's second responsibility was to coordinate or review the following activities conducted in conjunction with the testing (265):

- Military effects projects conducted by AFSWP Field Command Military Effects Group
- Technical projects conducted by the FCDA Civil Effects Test Group (CETG)
- Operational training projects conducted by the armed services of Exercise Desert Rock and coordinated by AFSWP Field Command
- Technical, training, and observation projects and troop maneuvers conducted by Exercise Desert Rock VI
- Public relations.

The Deputy for Military Operations, who served as the Test Manager's chief military advisor was in charge of all the military units of the Joint Test Organization. These units included the DOD Operations Coordination Staff, the Air Weather Service, the JTO Radiological Safety Group, the Lookout Mountain Laboratory Group, and the Field Command Support Group. The Deputy for Military Operations coordinated the weapons effects tests conducted by AFSWP Field Command Military Effects Group with test activities conducted by the test groups of LASL and UCRL, which were under the supervision of the Test Director.

The DOD Operations Coordination Staff worked with the Deputy for Military Operations to coordinate DOD programs with the other activities of the JTO. This staff unit included a liaison officer for Desert Rock exercises, as well as an officer in charge of the Air Operations Unit, and an officer in charge of the DOD operational training projects. The Air Operations Unit coordinated cloud sampling, air support to research programs, delivery of supplies and equipment, and operational control of all aircraft participating in the JTO test programs. The DOD operational training projects were conducted by the armed services and various service agencies as part of the JTO activities.

The FCDA Operations Group supervised demonstration and observer programs conducted by the CETG during Operation TEAPOT, including Operation CUE, a program of technical tests, field exercises, observer activities, and press coverage conducted at Shot APPLE 2 on 5 May 1955. An FCDA representative was present at all JTO meetings to coordinate FCDA activities with those of JTO and Exercise Desert Rock VI.

The Public Relations Unit provided the public and the press with information on the activities of the observer programs managed by the JTO, and maintained contact with State and local health authorities (265).

The Test Manager's third task of providing support for the activities at the NTS was coordinated by the Staff Services Unit, the Support Director's Staff, and the Field Command Support Unit (265).

Among other functions, the Staff Services Unit provided for the onsite radiological safety of participants. The Support Director and his staff were in charge of all auxiliary services required for the proper functioning of the JTO and Camp Mercury. These services included administration, engineering and construction, transportation for AEC personnel, communications, and management of housing, messing, recreation, and medical facilities for AEC personnel at Camp Mercury. The Support Director's Staff also handled security and the evacuation of JTO personnel from NTS test areas before the arming and firing of a nuclear device. The Field Command Support Unit performed all base command functions for which the Department of Defense was responsible.

Four functions necessary for the efficient operation of activities and the protection of all individuals who participated in the activities were provided by the following DOD units on a mission basis (265):

- The Air Weather Service
- The Radiological Safety Group
- The Air Support Group
- The Lookout Mountain Laboratory.

The Air Weather Service, which consisted of a maximum of 74 Air Force personnel during Operation TEAPOT, assisted the Technical Staff Operations Unit by providing meteorological data from several weather stations at and surrounding the NTS.

The Radiological Safety Group supervised onsite radiological safety monitors, forecasted the onsite radiological environment, and ensured that onsite radiological safety criteria were observed. Comprised of personnel from the Army's 1st Radiological Safety Support Unit from Ft. McClellan, Alabama, the Radiological Safety Group was ultimately responsible to the Deputy for Military Operations. At the NTS, however, the Radiological Safety Coordinator, who was a member of the Test Manager's Support Group, controlled the Radiological Safety Group's activities. The Chemical Corps Training Command provided 15 officers and approximately 100 enlisted men from the 1st Radiological Safety Support Unit as core personnel for the Radiological Safety Group (63; 265). When necessary, the group was augmented by personnel from other military organizations.

The Air Support Group was staffed by personnel from the Air Force Special Weapons Center (AFSWC). Its mission was to provide air support to the agencies participating in TEAPOT tests. The group exercised operational control over military aircraft flying over or near the NTS during Operation TEAPOT. AFWSC provided administrative and logistic support for Air Support Group personnel at Indian Springs AFB, Nevada, and Kirtland AFB, New Mexico.

The Lookout Mountain Laboratory from Hollywood, California, was staffed by the 1352nd Motion Picture Squadron, Air Photographic and Charting Service. It was administered by the Director of the Military Effects Group Program 9, Supporting Measurements. The Lookout Mountain Laboratory provided motion picture and still photography coverage of Operation TEAPOT in support of scientific and technical programs and for the JTO Joint Office of Test Information.

2.1.2 The Test Director's Organization

The Test Manager and his staff provided the technical and administrative guidance necessary in conducting Operation TEAPOT and its affiliated activities. However, the day-to-day responsibility for preparing the nuclear devices and planning and implementing the scientific, diagnostic, and military and civilian effects programs during Operation TEAPOT was delegated to the Test Director. The four principal organizations represented on the Test Director's staff were (265):

- The LASL Weapons Development Test Group
- The UCRL Weapons Development Test Group
- AFSWP Field Command Military Effects Group
- The FCDA Civil Effects Test Group (CETG).

The LASL Test Group and the UCRL Test Group developed the nuclear devices. They also conducted scientific and diagnostic experiments to evaluate their performance. The Military Effects Group conducted seven programs designed to determine the weapons effects of each nuclear device detonated. In addition, they coordinated 12 operational training projects for DOD. The Civil Effects Test Group performed programs and projects at Operation TEAPOT to assess the effects of nuclear detonations on civilian populations, structures, and food products, as well as to assure the capability of Civil Defense organizations to provide effective rescue, recovery, and support operations in the event of a nuclear emergency. Representatives from each of the four test groups acted as technical advisors to the Test Director.

As shown in figure 2-3, the Test Director's Organization also included representatives from two elements of the Test Manager's Organization: Staff Services and Support Services (47; 265). Staff Services were divided into six administrative sections that were each responsible for developing operating plans for scientific development, military, and civil effects activities.

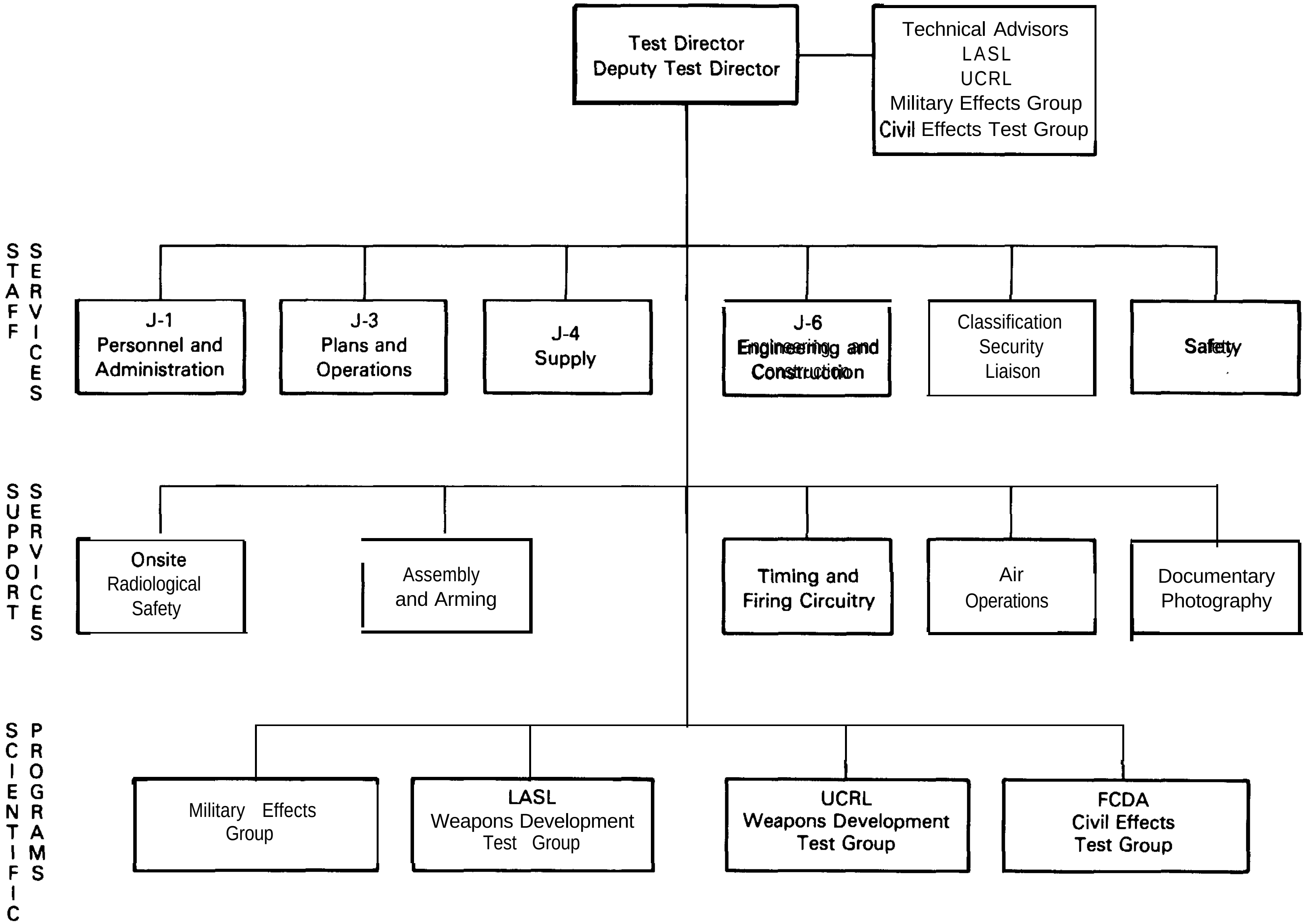

Figure 2-3: TEST DIRECTOR'S ORGANIZATION

Support Services representatives were responsible for developing adequate planning procedures for onsite radiological safety, assembly and arming, timing and firing circuitry, air operations, and documentary photography.

The Test Director's technical advisors and the members of the Test Manager's organizational units worked together to plan and conduct the day-to-day schedule of TEAPOT test activities. The technical advisors reviewed the proposed activities for each program and project of the respective laboratories and agencies. Working with personnel from the support groups and the technical advisors, the Test Director and his staff revised the proposed plans to include scheduling times, locations of necessary construction, supplies, transportation, radiological safety, air support, and postshot recovery operations. The Test Director and his staff then presented the revised plans to the Test Manager, who had final authority to review and approve activities associated with Operation TEAPOT.

2.2 THE ORGANIZATION OF EXERCISE DESERT ROCK VI

Exercise Desert Rock VI, sponsored by the Department of the Army, involved an estimated 8,000 DOD participants in the orientation projects, troop tests, and technical service projects conducted at Operation TEAPOT. This number included about 2,000 DOD personnel who were required to administer and support the exercises (133; 159; 162; 243).

Exercise Desert Rock VI was formally organized on 1 October 1954, and the Commanding General of the Sixth U.S. Army was appointed Exercise Director. The Exercise Director supervised participation by the armed services, provided administrative and logistical support to the exercise troops, and was responsible for the safety of DOD personnel involved in Exercise Desert Rock VI. During the planning phases, the Exercise Director conferred with representatives from the AEC Santa Fe Operations Office and from the AFSWP Field Command office to ensure that Exercise Desert Rock activities were coordinated with those of the JTO.

Throughout both the planning and operational phases of Exercise Desert Rock VI, the Exercise Director maintained his office at the Sixth U.S. Army headquarters, at the Presidio of San Francisco. Onsite, the Exercise Director was represented by his Deputy, who was at Fort Lewis during the planning phase and at Camp Desert Rock during the operational phase of the exercise.

In conducting the exercise and commanding the troops assigned to Camp Desert Rock, the Deputy Exercise Director was assisted by an Executive Officer and the administrative and staff units shown in figure 2-4. These staff elements and support units provided the services necessary to sustain the exercise troops assigned to Camp Desert Rock while they participated in specific test activities (90; 133; 161). The following paragraphs describe the duties of the staff units, including those that required Camp Desert Rock support troops to enter the forward areas.

The S-l Section, Administration, included such services as records-processing under the Adjutant General; law enforcement under the Provost Marshal; and recreation facilities, provided by Special Services. The Post Exchange and Chaplain were included in the S-l Section (133; 161).

The S-2 Section, Security and Intelligence, was responsible for ensuring that proper and adequate security safeguards had been arranged for all classified material connected with Exercise Desert Rock VI and that all personnel had proper security clearances. The S-2 Section maintained close liaison with the Security Branch of the JTO (133; 161).

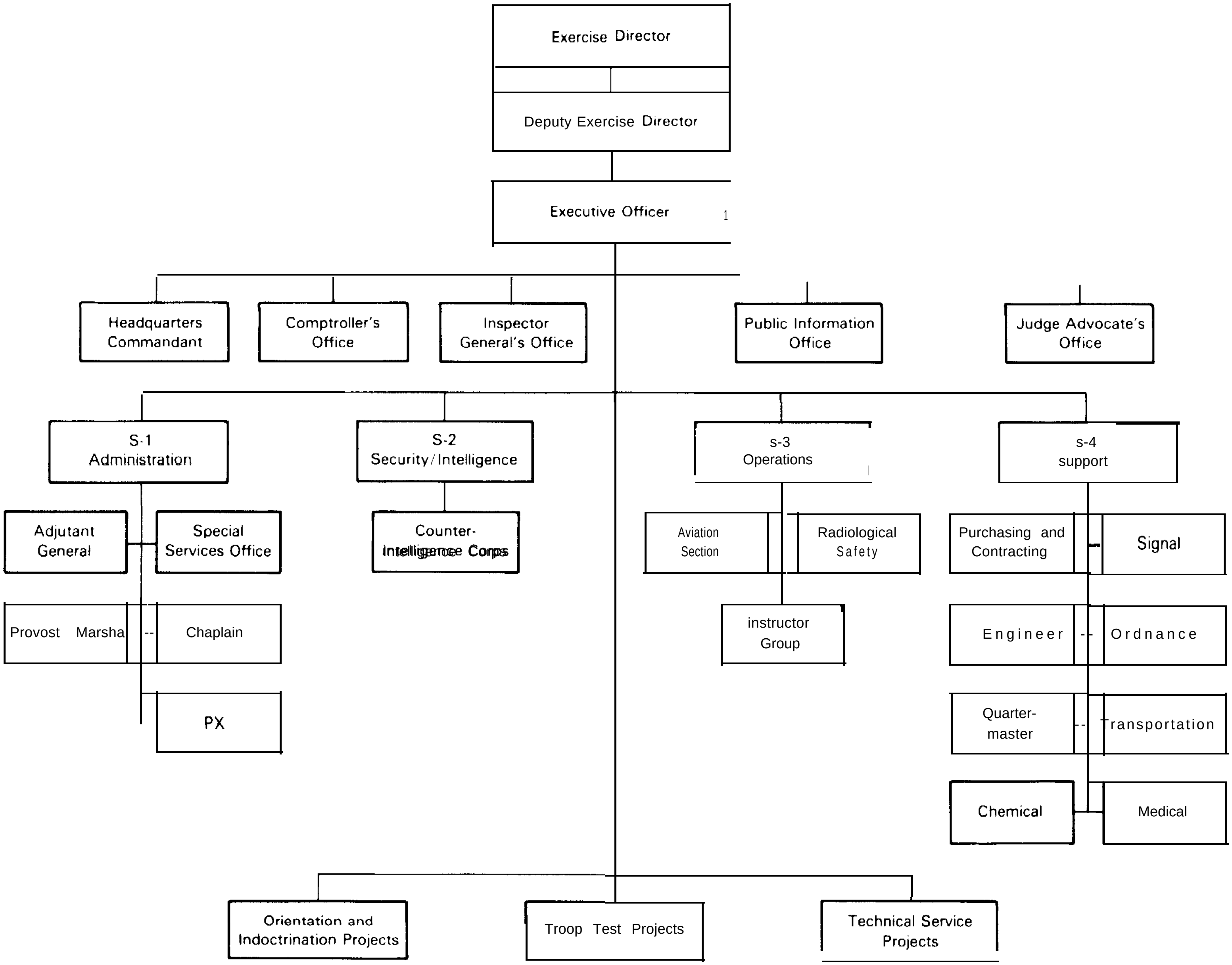

Figure 2-4: EXERCISE DESERT ROCK VI ORGANIZATION

The S-3 Section, Operations, was responsible for advising the Exercise Director in operational matters for both exercise and camp operations. Section S-3 also had purview over the Aviation Section, Radiological Section, and the Instructor Group. The S-3 operations staff provided vehicle rosters, traffic control points, and security lists for access into the equipment display areas (133; 161).

The primary responsibilty of the Aviation Section at Camp Desert Rock was to control and coordinate air operations. In addition, the Aviation Section provided Army aircraft for radiological safety surveys and a Provisional Aviation Flight Detachment to fly the Army aviation support associated with Exercise Desert Rock activities (133; 161).

Members of the Radiological Safety Section established the radiological safety procedures used to limit the exposure received by exercise troops entering the forward areas. The Desert Rock Radiological Safety Section operated separately from the JTO radiological safety organization, and was composed primarily of members of the 50th Chemical Service Platoon, which was assigned to the S-4 Section. Before each event, members of the Desert Rock Radiological Safety Section trained exercise troops in radiological safety procedures. After each event, this group conducted aerial and ground radiological surveys, monitored trenches, equipment displays, and troop maneuver areas, and decontaminated Desert Rock personnel leaving the forward areas. The Desert Rock Radiological Safety Section worked closely with members of the 232nd Signal Company, also assigned to the S-4 Section. In addition to issuing and processing film badges, the 232nd Signal Company also supplied and repaired radiological measuring devices. Chapter 5 of this volume describes in more detail the activities of the 50th Chemical Service Platoon in providing radiological safety services (133; 161).

The Instructor Group conducted the orientation program for incoming troops and observers. This group also instructed support personnel on the objectives of Exercise Desert Rock VI, the capabilities of nuclear weapons, and the protective measures to be taken against the blast, thermal, and radiation effects of a nuclear detonation. In addition, the instructor group assisted in performing such tasks as controlling troop movement to the forward area, calculating safe distances from the point of detonations for observer activities and troop maneuvers, and estimating damage to equipment in display areas (133; 161).

The S-4 Section was responsible for providing support services to the units of Camp Desert Rock and to the exercise troops. The S-4 Section provided field equipment, equipment and materials for display purposes, construction materials for trenches, bunkers, and gun emplacements, and heavy construction equipment. Services provided by the S-4 Section included medical care, construction, communications, and transportation. The units listed below were required to be in the forward area before, during, or after the nuclear events (88; 89; 133; 161):

- The 232nd Signal Company established wire and radio communications within the test areas and at Camp Desert Rock, as well as issuing and processing film badges for the S-3 Section.

- The 95th Engineer Battalion (C)* provided supplies, equipment, and personnel for construction of trenches, equipment displays, and other projects as necessary in the forward areas of the NTS and at Camp Desert Rock.

- The 23rd Transportation Truck Company and the 31st Transportation Truck Company provided the vehicles and drivers to transport Exercise Desert Rock troops. The 2nd Transportation Company (medium truck), provided fuel, water, and supply truck support to Camp Desert Rock.

- The 50th Chemical Service Platoon provided equipment and supplies for the Decontamination Station at Yucca Pass, and radiological safety monitors for Desert Rock project activities in the forward areas.

*Construction

- The 94th Medical Detachment was the Camp Desert Rock Veterinary Food Inspection Service Unit (VFIS).

- The 573rd Ordnance Company procured, distributed, and maintained weapons, ammunition, and combat vehicles for the exercise troops and equipment display areas. This unit was originally the 3623rd Ordnance Company; it was redesignated the 573rd Ordnance Company on 10 March 1955.

- The 163rd Quartermaster Company and the 53rd Quartermaster Company provided Quartermaster support to both Camp Desert Rock troops and exercise troops and field clothing to the observers.

- The 12th Evacuation Hospital (-) was the main medical unit at Camp Desert Rock and provided medical and dental support to the Desert Rock troops.

CHAPTER 3

EXERCISE DESERT ROCK VI PROGRAMS AT OPERATION TEAPOT

This chapter addresses the activities of Department of Defense (DOD) personnel at Exercise Desert Rock VI, the program of technical and training projects organized by the Army at Operation TEAPOT (160). Exercise Desert Rock VI was designed to provide selected individuals of the armed services with training in the effects of nuclear weapons. Exercise Desert Rock VI was a continuation of technical testing and training programs conducted during earlier series of nuclear weapons tests at the NTS. The first of these, Exercises Desert Rock I, II, and III, were conducted during Operation BUSTER-JANGLE in late 1951. Desert Rock IV was conducted during Operation TUMBLER-SNAPPER in 1952, and Desert Rock V was conducted during Operation UPSHOT-KNOTHOLE in 1953. Exercises Desert Rock VII and VIII were conducted during Operation PLUMBBOB in 1957, concluding the Desert Rock program.

The Desert Rock exercises conducted at TEAPOT were designed to (15; 133; 267):

- Assist the armed services in developing tactics and military doctrine on the use of nuclear weapons
- Assess the effects of nuclear detonations on military equipment and ordnance materiel
- Train armed services personnel in the effects of nuclear detonations.

According to a joint AEC-DOD press release, dated 16 March 1955, "the mission of Exercise Desert Rock VI...[is] to teach its soldiers to view nuclear weapons in their proper perspective... that powerful though these weapons are, they can be controlled and harnessed... and that despite the weapons' destructiveness there are defenses against them on the atomic battlefield" (178).

All DOD personnel at Exercise Desert Rock VI were assigned on a temporary duty basis to Camp Desert Rock. For purposes of this study, however, DOD personnel at Camp Desert Rock are divided into two groups: Camp Desert Rock troops and Desert Rock VI exercise troops.

Camp Desert Rock Troops

Camp Desert Rock troops consisted of about 2,000 soldiers drawn from Army units throughout the country. These personnel provided necessary support functions for the camp, such as administration, maintenance, transportation, engineer support, radiological safety, security, housing and food services, and laundry (133; 155; 156; 159; 162-164). Some support units frequently entered the forward testing area of Yucca Flat and Frenchman Flat to help prepare for specific Desert Rock projects, to assist in operations during test events, or to help ensure safe recovery operations following a nuclear detonation (133; 140-149).

Two of the support elements were the Radiological Safety Section and the Instructor Group. The functions of the Radiological Safety Section are discussed generally in chapter 2 and specifically in chapter 5 of this volume. The Instructor Group prepared and presented orientation programs for Desert Rock observers and maneuver troops. Before shot-day, the Instructor Group presented basic information on nuclear weapons characteristics and effects, weapons delivery, personal protection, and the medical effects of blast, thermal, and radiation exposure. During the rehearsal of shot-day exercises, instructors conducted tours of equipment and animal display areas and described the predicted effects of the detonation on these displays. On shot-day, participants were at the trenches before the detonation. Instructors then began their orientation over the loudspeakers. Following the exercises, they led maneuver troops and observers through display areas and discussed the effects of the detonation.

Other support elements entering the forward area included the (133):

- 95th Engineer Battalion (C)
- 232nd Signal Company
- 23rd Transportation Truck Company and the 31st Transportation Truck Company
- 573rd Ordnance Company
- 2nd Transportation Company (Medium Truck) (Petrol)
- 12th Evacuation Hospital (-)*
- 94th Medical Detachment.

For the most part, these units were present in the forward area only when large numbers of exercise troops were active, as at Shots WASP, TESLA, TURK, BEE, APPLE 1, and APPLE 2.

The 232nd Signal Company installed radio and wire communications systems, including a public address system, in main observer locations. Two signalmen usually operated mobile public address systems. These mobile systems were moved into display areas after the personnel received clearance from the radiological safety monitors. The Instructor Group used the public address system to make presentations. The 23rd Transportation Truck Company and the 31st Transportation Truck Company transported exercise troops from Camp Desert Rock to the observer areas before each detonation. Following the detonation and postshot activities, the transportation personnel transported the exercise troops back to Camp Desert Rock. The 12th Evacuation Hospital (-) personnel provided medical and dental support to Camp Desert Rock. Before each shot, the unit established a medical aid station in the Desert Rock observer trench area.

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*Some subordinate units were not present.

In order to familiarize as many medical personnel as possible to the effects of a nuclear detonation, a detachment of the 94th Medical Veterinary Food Inspection Service assisted the 12th Evacuation Hosptal (-).

Another support element that entered the forward area was the 95th Engineer Battalion (C). These personnel usually entered the shot areas during the days and weeks before scheduled detonations to construct trenches and equipment displays, and after the shots to retrieve display items when the area was radiologically safe (133).

Desert Rock VI Exercise Troops

An estimated 8,000 DOD personnel participated in Desert Rock VI technical and training projects. This estimate approximates the total of 8,185 DOD personnel accounted for in the Army's Final Report of Operations for Desert Rock VI. These exercise troops represented all armed services. Unlike the Camp Desert Rock troops who may have stayed at Camp Desert Rock for the entire TEAPOT Series, exercise troops were stationed at the camp for periods ranging from several days to several weeks (132-134; 159; 162; 243; 289; 299).

Exercise Desert Rock VI consisted of three programs: troop orientation and indoctrination, troop tests, and technical service. The number of participants is listed by shot in table 3-1 (133).

The troop orientation and indoctrination program was designed to acquaint official observers and DOD personnel with the effects of nuclear detonations. Participants from the Army, Navy, Marine Corps, Air Force, and other DOD organizations attended lectures, films, and tours of equipment display areas to prepare for observing nuclear detonations in the forward areas of the NTS. As part of their orientation, these observers often reviewed the equipment display again after the shot so that they might assess the damage caused by the nuclear detonation. At some shots, United Kingdom and North Atlantic Treaty Organization observers were present in this group (13; 24; 114; 122; 133).

The troop test program was designed to demonstrate and test military tactics, techniques, and doctrine developed for use with nuclear weapons (25). The Army troop tests at TEAPOT were sponsored hv The Armored School at Fort Knox, Kentucky, The Field Artillery School at Fort Sill, Oklahoma, and The Infantry School at Fort Benning, Georgia. The Third Marine Corps Provisional Atomic Exercise Brigade, composed of troops from various Marine Corps commands, sponsored a large troop test at Shot BEE (133).

The technical service program was designed to investigate the effects of nuclear detonations on ordnance materiel and field equipment and to familiarize DOD personnel with these effects. The technical service projects within this program were conducted by the Army Research and Development Commands of the Corps of Engineers, the Ordnance Corps, the Chemical Corps, the Transportation Corps, and the Quartermaster Corps (133; 248).

3.1 TROOP ORIENTATION AND INDOCTRINATION PROGRAM AT EXERCISE DESERT ROCK VI

About 4,600 Army, Navy, Marine Corps, and Air Force observers participated in the Desert Rock troop orientation and indoctrination program at Operation TEAPOT. Participants witnessed a nuclear event in the forward areas of the NTS and, whenever possible, toured a display of military equipment arrayed in the vicinity of ground zero (177).

The number of Desert Rock observers at each of the test events is listed by shot and project in table 3-1. As the table illustrates, the Troop Orientation and Indoctrination Program was

Table 3-1: EXERCISE DESERT ROCK VI, NUMBER OF PARTICIPANTS OPERATION TEAPOT, BY PROJECT

PROGRAM	PROJECT	TITLE	PARTICIPANTS	WASP	MOTH	TESLA	TURK	HORNET	BEE	ESS	HADR	APPLE 1	WASP PRIME	HA	POST	MET	APPLE 2	ZUCCHINI
Troop Orientation and Indoctrination	40.22	Army Volunteer Officer Observers	Army														10	
	41.3	Army Observers	Army	697	140	20	14		153	168		13					660	
	41.4	Navy Observers	Navy	146	3		2		160			2					36	
	40.11	Marine Observers	Marine Corps	28	4	24	1		92	9		28					11	
	41.7	Air Force Observers	Air Force														25	
	41.8	Air Force Observers	Air Force	105	6	1	2		112	3								
	–	Camp Desert Rock Observers	Camp Desert Rock Support Troops	47	40	478	445			176		550				163	57	
Troop Test	40.16	Army Demolition Munitions	271st Engineer Combat Battalion							210								
	40.18	Location of Atomic Bursts	Battery C (-), 532nd Field Artillery (Observation) Battalion		37	45	45	45	53	53		49	49		46	48	48	
	41.1	Infantry Regimental Communications Test	Provisional Company, 8th Infantry Division														200	
	41.2	Armored Task Force Exercise	Task Force RAZOR														(X)	
	41.6	Marine Brigade Exercise	Third Marine Corps Provisional Atomic Exercise Brigade						2,271									
Technical Service	40.9	Navy Passive Defense Training	Bureau of Ships							149								
	40.14	Chemical, Biological, and Radiological Defense Shelters Test	Chemical Warfare Laboratory; Engineer Research and Development Laboratory			*										*		
	40.15	Engineer Field Fortifications and Equipment Test	Engineer Research and Development Laboratory													*		
	40.15a	Engineer Heavy Equipment Test	Engineer Research and Development Laboratory													*		
	40.17	Effects on Steel Transporters or Containers	Army Transportation Research and Development Command													3	10	
	40.19	Sixth Army CBR Defense Team Training	Sixth Army	24	24	24	24		22			24				22		
	40.20	Clothing Test – Thermal Protection Afforded by Land Forces Environmental Gas and Protective Clothing	Quartermaster Research and Development Center													*		
	40.21	Ordnance Vehicular Equipment Test	Ballistic Research Laboratories	*	*		*		*	*		*	*			*		
	–	Damage Effects Evaluation	Camp Desert Rock Support Troops			*						*					*	

* Unknown

conducted at nine of the TEAPOT tests: Shots WASP, MOTH, TESLA, TURK, REE, ESS, APPLE 1, MET, and APPLE 2 (24; 114; 127; 159). The program consisted of eight projects, one of which included Camp Desert Rock support troops who were present as ohservers at eight of the fourteen nuclear events.

The Exercise Desert Rock troop orientation and indoctrination projects at TEAPOT can he clustered in four observer groups, based on the purpose of their assignments:

- Volunteer officer observers (Project 40.22)
- Troop observers (Projects 41.3 and 41.7)
- Service observers (Projects 40.11, 41.3, 41.4, and 41.8)
- Camp Desert Rock observers.

Volunteer officer observers participated in Army Project 40.22, which was conducted only at Shot APPLE 2. This project was a continuation of the volunteer officer observer program, begun in the 1953 UPSHOT-KNOTHOLE Series during Exercise Desert Rock V. At TEAPOT, participation in Project 40.22 was originally scheduled for Shot TURK. However, when TURK was delayed because of weather conditions, the project was re-scheduled for Shot APPLE 2. Project 40.22 participants consisted of ten personnel from various Army service schools. Nine were Army officers and one was a DOD civilian employee. These ten volunteers were authorized by the Test Manager to position themselves closer to the APPLE 2 ground zero than the other observers. The officer volunteers calculated the safe distance from ground zero based upon their knowledge of nuclear weapons effects. This distance was closer to ground zero than that dictated by JTO and Desert Rock VI radiological safety procedures for all others. They were authorized to receive a dose of radiation not to exceed 10 roentgens. By group consensus, these ten volunteers positioned themselves for the APPLE 2 detonation in a six-foot-deep trench located approximately 2,380 meters south of ground zero. The project is discussed in detail in the APPLE 2 shot volume (114; 127; 133; 159; 244).

Troop observers, Project 41.3 and Project 41.7, were present at eight shots during Operation TEAPOT. Personnel for these two projects were drawn from units or agencies of the Army and Air Force, and participated as a group in the observer program.

Unlike troop observers, service observers were usuallg members of a military unit or agency who were sent to Camp Desert Rock separately rather than as part of a group. Service observers were included in Project 40.11, Marine Observers, Project 41.4, Navy Observers, and Project 41.8, Air Force Observers. The Navy and Marine Corps service observers were primarilv concentrated at Shot BEE, when the Marine Corps Atomic Exercise Brigade conducted a tactical exercise. Individual service observers from the Army were included in Project 41.3, Army Observers (114).

The last category of observers were the Camp Desert Rock troops. These observers were not associated with any particular observer project, but were for the most part individuals assigned to Camp Desert Rock support units and sent to the forward areas to observe one or more shots. The size of this group of observers at any nuclear event varied with the participation of other observer and troop maneuver projects, and some Desert Rock troops may have taken part as observers at more than one nuclear test. All Desert Rock troops were given the opportunity and encouraged to observe at least one nuclear shot during their service at the Camp, and many did participate in the Troop Orientation and Indoctrination Program. The Department of Defense explained Camp Desert Rock support troop participation as observers at nuclear test events in an AK-DOD Joint Office of Test Information press release dated 13 April 1955:

> Army Planners who foresee a possible war on an atomic battlefield are convinced that a nuclear weapon... may present a bigger threat to a rear area cook or mechanic than to a...GI in a forward foxhole... for the simple reason that the supporting forces are a bigger and more lucrative target (178).

Camp Desert Rock troops account for about 2,000 of the approximately 4,600 participants in the Desert Rock observer program, although it is not known what portion of these may have been present at more than one test event.

Participation in nuclear test events was basically the same for all Desert Rock observers at any particular shot. Observers were to arrive at Camp Desert Rock a day or two before the nuclear detonation they were scheduled to witness. The observer population fluctuated considerably because of shot delays due to weather conditions, which caused the schedules of observers to overlap.

All observers operated as a single group before, during, and after each nuclear event in which they participated. Observers participated in a preshot orientation program of lectures and films, a security briefing, a description of the exercise in which they were to participate, and a preshot tour of the equipment display area, if such an area was to be included at the shot. The observers viewed shots from the same trenches, and toured the equipment display areas together. About one hour before each shot, the observers took their positions, were again briefed on what to expect at the time of detonation, and were reminded of safety procedures. After the shot, the observers were usually escorted on a tour of equipment display areas, if available, by radiological safety monitors and a member of the Instructor Group, who described the effects of the detonation on military equipment located at various distances from the point of detonation.

Initial plans for the Exercise Desert Rock VI Troop Orientation and Indoctrination Program called for each participant to witness several shots, in accordance with the following priorities:

- One shot of ten kilotons or more
- Two shots, one less than ten kilotons followed by one of ten kilotons or more, if possible
- One shot of less than ten kilotons.

These plans varied considerably because the schedule of nuclear events was repeatedly revised as unfavorable weather conditions and technical problems caused postponements and delays. Often, observers witnessed only one shot and, because of the delays involved, many observers departed for their home station without witnessing any shots (114; 133; 248).

3.2 TROOP TEST PROGRAM AT EXERCISE DESERT ROCK VI

During Desert Rock VI, the troop test program consisted of five projects as shown in table 3-1. The troop tests were conducted by the Army and the Marine Corps.

Project 40.16, Army Test of Atomic Demolition Munitions, was sponsored by The Engineer School, Fort Belvoir, Virginia. This project was unique to Shot ESS and is described in more detail in the chapter on Shot ESS in the appropriate multi-shot volume. The purpose of the project was to prepare a subsurface emplacement site for an atomic demolition munition test, emplace the munition, backfill the shaft, and fire the munition (133). A task unit of 210 men of the 271st Engineer Combat Battalion worked on the various tasks in the weeks before the detonation. The task unit was augmented by a weapons assembly team of men from Company B, 10th Ordnance Battalion (Special Weapons). Project personnel, supervised by officials of the Joint Test Organizaton, armed the device and backfilled the shaft on the night before the shot; the 39 persons of the 271st Engineer Combat Battalion who backfilled the shaft, as well as other battalion personnel, witnessed the detonation from a position 8,200 meters southwest of surface zero (22).

Project 40.18, Location of Atomic Bursts, was sponsored by The Field Artillery School, Fort Sill, Oklahoma. The participants, whose number varied from shot to shot, were from Battery C (-), 532nd Field Artillery (Observation) Battalion. Although the TEAPOT Operation Summary reports that 518 men participated in this test at Exercise Desert Rock VI, most participated at more than one event. The unit consisted of 95 men, of which 50 to 60 probably participated at each shot.

The objective of Project 40.18 was to test the capability of troops with conventional military equipment to locate and determine the vield of nuclear detonations. The equipment tested included AN/TVS-l cameras, MK-11 Bhangmeters, AN/MPQ-21X radar sets, and sound microphones. The general procedure required participants to proceed to predetermined locations before the shot and set up instrument stations. Generally, the eight to ten instrument stations were located between ten and 13 kilometers south of ground zero. They were placed at intervals several thousand meters from each other in the typical deployment of an artillery observation battery in the field. Each station was manned by two to eight soldiers, who monitored instruments during the detonation and for about five to ten minutes thereafter, in an attempt to locate the point of detonation and establish the yield of the nuclear device from their instrument readings. Figure 3-1 pictures Project 40.18 personnel in the field during Operation TEAPOT (U.S. Army photograph).

Although the location coordinates of these manned instrument stations generally changed from shot to shot, locations of field artillery personnel remained the same for some shots, such as at

Figure 3-1: PROJECT 40.18, LOCATION OF ATOMIC BURSTS, MEMBERS OF THE 532nd FIELD ARTILLERY (OBSERVATION) BATTALION USING EQUIPMENT TO DETECT LOCATION AND YIELD OF NUCLEAR EVENT.

BEE, ESS, WASP PRIME, and POST. Communications between the manned instrument stations and the project control point were maintained throughout the exercise by radio. Project personnel dismantled their instrument stations and returned to Camp Desert Rock about one hour after each detonation (133; 141-149; 204-208; 214; 215; 218; 219; 248).

Project 41.1, Infantry Regimental Communications Test, was sponsored by The Infantry School, Fort Benning, Georgia. The project involved personnel from a Provisional Communications Company, 8th Infantry Division, Fort Carson, Colorado. This project was performed only at Shot APPLE 2. The objectives of this troop test were to:

- Determine the ability of the communications system of an infantry regiment to withstand a nuclear attack
- Determine the capability of authorized personnel to re-establish communications after a nuclear attack
- Recommend changes, if necessary, in the Tables of Organization and Equipment to increase the capability of communications systems to withstand a nuclear attack and to increase the capability of the regiment to make repairs on communications equipment following a nuclear detonation.

The exercise required that a system of communication stations be established in the APPLE 2 shot area. The communications system consisted of one regimental and three battalion communications command post networks, all arranged in extended defensive positions south, east, and west of ground zero. On the day before the APPLE 2 event, 4 May 1955, the entire regimental communications system was installed and tested by project personnel. These stations were unmanned at the time of detonation, 0510 hours on 5 May. Project personnel witnessed the detonation with the other observers in a trench 3,200 meters south of ground zero. After the detonation, project personnel entered the test area to evaluate the damage and to restore communication. This project is unique to the APPLE 2 event and is therefore discussed in greater detail in the APPLE 2 volume (133; 149; 219; 248).

Project 41.2, Armored Task Force Exercise, was sponsored by The Armored School, Fort Knox, Kentucky. This project was also performed only at Shot APPLE 2. This tactical troop test was the second largest maneuver in Operation TEAPOT, and involved about 1,000 military personnel from the following units:

- 723rd Tank Battalion (-)
- Company C, 510th Armored Infantry Battalion, 4th Armored Division
- Battery A, 22nd Armored Field Artillery Battalion, 4th Armored Division
- 1st Platoon, Company C, 24th Armored Engineer Battalion, 4th Armored Division
- 1st Platoon, Company B, 510th Armored Infantry Battalion (less vehicles)
- Provisional Aviation Company, 1st Armored Division.

The objective of the Armored Task Force Troop Test was to demonstrate the capabilities of a reinforced tank battalion in nuclear warfare. The maneuvers of the armored task force, code-named Task Force RAZOR, consisted of three phases:

- A tactical march across the desert from Camp Irwin California, to the NTS, where the task force bivouacked
- A full tactical exercise on shot-day, using tanks and armored personnel carriers, and a helicopter airlift of armored infantry troops in support of an assault
- A return march overland to Camp Irwin following the completion of the exercise.

The maneuver required that the task force move from their bivouac position into Area 1 of Yucca Flat on the day before the shot.

On shot-day, immediately after detonation, the task force advanced 7,200 meters to an objective west-northwest of the APPLE 2 ground zero. This assault was supported by helicopter airlifts of supplies and men from the airstrip at Yucca Lake, located 11 kilometers south-southeast of ground zero. Following the maneuver, which lasted nearly two hours, personnel of Task Force RAZOR toured the APPLE 2 equipment display area, and then returned to the tank assembly area at Mine Mountain Junction. This troop test is described in detail in the APPLE 2 shot volume (20; 21; 133; 149; 158; 248).

Project 41.6, Marine Brigade Exercise, conducted by the Marine Corps at Shot BEE on 22 March 1955, was the largest single project of the TEAPOT Series. The Third Marine Corps Provisional Atomic Exercise Brigade, consisting of an estimated 2,271 officers and men, conducted a tactical exercise involving troops, tactical air support, air resupply, and helicopter troop airlifts. The objectives of the troop test were to provide Marine units with realistic training in planning and conducting a military assault operation following a nuclear detonation, and to evaluate tactics and techniques for the execution of air-to-ground task force missions. This troop test was performed to familiarize Marine Corps personnel with the passive defense measures which could be used to protect themselves against the effects of a nuclear detonation. At the time of the detonation, the Marine Brigade was deployed in five stations at various locations ranging from 3,250 meters southwest to about 20 kilometers south of the BEE ground zero. Following the detonation, the Marines launched a tactical assault on objectives west of the BEE ground zero with the use of a helicopter airlift. This Marine assault included the first use of tactical air support for a military maneuver at the NTS. When the assault was completed, the Marines toured the equipment display area located 460 to 2,560 meters southwest of ground zero. The Marine Brigade Exercise is discussed in detail in the BEE Shot volume (2; 3; 4; 146; 152-154; 181; 215; 248).

3.3 TECHNICAL SERVICE PROGRAM AT EXERCISE DESERT ROCK VI

The technical service projects were initially the responsibility of AFSWP Field Command Military Effects Group, the DOD test group within the JTO, but were placed under the supervision of the Director of Exercise Desert Rock VI before TEAPOT operations began (155). In all, nine technical service projects were conducted at Operation TEAPOT. Seven of these projects were sponsored by the Army and fielded by the Corps of Engineers, the Ordnance Corps, the Chemical Corps, the Transportation Corps, and the Quartermaster Corps. The remaining projects were sponsored by the Navy. Table 3-l lists the nine projects and displays the participation of DOD personnel in the technical service projects (133; 248).

Project 40.9, Navy Passive Defense Training, was conducted primarily at Shot ESS by the Navy Bureau of Ships, and included 168 men, mostly civilians. The objectives of the project were to train shore personnel to perform monitoring operations in a radiation area, to test current and prototype radiac equipment under field conditions, and to develop a more effective passive defense organization. Navy personnel for this project were drawn primarily from various shipyards across the U.S. and the Pacific. They arrived at Camp Desert Rock around 16 March 1955, and were divided into six groups called "Emergency Recovery Units." Between 17 March and 22 March 1955, they underwent classroom and practical training in radiation detection and passive defense measures (91; 147; 214; 248; 254).

On the morning of 22 March, project personnel observed Shot BEE from the observer trench located 3,200 meters southwest of ground zero. On 23 March, they observed Shot ESS from a position approximately eight kilometers southwest of surface zero. About 20 minutes after the ESS burst, after receiving clearance from radiological safety personnel, the Navy Emergency Recovery Unit teams proceeded to six stations located between 1,800 and 5,000 meters west and south of the ESS crater.

About two hours and twenty minutes after the detonation, when the Test Manager had declared recovery operations could begin, the Emergency Recovery Unit teams left their stations and monitored the shot area to locate the 0.25 and 2.5 R/h (Roentgens per hour) isointensity lines. This exercise continued that afternoon when the Emergency Recovery Units returned to the shot area to perform a simulated casualty exercise on several mannequins which had been placed in the vicinity of the ESS surface zero before its detonation. The Navy Passive Defense Training Project was completed three days after the ESS detonation, on 26 March 1955, during which time project personnel continued their monitoring and rescue operations activities (91; 147; 214; 248; 254).

Project 40.14, Chemical, Biological, and Radiological Defense Shelters Test, was sponsored by the Chemical Warfare Laboratory and the Engineer Research and Development Laboratory. The objective of Project 40.14 was to evaluate chemical, biological, and radiological protection methods being developed for use in field bunkers and foxholes. The bunkers were located about 420 meters from each ground zero. The foxholes were situated at distances from 450 to 1,800 meters from each ground zero. Before the detonation, these unmanned bunkers and foxholes were instrumented with film badges and dosimeters. This project was performed in conjunction with Military Effects Group Project 2.7, Shielding Studies. Although the exact activities of project personnel involved in Project 40.14 are not known, individuals were probably responsible for assisting Project 2.7 personnel in the preparation and retrieval of film badges and dosimeters and for conducting postshot inspections of the bunkers and foxholes. The length of time project personnel were in the areas after the detonations is also unknown (133; 248).

Project 40.15, Engineer Field Fortifications and Equipment Test, and Project 40.15a, Engineer Heavy Equipment Test, were conducted only at Shot MET, and were sponsored by the Engineer Research and Development Laboratory of the Army.

The objective of Project 40.15 was to determine the protection afforded against nuclear weapons by new field works designed for conventional warfare. This project was conducted by Company A, 95th Engineer Battalion, augmented by one platoon from Company C, 95th Engineer Battalion, in coordination with AFSWP Field Command Military Effects Group Project 2.7, Shielding Studies. Twenty structures were built in eight groups located at distances of 300, 345, and 420 meters from the MET ground zero. The structures included nine gun emplacements, seven shelters, two bunkers, and two domes. They were equipped with film-dosimetry instruments prior to shot-time. Instruments were probably removed from these structures by personnel from Project 2.7. It is believed that Desert Rock participation was limited to sharing data and results of the test with Project 2.7. Postshot evaluation of the structures was performed by six individuals of the Engineer School, Fort Belvoir, Virginia.

The purpose of Project 40.15a, Engineer Heavy Equipment Test, was to test the degree of protection against nuclear detonations provided by below-ground-level emplacement of engineer equipment. Military personnel involved in this project probably included Camp Desert Rock ordnance and transportation units, and one platoon from Company C, 95th Engineer Combat Battalion, which performed the trench construction work. Three groups of engineer equipment were positioned in trenches 480, 630, and 8,100 meters from the MET ground zero. The equipment included tractors, graders, truck-mounted air compressors, truck-mounted cranes, and generators. All equipment positions in Project 40.15a were unmanned at the time of detonation (133; 248).

Project 40.17, Effects on Steel Transporters or Containers, was conducted by the Army Transportation Research and Development Command, Fort Eustis, Virginia. The objective was to determine the amount of protection afforded by steel transporters or containers. Cargo packaged in different types of containers were placed at various distances from ground zero. At Shot MET, six display stations were established, each with two sets of cargo. The stations were situated approximately 1,110, 1,200, 1,360, 1,600, 1,900, and 2,525 meters from ground zero. At the APPLE 2 event, the same containers were placed about 500, 670, and 880 meters from ground zero (133; 248). The cargo containers were probably transported to the two test areas by a Camp Desert Rock transportation support unit and put in place several days before each event.

Project 40.19, Sixth Army Chemical, Biological, and Radiological Defense Team Training, was designed to determine the capabilities of Chemical, Biological, and Radiological (CBH) defense teams to perform radiological defense surveys under the conditions following a nuclear detonation. The project was also intended to test the adequacy of the organization and equipment provided by Department of Army directives to CBR defense teams.

Ten CBR defense teams from the following home stations participated at Operation TEAPOT:

- Two teams from Fort Lewis, Washington
- Two teams from Fort Ord, California
- Two teams from the Presidio of San Francisco, California
- One team from Camp Hanford, Washington
- One team from Fort Lawton, Washington
- One team from Fort MacArthur, California (Detachment 17 of the 6513th Service Unit)
- One team from Camp Irwin, California.

According to the Project 40.19 technical report, the 1st Canadian "Raddefense" Unit participated in the project (57; 165). However, neither the scope nor the depth of the involvement has been documented. One CBR defense team consisted of 11 enlisted men and one officer. According to a Department of Army directive dated 3 February 1953, a typical team was to include an officer-in-charge, a radio operator, a recorder, and three survey parties of three men each. During Operation TEAPOT, it was discovered that the survey parties could operate efficiently with only two men. Two of the extra participants formed a fourth survey party, while the third was free to perform special assignments. Thus, during TEAPOT, a CBR defense team was generally organized as follows (165): officer-in-charge, one radio operator, one recorder/plotter at the Control Point, four surveying parties of one monitor and one driver/radio operator each, and one soldier for special assignments.

Camp Desert Rock personnel were also involved in Project 40.19. One training officer from the Exercise Desert Rock VI Radiological Safety Section directed project training and testing, while officers and noncommissioned officers from the 50th Chemical Service Platoon were employed as instructors.

The first two teams arrived at Camp Desert Rock and completed their training before the first shot, WASP, on 18 February 1955. Two more teams were scheduled to arrive approximately two weeks later, with the remaining six teams arriving at ten-day intervals. Although the Sixth Army wanted the CBR defense teams to view a nuclear detonation, no attempt was made to correlate the arrival of the teams with shot schedules since, after the first detonation, residual radiation around the ground zeros of TEAPOT events was adequate for training purposes. Despite a number of AEC postponements, all Project 40.19 personnel were able to witness a nuclear detonation and complete their training with no interruption or delay (133; 165; 248).

Project participants spent an average of 10 to 21 days at Camp Desert Rock, depending on each team's state of training and the AEC shot schedule. Typically, a CBR defense team was trained as follows (165):

- Day One: eight hours of registration and film-badge processing
- Day Two: one hour of orientation, three hours of dose-recording training, and four hours of instruction on dosimetry instruments
- Day Three: four hours of instruction on aerial and ground monitoring, and four hours of practice on radio procedures
- Day Four: eight hours of instruction on survey procedures and rehearsals
- Day Five: eight hours of radio and instrument practice and examination
- Day Six: shot observation
- Day Seven: field monitoring
- Day Eight: field monitoring
- Day Nine : field monitoring
- Day Ten: preparation of operation report by officer in charge.

With the exception of the days spent monitoring in the field and observing a detonation, Project 40.19 personnel remained at Camp Desert Rock, where training took place. Field monitoring, which served as each team's practical examination, required project personnel to conduct a 360-degree survey of a radiation area in the forward area of the NTS.

Project personnel used either a grid system or a radial system in conducting their field tests. The grid system, chosen by eight of the ten teams, divided the area around ground zero into four quadrants. The control point was established beyond the 0.1 R/h area. Each quadrant was subdivided into tenths of a mile along the quadrant's axes. These grid lines were numbered along one axis, and lettered along the other axis. One surveying party would monitor an assigned quadrant using the grid lines to chart radiation intensities and to direct their progress.

The teams would move toward ground zero along a predesignated azimuth until they obtained an intensity reading of 1.0 R/h. By observing their jeep's odometer and correlating the distance traveled from their baseline with the azimuth along which they traveled, the teams could determine their location within their quadrant. After finding a point of 1.0 R/h intensity, the teams would return to the baseline by another azimuth. They would then proceed one-tenth of a mile along the baseline to the next grid line and continue monitoring until their entire quadrant was surveyed.

The second method of radiological monitoring was the radial system of surveying, which was used by two of the teams. This system used predetermined angles of movement that were subject to change depending on fallout pattern, terrain, or amount of debris. After establishing a control point outside the 0.1 R/h area, each CBR defense team traveled predetermined distances from that point on given azimuths to its assigned areas. For example, after ensuring that they were on the proper course, the team members would move forward into the area until they obtained an intensity of 1.0 R/h. The team would then note its mileage from the control point and continue on, stopping when the intensity reached 2.0 R/h. From this position the team would establish a return azimuth from its first penetration into the area and drive back to the point of the 1.0 R/h intensity. In this fashion, the team surveyed its area by describing a pattern comparable to that of a wheel, with ground zero at its hub (165).

A final examination concluded the field testing. One test required the team to enter an unfamiliar area and locate preselected isointensity lines within a specific period of time, such as one to two hours. Another form of examination required the plotting of an extra isointensity line which would lie between those already plotted (165). The time required by the CBR teams to survey an area of one square mile and to locate and plot several preselected isointensity lines, fluctuated from 45 minutes to one hour and 30 minutes.

Two aerial surveys were conducted by Project 40.19 personnel. These surveying procedures were conducted differently at Shots WASP, MOTH, TURK, and APPLE 1, as discussed in the shot and multi-shot volumes for Operation TEAPOT.

Project 40.20, Clothing Test--Thermal Protection Afforded by Land Forces' Environmental and Gas Protective Clothing, was conducted only at Shot MET. The project was sponsored by the Quartermaster Research and Development Command, Natick, Massachusetts. The purpose of the project was to test the ability of American, Soviet, and Communist Chinese protective clothing to withstand thermal radiation emitted by a nuclear detonation. Three stations were established 1,800, 2,700, and 3,350 meters from ground zero. Nine mannequins, three each fitted with chemical warfare gas capes, reflective barriers, and standard ponchos, respectively, were placed at each station. Project personnel responsibilities probably consisted of establishing the stations before the nuclear detonation and entering the test area after the detonation to assess the results (133).

Project 40.21, Ordnance Vehicular Equipment Test, was sponsored by the Ballistic Research Laboratories, Aberdeen, Maryland. The principal Desert Rock participant in the project was the 573rd Ordnance Company,* which placed the test equipment,

*The 573rd Ordnance Company was called the 3623rd Ordnance Company at Shots WASP, MOTH, and TURK. It was redesignated 573rd Ordnance Company on 10 March 1955.

with the assistance of Detroit Arsenal personnel. Ballistic Research Laboratories personnel from Military Effects Group Project 3.1 recorded blast pressures from gauges located on or near the test equipment, while Army Chemical Corps personnel from AFSWP Field Command Military Effects Group Project 2.7 took radiation measurements (240; 248).

The objectives of the project were to determine how well roll-over safety bars minimized damage to wheeled vehicles, to obtain experimental design data for the future design of ordnance equipment and to investigate the shielding effect of armor against gamma radiation. The equipment was placed in 11 positions, at distances of 240 meters to 1,110 meters from ground zero. The ordnance vehicles placed at each nuclear test varied, but generally included M48 tanks, M59 armored personnel carriers, T97 self-propelled guns, 1/4-ton jeeps, 2 1/2-ton M211 cargo trucks, and five-ton cargo trucks. Project personnel were not required to be in the test area at the time of detonations. Dosimetry data were recovered following the detonation, when radiation intensities permitted, and the equipment was removed from the test area for use at other events in the subsequent days and weeks (248).

As indicated earlier in this chapter, Camp Desert Rock support personnel assessed the damage to items in the equipment area not examined as part of Project 40.17. The damage effects evaluation team performed this task at Shots TESLA, APPLE 1, and APPLE 2 as part of the technical service program. This damage effects evaluation was not part of a numbered project.

CHAPTER 4

DEPARTMENT OF DEFENSE PARTICIPATION IN JOINT TEST ORGANIZATION PROGRAMS AT OPERATION TEAPOT

During Operation TEAPOT, the Joint Test Organization (JTO) coordinated a number of separate programs of research, including scientific tests of the nuclear devices, tests of the effects of the nuclear detonations on military equipment, hypothetical effects of nuclear detonations on civilian populations, a DOD operational training program, and support services. An estimated 1,500 DOD participants, both civilian and military, were involved in this aspect of the TEAPOT Series. In most cases, the individual projects conducted under each program required relatively small numbers of people. Although relatively few DOD personnel participated in JTO projects, as compared to Desert Rock participants, JTO activities are significant since their tasks were often repeated at several shots. The exercise troops of Desert Rock VI on the other hand, usually participated in one or two nuclear test events only.

In addition to the military personnel described above, DOD civilian scientists and technicians were employed with the AEC weapons design laboratories, with civilian contract agencies, and with the Federal Civil Defense Administration (FCDA). The numbers of these individuals and their areas of participation are not known. Therefore, although the TEAPOT reports are designed to describe all DOD participation, the projects described are only those with known DOD involvement.

This chapter describes JTO activities, beginning with the military effects projects and scientific experiments conducted by the four test groups:

- AFSWP Field Command Director, Weapons Effects Tests, and its Military Effects Group

- Los Alamos Scientific Laboratory (LASL) Test Group
- University of California Radiation Laboratory (UCRL) Test Group
- Federal Civil Defense Administration (FCDA) Civil Effects Test Group (CETG).

Composed of AEC and DOD scientists and technicians from various military and civilian laboratories, support contractors, and the armed services, the test groups developed and conducted field experiments to gather data before, during, and after nuclear detonations.

Of the test groups at Operation TEAPOT, the Military Effects Group, directed by Field Command, Armed Forces Special Weapons Project, involved the greatest number of DOD participants. The mission of the Military Effects Group was to determine weapons effects characteristics and evaluate the military applicability of the nuclear devices built by the AEC nuclear weapons design laboratories, LASL and UCRL. The data obtained from the atmospheric nuclear weapons tests were used to improve the United States nuclear arsenal and expand the country's techniques and strategies for using that arsenal. The Military Effects Group sponsored seven programs, which included about 50 separate projects.

The test groups associated with the two AEC nuclear weapons design laboratories, LASL and UCRL, performed scientific tests on the phenomena produced by their nuclear devices. The data were used to improve nuclear devices, to develop new types of devices, and to proof-test weapons before they entered the nuclear stockpile. The LASL Test Group sponsored eight programs, consisting of more than 20 projects, and the UCRL Test Group sponsored five programs, consisting of about 15 projects.

The FCDA Civil Effects Test Group (CETG) performed experiments to assess the effects of nuclear detonations on civilian populations, structures, and food supplies. The CETG conducted ten programs consisting of about 45 projects.

The experiments fielded by the test groups were primarily concerned with obtaining measurements of the physical characteristics of detonations. These measurements included blast and thermal effects, such as changes in air pressure, ground dislocations, and heat waves. In addition to these phenomena, the special nature of the nuclear weapons tests required thorough investigation of nuclear radiation effects.

Throughout the TEAPOT Series, numbers were used to identify the technical programs and experiments performed by the test groups. Programs 1 through 9 were conducted by the AFSWP Military Effects Group; Programs 10 through 19, by the LASL Test Group; Programs 20 through 29 by the UCRL Test Group; and Programs 30 through 39 by the Civil Effects Test Group.

In addition to describing DOD involvement in JTO military effects and scientific programs, this chapter also describes DOD participation in the armed services operational training program, which was coordinated through the Director for Weapons Effects Tests of Field Command. Like the Desert Rock exercises described in chapter 3, these DOD training projects were scheduled so that they would not interfere with the AEC diagnostic and DOD military effects tests. The operational training program was designed so that participants from various military organizations could receive instruction in the use of military tactics and equipment under conditions of nuclear warfare.

The final section of this chapter describes the air support and services provided by the Air Force Special Weapons Center (AFSWC), Kirtland Air Force Base, New Mexico. AFSWC supported the Test Manager and the test groups by supplying aircraft for airdrop delivery missions, cloud-sampling and cloud-tracking missions, aerial surveys, and'other air missions as requested. The Air Operations Center, located in Building One of the Control Point at Yucca Pass, was operated by AFSWC. The Air Operations Center maintained operational control over military aircraft flying over and near the NTS during TEAPOT.

In describing the various military effects and scientific programs, training programs, and support activities, this chapter strives to emphasize the activities of DOD participants, both military and civilian, which may have exposed them to ionizing radiation.

4.1 MILITARY EFFECTS GROUP PROGRAMS

The Military Effects Group conducted projects to obtain a better understanding of the effects of nuclear weapons for both offensive and defensive deployment. Specifically, the Military Effects Group projects were used by DOD to attain the following objectives:

- To develop the delivery systems for employing nuclear weapons
- To design military equipment able to withstand the effects of a nuclear detonation
- To develop doctrine for better use of the weapons
- To determine the military requirements for future nuclear weapons designs.

The Military Effects Group experiments were divided into five categories (248):

- Basic measurements of the output characteristics of nuclear devices, such as blast, thermal, and radiation measurements
- Tests to determine blast and thermal effects on structures, equipment, and materiel
- Operational tests to develop and evaluate techniques and equipment unique to nuclear warfare, such as Indirect Bomb Damage Assessment

- Tests of instruments developed to increase the reliability of basic measurements of the characteristic outputs of a nuclear device

- Measurements in support of other projects, such as technical photography.

At Operation TEAPOT, the Field Command Military Effects Group sponsored seven programs to study yield and weapons effects characteristics for the various nuclear devices:

- Program 1, Blast Pressure Measurements
- Program 2, Nuclear Radiation Effects
- Program 3, Effects on Equipment and Structures
- Program 5, Aircraft Structures
- Program 6, Electromagnetic Effects and Tests of Service Equipment
- Program 8, Thermal Radiation Effects
- Program 9, Supporting Measurements.

Programs 4 and 7 were not conducted at TEAPOT. In all, a total of about 50 projects were fielded under these seven programs by various military and civilian DOD laboratories and contractors. Table 4-l lists the programs and arrays the projects planned for each shot of Operation TEAPOT (47). This table serves as an index to project descriptions in this chapter and in the TEAPOT shot and multi-shot volumes.

The following section details the objectives and procedures employed during each project. The pertinent shot volumes contain information regarding tne number of people involved at each shot, their distances from ground zero, and their activities at a particular shot.

4.1.1 Program 1: Blast Pressure Measurements

Program 1, Blast Pressure Measurements, was designed to measure overpressure and dynamic pressure from a nuclear detonation in relation to time and distances from the point of detonation. Some of the experiments conducted during this program were

Table 4-1: MILITARY EFFECTS GROUP PROGRAMS INDICATING PROJECT PARTICIPATION BY SHOT

PROGRAM TITLE / SHOT NAMES	WASP	MOTH	TESLA	TURK	HORNET	BEE	ESS	APPLE 1	WASP PRIME	HA	POST	MET	APPLE 2	ZUCCHINI
Program 1. Blast Pressure Measurements	1.2 1.14b	1.14b	1.2 1.14b	1.1 1.2 1.11 1.14b	1.14b	1.2 1.10 1.14b	1.2 1.6 1.7	1.1 1.2 1.5 1.14b	1.2	1.1 1.2 1.3 1.9	1.2 1.14b	1.2 1.5 1.10 1.11 1.12 1.13 1.14a 1.14b	1.14b	1.14b
Program 2. Nuclear Radiation Effects	2.1 2.2 2.3a 2.4 2.5.1 2.6 2.7 2.8a	2.1 2.2 2.3a 2.4 2.5.1 2.8a	2.1 2.2 2.3a 2.4 2.5.1 2.7 2.8a	2.1 2.6 2.8a	2.1 2.2 2.3a 2.5.1 2.8a	2.1 2.2 2.5.1 2.8a 2.8b	2.1 2.3a 2.3b 2.4 2.5.1 2.5.2 2.6 2.7	2.1 2.2 2.6 2.7 2.8a 2.8b	2.1 2.2 2.4 2.8a	2.1 2.2 2.8a	2.1 2.2 2.3b 2.7 2.8a	2.1 2.2 2.6 2.7 2.8a 2.8b	2.6 2.8a 2.8b	2.8a 2.8b
Program 3. Effects on Equipment and Structures	3.1	3.1	3.1	3.1	3.1	3.1	3.3.1 3.3.2	3.1	3.1		3.1	3.1 3.2 3.4 3.6 3.7 3.8 3.9 3.10	3.1	
Program 5. Aircraft Structures				5.2	5.2	5.1 5.2		5.1 5.2		5.1		5.1 5.2 5.4 5.5a 5.5b	5.1 5.2	
Program 6. Electromagnetic Effects and Tests of Service Equipment	6.1.1a 6.1.1b 6.3 6.4	6.1.1b 6.3 6.4	6.1.1b 6.3 6.4	6.1.1a 6.1.1b 6.3 6.4 6.5	6.1.1a 6.1.1b 6.3 6.4 6.5	6.1.1a 6.1.1b 6.3 6.4 6.5	6.1.1a 6.1.2 6.3 6.4	6.1.1a 6.1.1b 6.1.2 6.2 6.3 6.4 6.5	6.3 6.4	6.3 6.4	6.3 6.4	6.1.1a 6.1.2 6.2 6.3 6.4 6.5	6.3 6.4 6.5	6.4 6.5
Program 8. Thermal Radiation Effects	8.4b 8.4c 8.4d 8.4f	8.4b 8.4d 8.4f	8.4b 8.4d	8.1 8.4e 8.4f	8.3 8.4b 8.4d 8.4f	8.1 8.4b 8.4d 8.4f		8.1 8.4d	8.4b 8.4c 8.4d 8.4f	8.4a 8.4b 8.4c 8.4d 8.4f	8.4d 8.4f	8.1 8.4b 8.4e	8.1	
Program 9. Supporting Measurements	9.1 9.4 9.6	9.1 9.4 9.6	9.1 9.4 9.6	9.1 9.4 9.6	9.1 9.4 9.6	9.1 9.4 9.6	9.1 9.4 9.6	9.1 9.4 9.6	9.1 9.4 9.6	9.1 9.4 9.6	9.4 9.6	9.1 9.4 9.6	9.4	9.4 9.6

specifically designed to obtain data about the pressure effects of high altitude and subsurface detonations. Thirteen projects were conducted under Program 1 during the TEAPOT Series, as listed in table 4-2.

The primary emphasis of Program 1 was to document the effects of the precursor, an auxiliary pressure wave that forms and moves in front of the main blast wave produced by a nuclear detonation. This precursor had caused an unexpectedly high degree of damage to the equipment display and instruments at Shot GRABLE, the tenth shot of the 1953 UPSHOT-KNOTHOLE testing series. During TEAPOT, studies of the precursor wave included comparisons of blast phenomena associated with various surfaces, such as desert, asphalt, and water. In addition, Program 1 supported nearly all TEAPOT shots with instrumentation to measure blast effects. These projects conducted under Program 1 measured the various types of pressure produced in a number of ways. In addition to the use of gauges and other ground-placed instruments, the projects used such means as parachute-borne instruments, photography, acoustical waves, and excavation of colored-sand columns for measurement.

Project 1.1, Measurement of Free Air Atomic Blast Pressures, used parachute-borne instruments dropped from aircraft to obtain data on the blast wave produced in the atmosphere by nuclear detonations. This project measured the blast forces of both high- and low-altitude nuclear detonations.

The aircraft dropped parachute-borne canisters, some containing transmitters and others containing gauges. The drop occurred approximately two minutes before the low altitude detonations, TURK and APPLE 1, and within seconds of the high-altitude detonation, HA (126).

Table 4-2: MILITARY EFFECTS GROUP PROJECTS CONDUCTED AS PART OF PROGRAM 1 DURING OPERATION TEAPOT

'roject	Title	Project Objectives	Shots	Participants
1.1	Measurement of Free Air Atomic Blast Pressures	To measure blast forces at various distances from a nuclear detonation	TURK, APPLE 1, HA	Air Force Cambridge Research Center
1.2	Shock Wave Photography	To photograph the progression of the blast produced by a nuclear detonation	WASP, TESLA, TURK, BEE, ESS, APPLE 1, WASP PRIME, HA, POST, MET	Naval Ordnance Laboratory
1.3	Microbarographic Pressure Measurements at Ground Level from High-altitude Shot	To measure the blast pressure, near the ground, produced by a high altitude nuclear detonation	HA	Sandia Laboratory
1.5	Preshock Sound Velocities Near the Ground in the Vicinity of an Atomic Explosion	To measure differences in pressure, due to a nuclear detonation, over various surfaces	APPLE 1, MET	Navy Electronics Laboratory
1.6	Crater Measurements	To characterize the crater formed by an underground nuclear detonation	ESS	Engineer Research and Development Laboratories; Ballistic Research Laboratories
1.7	Underground Explosion Effects	To measure the shock forces produced by an underground nuclear detonation	ESS	Stanford Research Institute
1.9	Material Velocity Measurements of a High Altitude Shot	To determine the progression of blast forces produced by a high altitude nuclear detonation	HA	Sandia Laboratory
1.10	Overpressure and Dynamic Pressure versus Time and Distance	To determine the pressure variations produced by a nuclear detonation over three surfaces	BEE, MET	Stanford Research Institute
1.11	Special Measurements of Dynamic Pressure versus Time and Distance	To measure pressure variations produced by a nuclear detonation over three surfaces	TURK, MET	Sandia Laboratory
1.12	Drag Force Measurements	To measure blast forces due to the winds produced by a nuclear detonation	MET	Naval Ordnance Laboratory
1.13	Dust Density versus Time and Distance in the Shock Wave	To determine pressure effects at various distances from a nuclear detonation over two surfaces	MET	Chemical and Radiological Laboratory
1.14a	Transient Drag Characteristics on Spherical Models	To measure blast forces due to a nuclear detonation	MET	Ballistic Research Laboratories
1.14b	Measurements of Air-blast Phenomena with Self-recording Gauges	To measure pressure variations produced by a nuclear detonation	WASP, MOTH, TESLA, TURK, HORNET, BEE, APPLE 1, POST, MET, APPLE 2, ZUCCHINI	Ballistic Research Laboratories

Project 1.2, Shock Wave Photography, used camera stations located at various distances from the point of detonation to photograph the development and progress of the shock wave produced by a nuclear detonation. Multiple rockets, launched from the ground, left visible smoke trails which were displaced by the shock wave. The smoke trails made the movement of the shock waves visible in the photographs (241).

Project 1.3, Microbarographic Pressure Measurements at Ground Level from High-altitude Shot, was conducted at Shot HA only. Project personnel measured pressure changes generated near the ground by a high-altitude nuclear detonation (263).

Project 1.5, Preshock Sound Velocities Near the Ground in the Vicinity of an Atomic Explosion, was designed to measure changes in the transmission of sound waves caused by the pressure changes over various surfaces, including asphalt, water, concrete, and such plants as ivy and fir boughs. Members of the Navy Electronics Laboratory, who fielded the experiment, measured the transit times of sound waves across these surfaces. Project participants tested their equipment on the APPLE 1 shot and made their final measurements during MET (238).

One underground detonation, Shot ESS, was conducted during Operation TEAPOT. Project 1.6, Crater Measurements, was designed to determine the physical characteristics, such as size and depth, of the crater and lip formed by the underground detonation. Before the detonation, project personnel placed columns of colored sand in the ground along a line running through surface zero. In October 1955, when residual contamination had decreased to an acceptable level, the columns of colored sand were excavated and their positions measured to determine the characteristics of the crater and the displacement produced by the ESS shock wave (229).

Project 1.7, Underground Explosion Effects, like Project 1.6, was conducted at Shot ESS only. Stanford Research Institute personnel fielded the experiment to measure shock forces produced by an underground detonation. The experiment measured how much pressure was exerted on the soil, how much soil was moved, and how fast the soil moved (270).

Project 1.9, Material Velocity Measurements of a High Altitude Shot, was a high-altitude version of Project 1.2. At Shot HA, participants photographed the displacement of smoke-particles in the air as they were affected by the shock wave of a high-altitude detonation. A number of smoke trails were produced in the air just before the detonation. A series of rapid time-lapse photographs were taken as the detonation occurred and its subsequent shock-wave spread. These photographs were then analyzed to assess the effect of the pressures on the smoke trails, and in that way measure the time-space history of the shock wave (262).

Project 1.10, Overpressure and Dynamic Pressure versus Time and Distance, was similar to Project 1.5 in that it used a variety of surfaces to measure variations in pressure. Data on the increases in air-pressure produced by a nuclear detonation and the movement of the blast wave through the surrounding atmosphere were obtained over three surfaces during MET: a dust-free reflecting surface (water), a dust-free absorbing surface (asphalt), and a desert surface. At Shot BEE, only the asphalt and desert surfaces were tested. Specific data were also furnished to other projects in Programs 1 and 5 for use in calculating structural effects (271).

Project 1.11, Special Measurements of Dynamic Pressure versus Time and Distance, also used water, asphalt, and desert surfaces to measure variations in pressure caused by a nuclear detonation. Instruments for this project were field-tested by Sandia Laboratory at Shot TURK. The experiment itself, which was performed at Shot MET, measured a variety of factors, including air-flow direction and the density and velocity of air and suspended dust particles (35).

Project 1.12, Drag Force Measurements, sought to provide data for predicting the effects of drag forces, or blast wind, on full-scale structures. Simple spheres containing gauges were mounted near the ground to record the effects of the winds produced by the MET detonation (222).

Project 1.13, Dust Density versus Time and Distance in the Shock Wave, was designed to measure the pressure effects at various distances from the MET nuclear detonation over desert and asphalt surfaces. Project personnel placed beta densitometers and dust-sampler equipment on the two surfaces between 610 and 910 meters from the shot tower (115).

Project 1.14a, Transient Drag Characteristics on Spherical Models, was similar to Project 1.12 in that it used instrumented spheres to measure the blast forces of the MET detonation (41).

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was designed to measure the variations in air-pressure at or near the ground surface produced by a nuclear detonation. In this project, self-recording pressure gauges and pressure-time instruments were placed at intervals along a line extending from the point of detonation to obtain information on the force and progress of the blast wave (307).

4.1.2 Program 2: Nuclear Radiation Effects

Program 2, Nuclear Radiation Effects, measured radiation to determine the extent of radiation resulting from nuclear detonations, and factors affecting the safety of troops and aircraft participating in nuclear testing. Eleven projects were conducted during the TEAPOT Series as part of Program 2.

The primary interest in Program 2 was to gain information about the effects of gamma, neutron, alpha, and beta radiation. As indicated in chapter 1, public interest in the effects of radiation and radioactive fallout had increased with Operation UPSHOT-KNOTHOLE in Nevada and Operation CASTLE in the Pacific. The experiments conducted at Operation TEAPOT as part of Program 2 were to provide the military with information on controlling the radiation caused by a particular nuclear detonation, predicting the effects of that radiation on human beings and on the environment, and devising the best means of protection against that radiation. Table 4-3 lists the projects planned for Operation TEAPOT, including a list of objectives, shots for which the project was planned, and fielding agencies.

Project 2.1, Gamma Exposure versus Distance, was designed to measure initial gamma intensities at various distances from a nuclear detonation. The data obtained from these measurements could be used to predict and evaluate the gamma radiation hazard posed by certain nuclear devices. Measurements obtained from devices detonated under similar circumstances were compared.

Two methods of obtaining gamma measurements were used: one for detonations at or near the surface where the point of detonation was fixed, and one for airdropped devices. For stationary devices, National Bureau of Standards (NBS) film dosimeters, each loaded with two film packets, were placed on posts at a range of distances from the point of detonation. This method of fielding was used for Shot ESS and the tower shots, including MOTH, TESLA, TURK, HORNET, BEE, APPLE 1 and POST. The other method was to use canisters containing the dosimeters. At Shots WASP and WASP PRIME, both low-altitude airdrops in which the point of detonation was readily determined, the canisters were fixed in the field. At Shot HA, a high-altitude detonation for which surface-placement would not serve, the canisters were dropped, probably from the delivery aircraft, before or after the device was dropped.

Table 4-3: MILITARY EFFECTS GROUP PROJECTS CONDUCTED AS PART OF PROGRAM 2 DURING OPERATION TEAPOT

Project	Title	Project Objectives	Shots	Participants
2.1	Gamma Exposure versus Distance	To evaluate the gamma radiation hazard at various distances from a nuclear detonation	WASP, MOTH, TESLA, TURK, HORNET, BEE, ESS, APPLE 1, WASP PRIME, HA, POST, MET	Army Signal Corps Engineering Laboratories
2.2	Neutron Flux Measurements	To evaluate the neutron radiation hazard at various distances from a nuclear detonation	WASP, MOTH, TESLA, HORNET, BEE, APPLE 1, WASP PRIME, HA, POST, MET	Naval Research Laboratory
2.3a	Neutron-induced Radioactive Isotopes in Soils	To evaluate the gamma radiation hazard from neutron-activated soil near a nuclear detonation	WASP, MOTH, TESLA, HORNET, ESS	Naval Radiological Defense Laboratory
2.3b	Gamma Radiation Fields Above Fallout Contaminated Ground	To evaluate the gamma radiation hazard from fallout at various distances from a nuclear detonation	ESS, POST	Naval Radiological Defense Laboratory
2.4	Gamma Dose Rate versus Time and Distance	To evaluate the gamma radiation hazard from fallout at various times after a nuclear detonation	WASP, MOTH, TESLA, ESS. WASP PRIME	Evans Signal Laboratory; Army Signal Engineering Laboratories
2.5.1	Fallout Studies	To evaluate the radiation hazard caused by fallout from a nuclear detonation	WASP, MOTH, TESLA, HORNET, BEE, ESS	Chemical and Radiological Laboratory
2.5.2	Distribution and Intensity of Fallout from the Underground Shot	To evaluate the hazard associated with fallout from an underground nuclear detonation	ESS	Naval Radiological Defense Laboratory
2.6	Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field	To evaluate the beta and gamma radiation hazards of an area contaminated by a nuclear detonation	WASP, TURK, ESS, APPLE 1, MET, APPLE 2	Naval Medical Research Institute
2.7	Shielding Studies	To evaluate the effectiveness of various shields at reducing gamma and r tron radiation hazards caused by a nuclear detonation	WASP, TESLA, ESS, APPLE 1, POST, MET	Army Chemical Center; Chemical and Radiological Laboratory; Bureau of Yards and Docks (ESS only
2.8a	Contact Radiation Hazard Associated with Contaminated Aircraft	To evaluate the radiological hazard associated with maintenance on contaminated aircraft	WASP, MOTH, TESLA, TURK, HORNET, BEE, APPLE 1, WASP PRIME, HA, POST, MET, APPLE 2, ZUCCHINI	Air Force Special Weapons Center
2.8b	Manned Penetration of Atomic Clouds	To evaluate the radiological hazard of flying through a nuclear cloud	BEE, APPLE 1, MET, APPLE 2, ZUCCHINI	Air Force Special Weapons Center

The surface stations for all shots except ESS were located in predicted upwind sectors to ensure that the initial gamma exposures could be measured. Dosimeters were recovered as soon after the detonation as possible, so that the initial gamma radiation produced by the detonation of the device itself could be distinguished from gamma radiation from fallout or from radioactivity induced in the soil by the detonation (117).

Project 2.2, Neutron Flux Measurements, was designed to measure neutron radiation as a function of distance from a nuclear detonation. The data obtained from this experiment could be used to predict and evaluate the hazard posed by neutron radioactivity from certain nuclear devices. Once again, measurements were compared with similar devices detonated under similar conditions. Table 4-3 lists the shots at which Project 2.2 was conducted.

The detectors used to measure neutron radiation were placed in the field or dropped from the delivery aircraft before or after the nuclear device was dropped. Early recovery was a necessity for accurate evaluation of neutron activity. For shots at which measurements close to ground zero were desired, the detectors were attached to a cable so that promptly after the shot the cable could be pulled out of regions of high radioactivity into areas of lower intensity, where samples could be removed and sent to the laboratory for analysis. For measurement stations farther from the point of detonation, the detectors were placed on stakes. After the detonation, they were removed from the stakes. Following recovery, the detectors from this project were taken to Mercury for analysis (123; 255).

Project 2.3, Gamma Ray Spectral Measurements, consisted of two parts: Project 2.3a, Neutron-induced Radioactive Isotopes in

Soils, and Project 2.3b, Gamma Radiation Fields Above Fallout Contaminated Ground. The primary objective of Project 2.3 was to distinguish between the contribution to residual gamma radiation produced by neutron-induced radioactivity in the soil surrounding a nuclear detonation and radioactivity resulting from fallout. To evaluate gamma radiation, gamma-spectrum measurements were performed within radiation fields near the surface zeros of WASP and ESS, and the ground zeros of MOTH, TESLA, and HORNET. Measurements were repeated at various distances from the points of detonation of these shots periodically after the nuclear events.

Project 2.3a, Neutron-induced Radioactive Isotopes in Soils, studied the secondary gamma radiation induced in the soil surrounding a nuclear detonation by neutrons produced from the nuclear detonation. Soil samples were collected near the surface zeros of WASP and ESS, and the ground zero of TURK. At Shot TESLA, however, pieces of metallic debris were collected from the area near ground zero and analyzed (174).

Project 2.3b, Gamma Radiation Fields Above Fallout Contaminated Ground, addressed gamma radiation resulting from fallout on the soil surface surrounding a nuclear detonation. Data were obtained by teams of project participants who measured postshot radiation levels near the points of detonation (235).

Project 2.4, Gamma Dose Rate versus Time and Distance, was similar to Project 2.1 in that it was performed to measure gamma radiation. Unlike Project 2.1, however, the measurements were taken as functions of both time and distance from the points of detonation. Measurements were obtained by placing arrays of radiation-detection instruments at various distances from each point of detonation (116).

Project 2.5.1, Fallout Studies, was conducted to study the radiation hazard posed by fallout. Project 2.5.1 was an extension of fallout studies performed at previous continental and oceanic tests, and involved both ground and aerial surveys, and soil sampling. Personnel from Project 2.5.2, and from Project 37.2, a CETG project, contributed to this project (274).

Project 2.5.2, Distribution and Intensity of Fallout from the Underground Shot, was to determine how the material and radioactive debris thrown up by the underground detonation were distributed around surface zero. The second objective was to investigate and evaluate the intensity of fallout from the ESS event by sampling the fallout at ground level. Project personnel associated with Project 2.5.2 coordinated their work with Project 2.5.1. Except for some soil samples taken after the event, fall-out samples were taken by capturing debris and materials as they fell to the ground after the ESS detonation.

Planning the ESS event provided that the detonation should be accomplished when the wind direction would result in a fallout pattern southeast of surface zero. A special sample collection road was constructed across this sector. Most samples were col-lected in steel buckets installed in the field singly, in pairs, or in multiple arrays. A second type of fallout collector, gummed paper, was mounted next to these collectors at all loca-tions. A third type of sampler, called incremental collectors, had a number of compartments that opened and closed in sequence and at measured intervals of time. These collectors provided information on the particulate nature and rate of arrival of fallout in the period of time following a detonation (279).

Project 2.6, Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field, was performed to estimate how beta and gamma radiation contributed to the whole-body dose and dose received by specific organs of the human body.

Project personnel designed mannequins of laminated pressed wood, constructed to conform closely to the dimensions of the average person. The mannequins were about 1.8 meters tall and weighed 160 pounds. Mannequins were placed in prone and upright positions. A wooden frame called a kite, which held radiation measurement instruments to record baseline information on radioactivity in the environment, was constructed to surround each mannequin. Each mannequin also had a hollowed chest-cavity filled with plastic sponge to simulate lung material. Miniature ionization detectors and other radiation intensity meters were implanted at various positions within the mannequins, approximating the locations of principal vital organs. These radiation detectors were used to record beta- and gamma radiation doses received at the organ sites over time.

Following a detonation, project personnel rapidly placed these mannequins within the fallout field, where they were left for a period of time, often days, to accumulate radiation exposure. Then project personnel would retrieve them and assess the accumulated doses of radiation (171; 232).

Project 2.7, Shielding Studies, was conducted on a variety of surface and underground structures, shelters, field fortifications, foxholes, vehicles, and vehicle trenches. Personnel from Projects 2.1, 2.2, 3.1, and CETG Project 39.6 assisted in Project 2.7 to evaluate a variety of structures and equipment to determine how well they reduced gamma and neutron hazards.

The gamma dose measurements on these structures, vehicles, and fortifications were obtained by using Evans Signal Laboratory and National Bureau of Standards film packets, dosimeters, standard holders, and neutron detectors. Before each shot, project personnel placed the instruments at various locations within the fortifications, vehicles, and trenches being tested and recovered them after the test. Project 2.7 personnel did not construct any structures or field fortifications specifically for this project, except for some one- and two-man foxholes. The structures instrumented were those remaining from previous nuclear weapons test series at the NTS (256; 308).

Project 2.8, Contact Radiation Hazard Associated with Contaminated Aircraft, consisted of two separate but related experiments: Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, and Project 2.8b, Manned Penetration of Atomic Clouds. In some cases, the same aircraft were used for both projects.

The objective of Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was to assess the hazard presented by personal contact with aircraft that had just flown through a nuclear cloud. The project included several phases, including aircraft penetration of the nuclear cloud, survey of the aircraft surfaces, study of the decay of radiation on the aircraft, and personnel exposure studies.

Air Force jet aircraft departed from Indian Springs AFB after each detonation, flew through the nuclear cloud, and returned immediately to Indian Springs AFB. In the earlier shots of Operation TEAPOT, Project 2.8a studies were confined to F-84 aircraft, which were used for nuclear cloud-sampling missions by the 4926th Test Squadron (Sampling). At later shots, B-36, B-57, and T-33 aircraft were studied. The T-33s were also used for Project 2.8b, which required the aircraft to fly through the nuclear cloud much earlier than the sampling aircraft in an effort to obtain data on how time of penetration affected the levels of surface contamination.

After the aircraft landed, project personnel held standard gamma survey meters near the contaminated surfaces to determine their radiation intensities. Several types of meters were used and their readings were compared. After the initial surface contamination studies, Project 2.8a personnel evaluated the decay of radioactivity on the aircraft in two ways. Aircraft were resurveyed periodically over the next two days to assess the rate of decay, and project participants attached film to contaminated areas of the aircraft with masking tape to assess the accumulation of radiation exposure. The film was removed for analysis within 24 hours after the detonation.

The last phase of Project 2.8a was a study of project personnel involved in making the film surveys described above. Some participants placed film over the hands and fingers of their gloves while they performed the radiation survey work. The film was then removed, developed, and evaluated to assess accumulated dose to ground-crews working on contaminated aircraft. Another technique was to have the project personnel rub the base of their hands over the surface of an aircraft with known contamination. An autoradiograph of the hand was then made by placing the hand on a large x-ray film packet for a period of time and then developing the film to observe the image created. In this way, changes in the contamination patterns of aircraft and relative amounts of contamination transferred to the hand could he measured. While conducting these studies, none of the survey team exceeded the AFSWC maximum permissible exposure of 3.9 roentgens for ground crew personnel (80).

Project 2.8b, Manned Penetration of Atomic Clouds, was a study to measure the radiation dose rate and dose received by air crews flying near and into the nuclear cloud. As indicated above, the same aircraft may have been used as for Project 2.8a. Specific information was sought by the Air Force on radiation dose rates inside the cloud, the total dose received during passage through the cloud, and the dose received on the return flight. In addition, it is likely that lead vests were also tested for their effectiveness in shielding the crew against radiation. Seven aircraft penetrations were made through the nuclear clouds of five detonations, which ranged in yield from eight to 30 kilotons. Project personnel instrumented F-84s, B-36s, B-57s, and T-33s to measure gamma radiation dose rates. All instrumentation was prepared and checked for proper operation on the day before each shot. Typically, two automatic recording dose-rate meters were used in each aircraft. One was mounted in the nose compartment, and the other in the rear of the cockpit. A non-recording meter for use by the pilot was also installed in each aircraft. In addition to the dose-rate meters, a number of film devices were used. National Bureau of Standards film packets were placed in the cockpit and nose of each aircraft near the recording dose rate meter to determine accumulated radiation dose at the recorders during the mission.

The pilot of each aircraft was accompanied by a technical observer in all aircraft but the F-84, which had a maximum crew of one. Pilots and technical observers wore film badges issued bv the Radiation Safety Division of the AFSWC 4926th Test Squadron. The pilot and technical observer also carried a number of small pieces of Dupont dental x-ray film. One special film pack was designed to measure internal bodv radiation dosage. This film packet consisted of nine small disks of film enclosed in a watertight capsule attached to a string. The capsule containing the film was swallowed by the technical observer and the pilot prior to take-off and retrieved after the flight was completed. A similar capsule containing film was attached to the outside of the pilot's flight suit near his stomach. The pilot and the technical observer wore lead vests to reduce radiation exposure to the body (46; 112; 284; 306).

Typically, the aircraft left Indian Springs AFB before shot-time, climbed to an altitude of about 40,000 feet, and flew to a position about 48 kilometers east of the ground zero to observe the detonation and the subsequent development of the nuclear cloud. The aircraft then flew by the cloud to estimate the time required to fly through the most dense section of the cloud. The aircraft then flew through the cloud. The technical observer, who had a stopwatch, recorded the time of entry into and exit from the visible cloud. In addition, an automatic dose-rate recording meter was also used to measure time in the cloud. After emerging from the cloud, the aircraft returned immediately to Indian Springs AFR, and the crew and instruments were removed from the aircraft. Crew members left the aircraft by climbing onto a forklift, which lowered them to the ground. They were then decontaminated. A description of these procedures is found in section 5.3 of this volume (46; 80; 306).

For these missions, the Test Manager authorized a special exemption to the radiation exposure limit for four Project 2.8b Air Force officers. Each officer was authorized to receive a total of 15 roentgens whole-body gamma radiation during participation in the project (285).

4.1.3 Program 3: Effects on Equipment and Structures

The purpose of Program 3 was to document blast and shock effects of nuclear detonations on vehicles and buildings. The nine projects conducted under Program 3 during TEAPOT were considerably reduced from the extensive testing conducted during UPSHOT-KNOTHOLE, and focused on assessing the destructive characteristics of the precursor zone of the blast wave. The program included tests on vehicles placed near ground zero and on a variety of concrete and steel structures, including under ground shelters. The data from these projects were used to assess the damage potential of nuclear detonations on large, fixed targets and rigid structures.

Table 4-4 lists the projects of Program 3 scheduled for Operation TEAPOT, along with a statement of their objectives, the shots for which they were planned, and the fielding agency of each project.

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, was conducted to test how well vehicles were able to withstand the destructive pressures present in the precursor zone created by a nuclear detonation. The vehicle targets were positioned over three different surfaces: water, asphalt, and desert. Some vehicle targets were placed close to ground zero to test the hypothesis that they would sustain less damage than those placed further away. Data from the project were used to determine damage effects, to develop damage criteria, and to obtain data to improve equipment design and construction (40).

Project 3.2, Study of Drag Loading of Structures in the Precursor Zone, was conducted only at Shot MET. While Project 3.1 tested the ability of vehicles to withstand the blast effects of a nuclear detonation, Project 3.2 tested the capacity of concrete structures to withstand the destructive characteristics of the precursor zone of the blast front (272).

Project 3.3.1, Flexible Measuring Devices and Inspection of Operation JANGLE Structures, was conducted to study the effects of the ESS underground detonation on steel and concrete structures. The data were used to assess the destructive potential of the blast and shock loading created by the atomic demolition munition. To perform this experiment, 15 structures of various steel and concrete construction designs were built on an arc around the ESS ground zero and instrumented by project personnel. In addition, several structures remaining from the 1951 BUSTER-JANGLE Series located within 305 meters of the ESS ground zero were also instrumented and inspected before and after

Table 4-4: MILITARY EFFECTS GROUP PROJECTS CONDUCTED AS PART OF PROGRAM 3 DURING OPERATION TEAPOT

Project	Title	Project Objectives	Shots	Participants
3.1	Response of Drag-type Equipment Targets in the Precursor Zone	To determine the ability of vehicles to withstand the blast effects of a nuclear detonation	WASP, MOTH, TESLA, TURK, HORNET, BEE, APPLE 1, WASP PRIME, POST, MET, APPLE 2	Ballistic Research Laboratories
3.2	Study of Drag Loading of Structures in the Precursor Zone	To determine the ability of concrete buildings to withstand the blast effects of a nuclear detonation	MET	Wright Air Development Center
3.3.1	Flexible Measuring Devices and Inspection of Operation JANGLE Structures	To determine the ability of steel and concrete buildings to withstand the blast and shock forces from an underground nuclear detonation	ESS	Bureau of Yards and Docks
3.3.2	Behavior of Underground Structures Subjected to an Underground Explosion	To determine the ability of underground concrete buildings to withstand the shock forces from an underground nuclear detonation	ESS	Office, Chief of Engineers
3.4	Air Blast Effects on Underground Structures	To assess the damage caused to underground concrete and steel structures by an above-ground nuclear detonation	MET	Office, Chief of Engineers; Ballistic Research Laboratories
3.6	Evaluation of Earth Cover as Protection to Underground Structures	To determine the effectiveness of covering shelters with dirt as shielding against the blast and radiation effects of a nuclear detonation	MET	Bureau of Yards and Docks
3.7	Effect of Positive Phase Length of Blast on Drag Type Structural Buildings	To determine the ability of differently constructed buildings to withstand the pressure and blast effects of a nuclear detonation	MET	Air Force Special Weapons Center; Wright Air Development Center
3.8	Test of Concrete Panels	To determine the ability of reinforced concrete buildings to withstand the pressure and blast forces of a nuclear detonation	MET	Bureau of Yards and Docks
3.9	Response of Small Petroleum Products Storage Tanks	To determine the ability of containers used to store petroleum products to withstand the pressure and blast effects of a nuclear detonation	MET	Wright Air Development Center
3.10	Structures Instrumentation	To measure changes in underground and above-ground buildings caused by the blast forces of a nuclear detonation	MET	Ballistic Research Laboratories

the ESS detonation to determine the damages caused by blast and shock loading (92).

Project 3.3.2, Behavior of Underground Structures Subjected to an Underground Explosion, was conducted to study the effects of a shock loading produced by an underground detonation on buried structures. Results were correlated with data obtained from previous tests of conventional high-explosive charges and from Shot UNCLE, the subsurface nuclear event in the BUSTER-JANGLE Series conducted at the NTS in late 1951.

Two reinforced concrete structures were constructed below ground for this project. Measurements were made of earth pressure and movement produced by the shock wave, and the deflection of shock forces with time at various points on the structures (277).

The purpose of Project 3.4, Air Blast Effects on Underground Structures, was to assess the destructive capacity of blast and secondary shock forces created by an above-ground detonation on underground structures. Project 3.4 was a variation of the investigations conducted at the ESS detonation in Projects 3.3.1 and 3.3.2, where above-ground and underground structures were subjected to the shock and secondary blast loading produced by an underground detonation. The underground structures instrumented at Shot MET had originally been constructed for tests during the UPSHOT-KNOTHOLE Series in 1953, and were positioned within 2.5 meters of the surface on an arc about 270 meters from the point of detonation (301).

For Project 3.6, Evaluation of Earth Cover as Protection to Underground Structures, two full-scale and four quarter-scale buildings, constructed of steel and aluminum, were positioned around the MET ground zero and shielded with earth revetments. The structures were instrumented with air-pressure gauges and radiation detectors to provide data both on the protection provided bv the earth cover from the destructive forces of the blast wave, and the radiation-shielding properties of the earth cover (293).

For Project 3.7, Effects of Positive Phase Length of Blast on Drag Tvpe Structural Buildings, steel-frame buildings covered with roofing and siding were constructed 1,325 and 2,000 meters from ground zero. These positions placed all four buildings within the range of the positive air-pressure phase of the MET blast wave (276).

For Project 3.8, Test of Concrete Panels, project personnel positioned and instrumented pairs of ribbed and solid concrete panels about 1,000 and 1,500 meters from the point of detonation to obtain data on the behavior of concrete structures subjected to the dynamic blast loads from a nuclear detonation. The data were used to improve design standards for building construction (9).

Project 3.9, Response of Small Petroleum Products Storage Tanks, was planned and designed by the Air Force Headquarters Directorate of Intelligence. Four tanks remaining from Operation UPSHOT-KNOTHOLE in 1953 were repositioned in the MET shot area and filled to 80 percent capacity with water. The purpose of the study was to obtain safety data on damage sustained from pressure and blast forces that would crush, rupture, or overturn petroleum storage tanks, or break pipe connections, and thereby increase the hazard of secondary fires produced bv a nuclear detonation (242).

For Project 3.10, Structures Instrumentation, the structures constructed and vehicles used for the MET event by Projects 3.2, 3.4, and 3.7 were instrumented with 95 different data-collection sources to provide information on pressure, acceleration, strain, and displacement produced by the MET blast wave (231).

4.1.4 Program 5: Aircraft Structures

As part of a Department of Defense effort to understand the effects of nuclear detonations on military equipment, AFSWP tested aircraft and aircraft components at Operation TEAPOT to determine how well they could withstand blast and heat produced by a nuclear detonation. Program 5 tested both jet fighter aircraft and missile models. Aircraft were tested in flight to determine the effects of heat and pressure on the aircraft's response and overall structure, while components were instrumented and mounted on the ground. Table 4-5 lists the projects conducted as part of Program 5 during Operation TEAPOT. A statement of objectives, planned shot participation, and fielding agency accompany each project listing.

Project 5.1, Destructive Loads on Aircraft in Flight, was designed to assess how the overall structure of jet-fighter aircraft responded to the destructive blast forces produced by a nuclear explosion. Because the equipment used to record data in this test had caused some problems previously, the equipment was tested at Shot BEE. In addition to one QF-80A drone carrying the test equipment, a manned jet-fighter also participated at BEE to provide a check on the instrumentation system. During Shots APPLE 1 and APPLE 2, only ground personnel of Project 5.1 performed the project. At APPLE 1, ground controllers practiced in preparation for Shot MET. During APPLE 2, ground personnel performed radar functions in conjunction with Projects 5.2 and 8.1. The full experiment was performed at Shot MET with three QF-80K drone aircraft. The drones flew within range of the blast to record its effects (258).

Project 5.2, Effects on Fighter Type Aircraft in Flight, was conducted to investigate the response of F-84F jet-fighter aircraft to the blast forces produced by a nuclear detonation. Except for HORNET, the flight pattern was planned so that aircraft would receive the blast effects from the rear. At HORNET, the aircraft received the blast from the side.

Table 4-5: MILITARY EFFECTS GROUP PROJECTS CONDUCTED AS PART OF PROGRAM 5 DURING OPERATION TEAPOT

roject	Title	Project Objectives	Shots	Participants
;.1	Destructive Loads on Aircraft in Flight	To determine the ability of various aircraft structures to survive the wind gusts produced by a nuclear detonation	BEE, APPLE 1, HA, MET, APPLE 2	Wright Air Development Center; Air Proving Ground
;.2	Effects on Fighter Type Aircraft in Flight	To determine the ability of fighter aircraft to survive the blast forces produced by a nuclear detonation	TURK, HORNET, BEE, APPLE 1, MET, APPLE 2	Wright Air Development Center
;.4	Evaluation of Fireball Lethality Using Basic Missile Structures	To determine the ability of various missile shapes and materials to survive the high temperatures produced by a nuclear detonation	MET	Wright Air Development Center
5.5a	Effects of Nuclear Explosions on Fighter Aircraft Components	To determine the structural response of fighter aircraft components to the blast forces produced by a nuclear detonation	MET	Wright Air Development Center; University of Dayton
5.5b	Thermoelastic Response of an Aluminum Box Beam	To determine the ability of aluminum aircraft components to survive the blast forces and high temperatures produced by a nuclear detonation	MET	Wright Air Development Center; University of Dayton

For the test flights at all of the shots except HORNET, two aircraft flew set patterns at two different altitudes. Only one F-84F flew at Shot HORNET. The takeoff time for the aircraft was about 35 minutes prior to each detonation. The aircraft entered their respective traffic patterns about 23 minutes before shot-time and made two complete fly-arounds to establish heading, turn rate, and time position. Seven minutes before the detonation, the aircraft passed the original traffic pattern entry point and proceeded to the final 180-degree turn. The aircraft entered the final flight pattern at three minutes before shot-time and proceeded on course until after detonation and the final blast wave had passed. They returned to base about five minutes after shot-time (259).

Project 5.4, Evaluation of Fireball Lethality Using Basic Missile Structures, had two objectives. The first was to measure how the heat of a nuclear fireball affected such basic missile structures as spheres and cylinders. The second was to determine how well various ceramic materials withstood the heat of the nuclear fireball.

For the first objective, spherical and cylindrical test specimens were positioned on five towers located at distances ranging between 19 and 92 meters from the MET point of detonation. For the second objective, ceramic materials were placed on three delta-wing pylons located about 335, 671, and 945 meters from ground zero (221; 264).

Project 5.5a, Effects of Nuclear Explosions on Fighter Aircraft Components, was conducted to study how aircraft components were affected by the blast forces of a nuclear detonation. Horizontal stabilizers from F-80 and F-86 aircraft were mounted on the ground for exposure to the blast produced by the nuclear detonation (297).

The purpose of Project 5.5b, Thermoelastic Response of an Aluminum Box Beam, was to'determine how aluminum aircraft components were affected by the heat and blast forces produced by a nuclear detonation. The sample tested was located about 1,220 meters from ground zero on a stand about two meters high (170).

4.1.5 Program 6: Electromagnetic Effects and Tests of Service Equipment

This program had two basic objectives:

- To evaluate field tests of radiation detection instruments and associated electronic equipment
- To evaluate methods for determining the ground zero, height of burst, and yield of a nuclear detonation.

Both of these objectives were continuations of goals in similar projects conducted during Operation UPSHOT-KNOTHOLE in 1953. In addition to these projects, Program 6 included an evaluation of a radiological defense warning system. Table 4-6 indicates the six projects conducted during the TEAPOT Series as part of Program 6. The table includes a list of project objectives, shots for which the projects were planned, and fielding agencies.

Project 6.1.1a, Evaluation of Military Radiac Equipment, field-tested six models of radiation detection instruments. Two of the instruments were field-tested by Camp Desert Rock radiological safety personnel, who compared the new instruments with those currently in use as checks of their accuracy (49).

Project 6.1.1b, Evaluation of a Radiological Defense Warning System (Project CLOUDBURST), was designed to evaluate a radiological defense warning system developed by the Army Signal Corps. The system was designed so that activation of any part of it could be used to trigger a secondary alarm circuit. The device could be used to control protective devices which would be activated automatically in case of a nuclear attack (250).

Table 4-6: MILITARY EFFECTS GROUP PROJECTS CONDUCTED AS PART OF PROGRAM 6 DURING OPERATION TEAPOT

Project	Title	Project Objectives	Shots	Participants
6.1.1a	Evaluation of Military Radiac Equipment	To evaluate new radiation detecting instruments	WASP, TURK, HORNET, BEE, ESS, APPLE 1, MET	Army Signal Corps Engineering Laboratories
6.1 .lb	Evaluation of a Radiological Defense Warning System	To evaluate a new radiological defense warning system	WASP, MOTH, TESLA, TURK, HORNET, BEE, APPLE 1	Army Signal Corps Engineering Laboratories
6.12	Accuracy of Military Radiacs	To determine the accuracy of radiation detection instruments	ESS, APPLE 1, MET	Naval Radiological Defense Laboratory
6.2	Effects on Selected Components and Systems	To evaluate radiation effects on electronics equipment	APPLE 1, MET	Army Signal Corps Engineering Laboratories
6.3	Missile Detonation Locator	To evaluate a radar system used to determine the location of a nuclear detonation from a tactical range	WASP, MOTH, TESLA, TURK, HORNET, BEE, ESS, APPLE 1, WASP PRIME, HA, POST, MET, APPLE 2	Army Signal Corps Engineering Laboratories
6.4	Test of IBDA Equipment	To evaluate a system, mounted in an aircraft, that determined the location, height of burst, and yield of a nuclear detonation	WASP, MOTH, TESLA, TURK, HORNET, BEE, ESS, APPLE 1, WASP PRIME, HA, POST, MET, APPLE 2, ZUCCHINI	Wright Air Development Center
6.5	Test of Airborne Naval Radars for IBDA	To evaluate the suitability of standard Navy radar to determine the location, height of burst, and yield of a nuclear detonation	TURK, HORNET, BEE, APPLE 1, MET, APPLE 2, ZUCCHINI	Bureau of Aeronautics

Project 6.1.2, Accuracy of Military Radiacs, was similar to Project 6.1.1a in that it evaluated radiation detection instruments. The project was designed to measure the accuracy of standard military radiation detection equipment (30; 250; 302; 303).

Project 6.2, Effects on Selected Components and Systems, was fielded to evaluate the radiation effects of a nuclear detonation on the reliability of electronic equipment either in use or in storage at the time of a nuclear detonation (118).

Project 6.3, Missile Detonation Locator, tested a radar system designed to locate ground zero by detection and analyses of the electromagnetic radiation emitted by the burst. The detonation locator consisted of broadband receivers based approximately 115 and 320 kilometers southwest of the Nevada Test Site. Fielding activities were not required at the NTS for this project (239).

Project 6.4, Test of IBDA Equipment, was conducted at all fourteen nuclear events of the TEAPOT Series. The primary objective of this project was to evaluate a system, installed in a B-50D aircraft, that determined the location, height of burst, and yield of a nuclear detonation. A secondary objective was to determine the operating range of the system's yield-measuring component, which was placed in two F-94 aircraft (84).

Project 6.5, Test of Airborne Naval Radars for IBDA, was similar to Project 6.3 in that it evaluated the suitability of using radar to determine the location, height of burst, and yield of a nuclear detonation. Project 6.5 differed from 6.3, however, because it tested standard Navy radars rather than new, developmental models (305).

4.1.6 Program 8: Thermal Radiation Effects

This program was designed to document thermal radiation characteristics of nuclear detonations. Of particular importance in this program was the evaluation of the thermal characteristics of almost identical devices detonated both at high and low altitudes. Eight projects which were part of Program 8 were implemented during the TEAPOT Series, as shown in table 4-7.

Project 8.1, Measurement of Direct and Ground-reflected Thermal Radiation at Altitude, was conducted to study how the heat reflected from the earth's surface contributed to the total heat received by aircraft in the vicinity of nuclear detonations. At each of the shots, three Navy AD aircraft carrying thermal radiation detection instruments flew around ground zero at a speed of approximately 175 knots. Twenty seconds before the detonation, the pilots turned on the radiation detection instruments in each aircraft. At approximately two seconds after the detonation, the pilots turned their aircraft to the outside of their orbit in order to receive the subsequent blast wave in a near tail-on position (223).

Project 8.3, Protection Afforded by Operational Smoke Screens Against Thermal Radiation, was fielded at HORNET to evaluate how well a smoke screen served as a shield against the heat produced by a nuclear detonation (96).

Project 8.4, included six separate subprojects, 8.4a through 8.4f. Project 8.4a, Thermal Measurements from Aircraft in Flight, was conducted to measure the thermal radiation produced by a high-altitude nuclear detonation (82).

Project 8.4b, Thermal Measurements from Fixed Ground Installations, was designed to measure the thermal radiation damage on military targets. Standard thermal-radiation measurements

Table 4-7: MILITARY EFFECTS GROUP PROJECTS CONDUCTED AS PART OF PROGRAM 8 DURING OPERATION TEAPOT

Project	Title	Project Objectives	Shots	Participants
8.1	Measurement of Direct and Ground-reflected Thermal Radiation at Altitude	To determine the ability of Navy aircraft to withstand the heat produced by a nuclear detonation	TURK, BEE, APPLE 1, MET APPLE 2	Navy Bureau of Aeronautics
8.3	Protection Afforded by Operational Smoke Screens Against Thermal Radiation	To evaluate the effectiveness of a smoke screen as a shield against the heat produced by a nuclear detonation	HORNET	Army Chemical Center, Chemical and Radiological Laboratories, 2d Chemical Weapons Battalion
8.4a	Thermal Measurements from Aircraft in Flight	To measure the thermal radiation produced by a high altitude nuclear detonation	HA	Naval Radiological Defense Laboratory
8.4b	Thermal Measurements from Fixed Ground Installations	To determine the heat produced by a nuclear detonation	WASP, MOTH, TESLA, HORNET, BEE, WASP PRIME, HA, MET	Naval Radiological Defense Laboratory
8.4c	Thermal Measurements Prior to the First Minimum	To characterize the thermal radiation produced by a nuclear detonation	WASP, WASP PRIME, HA	Naval Radiological Defense Laboratory
8.4d	Spectrometer Measurements	To measure changes in the thermal radiation produced by a nuclear detonation	WASP, MOTH, TESLA, HORNET, BEE, APPLE 1, WASP PRIME, HA, POST	Naval Radiological Defense Laboratory
8.4e	Air Temperature Measurements	To measure changes in air temperature following a nuclear detonation	TURK. MET	Naval Radiological Defense Laboratory
8.4f	Bolometer Measurements	To determine changes in the amount of heat produced at various times after a nuclear detonation	WASP, MOTH, TURK, HORNET, BEE, WASP PRIME, HA, POST	Naval Radiological Defense Laboratory

were made from ground installations relativelv close to the points of detonation (166).

Project 8.4c, Thermal Measurements Prior to the First Minimum, conducted at the three aerial nuclear detonations, was designed to study characteristics of the thermal radiation produced by a nuclear detonation. Measurements of thermal radiation were made by high-sensitivity equipment installed in Building 410 above the Control Point area in Yucca Pass (168).

Project 8.4d, Spectrometer Measurements, was conducted to measure changes in the thermal radiation produced by a nuclear detonation. As with Project 8.4c, the recording instruments were located in Building 410 above the Control Point area (253).

Project 8.4e, Air Temperature Measurements, measured changes in air temperature following a nuclear detonation (172).

Project 8.4f, Bolometer Measurements, was conducted to measure changes in the thermal radiation as a function of time after a nuclear detonation. Primary emphasis was placed on the aerial nuclear detonations, Shots WASP, WASP PRIME, and HA. As in Projects 8.4c and 8.4d, all data were taken from Building 410 (173; 252).

4.1.7 Program 9: Supporting Measurements

This program had two primary objectives:

- To provide photographs and motion pictures of the TEAPOT Series for scientific and historical purposes and also for release to the public press
- To gather data describing the movement of a nuclear cloud.

As table 4-8 indicates, onlv two projects were conducted during the TEAPOT Series as part of Program 9.

Table 4-8: MILITARY EFFECTS GROUP PROJECTS CONDUCTED AS PART OF PROGRAM 9 DURING OPERATION TEAPOT

Project	Title	Project Objectives	Shots	Participants
9.1	Technical Photography	To document project activities and results	WASP, MOTH, TESLA, TURK, HORNET, BEE, ESS, APPLE 1, WASP PRIME, HA, MET, APPLE 2, ZUCCHINI	Air Force Special Weapons Center; Lookout Mountain EG and G; Army Map Service
9.4	Atomic Cloud Growth Study	To study the movement of the cloud produced by a nuclear detonation	WASP, MOTH, TESLA, TURK, HORNET, BEE, ESS, APPLE 1, WASP PRIME, HA, POST, MET, APPLE 2, ZUCCHINI	Air Force Cambridge Research Center; EG and G; Army Map Service; Strategic Air Command; U.S. Weather Bureau
9.6	Weather Reconnaissance Support	To gather weather information for the Test Manager	All shots except APPLE 2	Air Weather Service

Project 9.1, Technical Photography, provided technical and documentary photographs and motion pictures of Operation TEAPOT. The photographs were taken both on the ground and in the air. Project personnel filmed pre- and postshot activities, such as the setting up and retrieval of instruments, and maintained remote-controlled cameras that recorded phenomena of scientific interest which occurred at detonation.

Project personnel also provided photographic support to other AFSWP projects, including:

- Project 1.1, Measurement of Free Air Atomic Blast Pressures
- Project 1.2, Shock Wave Photography
- Project 3.7, Effects of Positive Phase Length of Blast on Drag Type Structural Buildings
- Project 5.1, Destructive Loads on Aircraft in Flight
- Project 5.4, Effects of Fireball Lethality Using Basic Missile Structures
- Project 5.5, Effects of Nuclear Explosions on Fighter Aircraft Components

- Project 8.3, Protection Afforded by Operational Smoke Screens Against Thermal Radiation
- Project 8.4, Basic Thermal Radiation Measurements.

Project personnel photographed the nuclear clouds of the TEAPOT atmospheric events and the ESS crater. In addition, the 1352nd Motion Picture Squadron of Lookout Mountain Laboratory performed the documentary filming of various activities before and after shot, while Edgerton, Germeshausen, and Grier (EG and G) performed the technical photography. Air support for Project 9.1 was provided by an RC-47 from the Air Photographic and Charting Service. The aircraft was manned by personnel from AFSWC and the Air Force Missile Test Center. At each shot except POST, APPLE 2, and ZUCCHINI, the RC-47 flew a holding pattern from 10 to 16 kilometers southeast of ground zero at an altitude of 8,000 to 10,000 feet. According to the AFSWP <u>Operational Summary</u>, this RC-47 also performed cloud photography for Project 9.4. This source also states that B-50 aircraft did cloud and burst photography for Project 9.1 at WASP, HA, and HORNET, respectively (95; 97; 248).

Project 9.4, Atomic Cloud Growth Study, was designed to study the movement of the cloud produced by a nuclear detonation. Data were obtained by the use of manned and radio-controlled cameras operated by EG and G at all shots but HA, POST, and MET. The cameras were operated by personnel form the Army Map Service at these shots. To measure the rate of rise and maximum cloud height of the detonations, personnel from the Air Force Cambridge Research Center and the U.S. Weather Bureau positioned a theodolite at the north fence of the Control Point for all shots except HA, for which it was placed near Frenchman Flat to provide a longer base line for the high altitude shot (121).

During Shots TURK, APPLE 1, MET, and APPLE 2, aircrews from Strategic Air Command performed cloud photography for the Air Force Cambridge Research Center in conjunction with Operational Training Project 40.5, Crew Training Reconnaissance. Two RB-47s flew directly over ground zero, taking photographs of the developing nuclear cloud (97; 248).

The AFSWP Operational Summarv (248) lists a third Program 9 project, Project 9.6, Weather Reconnaissance support. The Air Weather Service, using one F-84 aircraft, performed local weather reconnaissance on all shots except APPLE 2 at least 12 hours before each detonation. The purpose of the project was to gather meteorological information to help the Test Manager decide whether a shot should be fired when scheduled. Since this project was routinely performed at almost all shots, it is discussed in this volume only.

4.2 DEPARTMENT OF DEFENSE INVOLVEMENT IN PROGRAMS OF THE AEC NUCLEAR WEAPONS DESIGN LABORATORY TEST GROUPS

Two AEC civilian nuclear weapons design laboratories, the Los Alamos Scientific Laboratory (LASL) and the University of California Radiation Laboratory (UCRL) conducted 13 programs at Operation TEAPOT. Although civilian DOD scientists and technicians were semi-permanently assigned to both of these laboratories to perform research and provide support, only DOD organizational participation is discussed in this report. Seven projects included DOD organizational participation.

4.2.1 Los Alamos Scientific Laboratory Test Group Programs

LASL sponsored nine of the nuclear devices tested at Operation TEAPOT. LASL also performed diagnostic tests to measure the characteristics and effects of the nuclear devices detonated during TEAPOT. These tests were divided into eight programs, shown in table 4-9 (47). Of the eight LASL programs, only two included DOD participation: Program 11, Radiochemistry, and Program 18, Thermal Radiation and Spectroscopy. Table 4-9 lists all pro.jects conducted during TEAPOT, with the pro.jects with DOD participation in bold print. In Program 11, DOD participation was limited to Project 11.2, Radiochemistrv Sampling, which was performed by pilots, crews, and aircraft of the Air Force Special Weapons Center (AFSWC) 4926th Test Squadron (Sampling). The activities of this project are discussed in this volume under Section 4.5, AFSWC Support Activities.

Program 18, Thermal Radiation and Spectroscopy, consisted of five projects, four of which were performed by the Naval Research Laboratory of Washington, D.C.:

- Project 18.1, High Temperature Measurements
- Project 18.2, High Altitude Measurements
- Project 18.3, Time Interval Measurements
- Project 18.4, Spectroscopy
- Project 18.5, Disturbed Air Element.

Of these five projects, detailed documentation has been located only for Project 18.3.

Project 18.3, Time Interval Measurements, was performed by the Naval Research Laboratory at Shots TURK, BEE, APPLE 1, APPLE 2, and ZUCCHINI. The objective of this project was to measure the time interval from the detonation to emission of gamma rays released. Three Bowen cameras were set up in Station 400, located above the Control Point, to photograph the detonations (47; 204; 206; 215; 216; 219).

Table 4-9: LASL TEST GROUP PROJECTS CONDUCTED DURING OPERATION TEAPOT

PROGRAM TITLE \ SHOT NAMES	WASP	MOTH	TESLA	TURK	HORNET	BEE	ESS	HADR	APPLE	WASP PRIME	HA	POST	MET	APPLE 2	ZUCCHINI
Program 10. Hydrodynamics	101 10 2	10.1 102	101 102	101 10.2	101 10.2	10.1 10.2			101 102	10.1 102	101 102	101 10.2	101 10.2	101 102	101 10.2
Program 11, Radiochemistry	11.1 11.2	11 1 11.2	11 1 11.2	11 1 11.2	11 1 11.2	11.1 11.2			11 1 11.2	11 1 11.2	11 1 11.2	11 1 11.2	11 1 11.2	11 1 11.2	11 1 11.2
Program 12. External Neutron Measurements		12			12	12				12			12	12	
Program 13, Gamma Ray Measurements	131 13.3a	131 13.2 13.3a	13.2 13.3a	13.2 13.3a	131 132 13.3a	131 132 13.3a 13.3b 13.5	13.3a		13.1 13.2 13.3a 13.3b 135	13.1 13.3a 135	13.3a	132 13.3a	131 13.3a 13.3b	131 13.2 13.3a 13.5	131 132 133a 13.5
Program 14. Scientific Measurements		141 14.2	14.1		14.1 14.2							14.1			
Program 15. Photophysics	151 15.2	15.1 152			15.1 15.2	15.1 152			151 15.2 153 15.4	151 15.2	15.1 152		151 152	15.1 15.2 15.3 15.4	151 15.2 153 154
Program 16. Reaction History	16.3	163	163	163	16.2 16.3	163	16.3	163	16 1 162 16.3	16.3	16.3	16.3	16.3	16.1 16.2 16.3	16.1 162 16.3
Program 18, Thermal Radiation and Spectroscopy	18.2 18.4	18.5		18.3 18.4 18.5	18.4 185	18.3 18.4 18.5		18.2	18.1 18.3 18.4 18.5	18.2 18.4 18.5	18.2 18.5	18.5		18.1 18.2 18.3 18.4	18.3 18.5

NOTE: Bold print indicates projects with DOD participation.

4.2.2 University of California Radiation Laboratory Test Group Programs

The University of California Radiation Laboratory (UCRL), the second AEC civilian nuclear weapons design lahoratory, sponsored three of the 14 TEAPOT nuclear devices tested. This laboratory's diagnostic experiments were organized into five programs, shown in table 4-10 (47). Of the five UCRL programs, only Program 21, Radiochemistry, has been identified as having organizational participation by DOD personnel. In Program 21, DOD participation was limited to Project 21.2, Sample Collecting, which was performed by sampling pilots and crews of the AFSWC 4926th Test Squadron (Sampling). The activities of Air Force personnel in this project, which is identical to the LASL Test Group Project 11.2, Radiochemistry Sampling, are discussed together in this volume under Section 4.5, AFSWC Support Activities (47).

4.3 DEPARTMENT OF DEFENSE INVOLVEMENT IN PROGRAMS OF THE CIVIL EFFECTS TEST GROUP

During the TEAPOT Series, the Federal Civil Defense Administration Civil Effects Test Group conducted ten programs, subdivided into 44 projects. These activities, which were designed to assess the possible effects of nuclear detonations on civilian populations, structures, and consumer products, involved biological studies, tests of civilian shelters, radiation fallout studies, radiation defense training evaluation, and studies of the effects of fallout on foodstuffs (78).

The Civil Effects Test Group programs were numbered in consecutive order from 30 to 39. DOD personnel participated in

Table 4-10: UCRL TEST GROUP PROJECTS CONDUCTED DURING OPERATION TEAPOT

PROGRAM TITLE \ SHOT NAMES	WASP	MOTH	TESLA	TURK	HORNET	BEE	ESS	HADR	APPLE 1	WASP PRIME	HA	POST	MET	APPLE 2	ZUCCHINI
Program 21, Radiochemistry			21.1 **21.2**	21.1 **21.2**	21.1	21.1 **21.2**			21.1			21.1 **21.2**	21.1	**21.2**	21.1
Program 22, History of Reaction			22.1 22.2	22.1 22.2	22.2	22.2			22.2			22.1 22.2			
Program 23, Scientific Photography			23.1 23.2	23.1 23.2 23.3 23.4 23.5								23.1 23.2			
Program 24, External Neutron Measurements			24.1									24.1			
Program 29, Technical Photograpy			29	29								29			

NOTE: Bold print indicates projects with DOD participation.

projects that were part of the following programs (9; 12; 36; 37; 42; 48; 65; 79; 83; 110; 113; 120; 124; 125; 167; 175; 176; 227; 228; 236; 246; 247; 251; 260; 261; 269; 273; 275; 278; 283; 287; 288; 296; 298; 300):

- Program 31: Response of Residential, Commercial, Industrial Structures, and Materials to Nuclear Effects
- Program 33: Biological and Medical Investigation
- Program 34: Shelters for Civil Populations
- Program 37: Fallout Studies
- Program 38: Civil Defense Radiological Effects Studies
- Program 39: Program Instrumentation and Photography.

The weapons test reports are the major source of information on the activities of the Civil Effects Test Group. The reports deal with the technical aspects of the CETG programs and do not include much information on operations. Table 4-11 shows in bold print the projects involving DOD participation and the shots at which the projects were conducted. The following paragraphs discuss DOD participation in the activities sponsored by the CETG (78).

Program 31 recorded and analyzed how nuclear detonations could damage typical American homes, commercial and industrial structures such as aluminum-paneled warehouses, and building materials such as concrete and steel plate. DOD personnel served as consultants on two Program 31 projects.

In Project 31.5, Thermal Ignition and Response of Materials, the Naval Materiel Laboratory helped evaluate the data, while the Quartermaster Research and Development Center acted as technical consultants. The objectives of Project 31.5 were to study the ignition of wooden and untreated surfaces, and to estimate the effects of heat on a variety of materials (224).

Table 4-11: CIVIL EFFECTS TEST GROUP PROJECTS CONDUCTED DURING OPERATION TEAPOT

PROGRAM TITLE \ SHOT NAMES	WASP	MOTH	TESLA	TURK	HORNET	BEE	ESS	HADR	APPLE 1	WASP PRIME	HA	POST	MET	APPLE 2	ZUCCHINI
Program 30, Evaluation and Documentation of Radiological Contamination	30.1 30.2	30.1 30.2 30.3	30.1 30.2 30.3	30.1 30.2 30.3	30.1 30.2 30.3	30.1 30.2 30.3	30.1 30.2 30.3		30.1 30.2 30.3	30.1 30.2 30.3		30.1 30.2 30.3	30.1 30.2 30.3	30.2	30.1 302
Program 31, Response of Residential, Commercial, Industrial Structures, and Materials to Nuclear Effects						31.6								31.1 31.2 31.4 31.5 31.6	
Program 32, Exposure of Foodstuffs to Nuclear Explosions									32.1					32.1 32.2 32.3 324 32.5	
Program 33, Biological and Medical Investigation									**33.1** 33.2 33.4					33.2 33.4 **33.1**	
Program 34 Shelters for Civil Populations				34.2					**34.1b** **34.3**					**34.1a** **34.1b** **34.3** 34.4	
Program 35 Utilities, Services, and Associated Equipment Exposed to Nuclear Explosions														35.1 352 3540 35.4b 355	
Program 36, Mobile Housing and Emergency Vehicles														36.1 36.2	
Program 37, Fallout Studies				**37.1** **37.2**		37.1 37.2	37.1 **37.2**		37.1 37.2				**37.1** **37.2**	37.1 37.2 37.3	
Program 38, Civil Defense Radiological Effects Studies									38.1					**38.1** 38.2 38.3 38.4 38.5	38.3
Program 39, Program Instrumentation and Photography	39.1 39.4a 39.6 **39.7**	39.1 39.4a **39.6** **39.7**	39.1 39.4a	39.2 39.4a	39.1 39.4a 39.6 **39.7**	39.1 39.4a 39.5 **39.7**	39.1 **39.6**		39.1 39.2 39.4a 39.4b 39.5 **39.7**	39.1 39.4a **39.7**	39.5	**39.6**	39.1 **39.6**	39.1 39.2 39.3 39.4a 39.4b 39.4c	

NOTE: Bold print indicates projects with DOD participation

In Project 31.6, Methods for Determining Yield Location of Nuclear Explosions, the Quartermaster Research and Development Center prepared experimental instruments for determining the yield and location of nuclear detonations. The Ballistic Research Laboratories served as consultants. The purpose of Project 31.6 was to develop quick and simple means by which Civil Defense organizations could determine the yield and location of nuclear detonations. There were no DOD personnel involved in either Project 31.5 or 31.6.

Program 33 recorded and analyzed the biological and medical effects from the blast, pressure, and noise produced by a nuclear detonation. One Air Force participant took part in this program (78). Project 33.1, Biological Effects of Pressure Phenomena Occurring Inside Protective Shelters Following a Nuclear Detonation, tested the effects of blast on dogs, rats, and mice which were sealed in instrumented above- and below-ground shelters during the detonation. The data-were used to check the biological effects of changes in pressures occurring in blast-protective shelters following nuclear detonations (294).

For Program 34, personnel of the Army Chemical Center and the Chemical Warfare Laboratory tested the reliability of various types of civilian bomb shelters. Of the program's four projects, two involved DOD participation. In Project 34.1a, Effects of an Atomic Explosion on Group and Familv-type Shelters, Project 34.1b, Evaluation of Indoor Home Shelters Exposed to Nuclear Effects, and Project 34.3, Structural Behavior of Group Shelters under Various Blast Loads, personnel evaluated the protection of various types of shelter against nuclear detonations (294).

Program 37 was designed to record and evaluate the biological effects and physical activity of fallout. The Air Force Special Weapons Center flew radio-relay missions for Project 37.1, Factors Influencing the Biological Fate and Persistence of Radioactive Fallout, and Project 37.2, Phenomenologv of Fallout at Near Distance. The objective of Project 37.1 was to gather data on the accumulation and distribution of fallout, while Project 37.2 sought to observe the downwind concentrations of airborne activity at various distances from ground zero. This AFSWC activity was part of terrain surveying and is discussed in Section 4.5, which describes AFSWC participation in Operation TEAPOT (230).

Program 38 was designed to study and test conventional and experimental radiological defense methods. Members of the 1st Radiological Safety Support Unit participated in Project 38.1, Civil Defense Monitoring Techniques, which developed and demonstrated techniques of radiation monitoring that could be used during civil defense emergencies (266).

Program 39 tested the reliability and utility of radiation detection instruments and the methods of photographing nuclear detonations. Two of the program's projects, 39.6, and 39.7, involved DOD participation at some of the shots (282).

Personnel of the Army Signal Engineering Laboratories participated in Project 39.6, Measurement of Initial and Residual Radiations by Chemical Methods. Five DOD participants assisted in placing and recovering the instruments used in the experiment at Shots MOTH, ESS, and MET. Project 39.6 data were used to evaluate various methods of gamma radiation measurement and to obtain dosimetry readings at stations where various biological investigations were being conducted (282).

Project 39.7, Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects, correlated radiation instrument measurements with biological effects in animals (125). For the entire TEAPOT Series, 23 civilian and military DOD personnel participated in the project as consultants, fielding personnel, and radiological safety monitors. Personnel were from the School of Aviation Medicine at shots with DOD participation. At BEE, personnel were from the Naval Research Laboratory.

4.4 DEPARTMENT OF DEFENSE OPERATIONAL TRAINING PROJECTS

In late 1954, the armed services submitted proposals to the AEC for operational training projects to be performed before, during, and after various scheduled shots of the TEAPOT Series. The following armed service agencies submitted proposals which were accepted for the Series:

- U.S. Navy
- U.S. Air Force Strategic Air Command
- U.S. Air Force Tactical Air Command
- U.S. Air Force Cambridge Research Center
- U.S. Air Defense Command
- U.S. Air Force Office of Assistant to Atomic Energy
- U.S. Marine Corps Fleet Marine Force Pacific.

The Manager of the AEC Santa Fe Operations Office considered each operational training project proposal individually and consulted the Director, Weapons Effects Tests, of AFSWP Field Command before including proposed training activities into the final JTO operational plan. In two respects, these programs were similar to those of Exercise Desert Rock. First, their primary objectives were to test service tactics and equipment, and to train personnel. Second, these projects were planned and conducted so they would not interfere with the AEC diagnostic and DOD military effects tests. Unlike Exercise Desert Rock, however, these projects were under the direct supervision of the JTO and AFSWP.

The Director, Weapons Effects Tests, had the overall responsibility for implementing the DOD operational training programs and coordinating the projects with the participating armed service agencies. In all, 11 air operational training projects and two ground operational training projects were conducted during Operation TEAPOT. Table 4-12 summarizes the actual service participation by shot for the air operational training projects (17; 19; 248).

To expedite the projects, liaison officers from each of the armed service agencies were present at the NTS to coordinate participation in the operational training program. The liaison officers were responsible for disseminating information about shot schedules, preshot indoctrination and training flights, delay or cancellation information, and control and flight-safety criteria (7; 19; 97; 248; 280).

4.4.1 Air Operational Training Projects at Operation TEAPOT

The air operational training projects consisted of various exercises to train aircrews in the tactics to be used during a nuclear detonation. Exercises included simulated combat missions, observation of shots, and photo reconnaissance missions. DOD air operational training projects also required coordination with AFSWC and the Air Operations Center at the Control Point, which had operational control of all flights (7; 97; 248).

Table 4-12: DOD OPERATIONAL TRAINING PROJECTS AT OPERATION TEAPOT

Project	Title	Participants	WASP	MOTH	TESLA	TURK	HORNET	BEE	ESS	HADR	APPLE 1	WASP PRIME	HA	POST	MET	APPLE 2	ZUCCHINI
40.1	Evaluation of IBDA Equipment and Techniques	Strategic Air Command				●					●				●		●
40.2	Crew Indoctrination	Strategic Air Command											●				
40.3	Crew Indoctrination	Tactical Air Command		•	•	●	●	●	●		●	●			●		●
46.4	Gust Effects on 6-36 Aircraft	Strategic Air Command				●									●		
40.5	Reconnaissance Crew Indoctrination	Strategic Air Command				●				●					●	●	
40.5a	Accurate Location of Electromagnetic Pulse	Air Force Cambridge Research Center	*	*	*	*	*	*	*	*	*	*	*	*	*	●	*
46.6	Calibration of Electromagnetic Effects	Air Force	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
40.8	Calibration of Bomb Debris	Air Force	●	•	•	●	●	●			●	●	●	●	●	●	●
40.10	Delivery Crew Indoctrination	Navy				●	●				●			●	●	●	●
46.12	Delivery Crew Indoctrination - Dive Bombing	Marine Corps					●										
40.13	Tactical Indoctrination for a Marina Aircrew	Marine Corps				●		●			●				●	●	
46.23	Crew Indoctrination	Air Defense Command								●			●				
40.24	Crew Indoctrination	Air Research and Development Command															●

* Participation Unknown

For Project 40.1, Evaluation of Indirect Bomb Damage Assessment (IBDA) Equipment and Techniques, combat crews learned IBDA techniques while testing the suitability of IBDA equipment under bomb-drop and actual nuclear detonation conditions. This was done by simulating a nuclear bomb delivery mission and using standard air escape methods. The project required four RB-47 aircraft at any single event to operate at heights ranging from 34,500 feet to 40,000 feet (19; 97; 248).

Project 40.2, Crew Indoctrination, was planned for Shots TURK, HADR, HA, APPLE 1, MET, and APPLE 2. The project was to provide an opportunity for B-36 aircrews to observe a detonation while flying at medium altitudes in the immediate vicinity of the shot area. With the exception of HA, no aircraft participated in this project because of shot postponements (19; 97; 298).

Project 40.3, Crew Indoctrination, was established to train aircrews in the effects of a nuclear detonation while flying simulated tactical delivery techniques and flyby maneuvers. This project consisted of several exercises which were performed at the various TEAPOT shots, as follows:

- Crew Training Flyby Missions

  Shot TURK
  Shot HORNET
  Shot APPLE 1
  Shot WASP PRIME
  Shot ZUCCHINI

- Simulated Low Altitude Bombing Systems (LABS) Exercises

  Shot ESS
  Shot MET

- Simulated BT-9 Maneuvers*

  Shot MOTH
  Shot TESLA
  Shot BEE

*A type of bomb release maneuver

- Simulated Dive Bombing Exercises

  Shot MOTH
  Shot TESLA
  Shot BEE

- Photographic Reconnaissance Mission

  Shot MET.

Except for the photographic reconnaissance missions, which employed RB-57 aircraft, all aircraft for this project operated from George AFB, California. Information about this project is available primarily for the crew training flyby missions.

MSQ-1 radar located 13.6 kilometers south of Frenchman Flat and other electronic devices were used to position the aircraft for each crew training flyby mission. Project personnel also operated a high frequency radio circuit from Camp Mercury to George AFB, California. The NTS radio set was located at Camp Desert Rock and had a remote control line to the project office at Camp Mercury (97; 248; 280).

Project 40.4, Gust Effects on B-36 Aircraft, was designed to test the delivery capability handbook for the B-36 aircraft, which set forth escape distances for bombs of varying yields under different delivery conditions (19; 97; 248).

The objective of Project 40.5, Reconnaissance Crew Indoctrination, was to familiarize photo reconnaissance crews with the effects of nuclear weapons and to obtain vertical photographic documentation of the nuclear cloud growth immediately after detonation. The second objective was to support Military Effects Group Program 9 (19; 97; 248).

Project 40.8, Calibration of Bomb Debris, was performed to determine the relative yields of nuclear products and residues of use in characterizing nuclear weapons. Following each nuclear detonation, particulate and gaseous samples of cloud debris were collected and analyzed in Air Force and contractor laboratories. Air Force requirements for collecting particulate and gaseous samples were integrated with those of LASL and UCRL. Gas samples were to be taken with squeegee equipment in AFSWC F-84 sampler aircraft. The squeegee equipment consisted of a spherical steel bottle filled by means of a high-speed compressor. The project activities are identical to those of LASL and UCRL Projects 11.2 and 21.2, respectively, and are discussed under section 4.5, AFSWC Support at TEAPOT (97; 248).

Project 40.10, Delivery Crew Indoctrination, familiarized Navv aircrew personnel with the effects of a nuclear detonation on Navy aircraft. The participating aircraft were based in Inyokern Naval Air Station, California. To perform this project, Navy aircrews performed various simulated delivery techniques and flyby maneuvers in the vicinity of nuclear detonations. The project consisted of three maneuvers: a flyby maneuver, a loft maneuver, and a simulated dive-bombing run (19; 97; 248).

Project 40.12, Delivery Crew Indoctrination--Dive Bombing, was designed to indoctrinate Marine Corps aircrews on the effects of a nuclear detonation while flying simulated dive-bombing maneuvers in the near vicinity of a test event (97; 248).

Pro.ject 40.13, Tactical Indoctrination for a Marine Aircrew, enabled Marine aircrews to experience the effects of a nuclear detonation while flying at medium altitudes near a test event. The project consisted of flyby maneuvers involving R4D, R5D, and F3D Marine Corps and Navy aircraft (97; 248). At the time of detonation, the aircraft were orbiting at assigned altitudes about 40 kilometers southwest of ground zero. Aircrews observed the detonation and subsequent cloud development and then returned to their staging base at El Toro Air Base, California. The aircraft were positioned before the detonation with the aid of a low frequency homing device located at Lathrop Wells, Nevada, southwest of the NTS (97; 248).

Project 40.23, Crew Indoctrination, was conducted at Shots HADR and HA by the Air Force to familiarize Air Defense Command aircrews with the effects of a nuclear detonation under simulated operational conditions (97; 248).

Project 40.24, Crew Indoctrination, conducted at Shot ZUCCHINI, was designed to train Air Research and Development Command aircrews operating F-100 aircraft in a flyby maneuver (97; 248).

4.4.2 Ground Operational Training Projects at Operation TEAPOT

In addition to the air operational training projects performed by various commands of the Air Force, Navy, and Marine corps, ground operational training projects were conducted by two Air Force Commands. Project 40.5a was conducted by the Air Force Cambridge Research Center, and Project 40.6 was performed by the Air Force personnel.

Project 40.5a, Accurate Location of Electromagnetic Pulse, was to use the electromagnetic pulses generated by nuclear detonations to determine the location and to obtain a yield measurement of the detonation. The three observation stations to record the signal from the detonation were located at Santa Maria, Oceanside, and Palo Alto, California (19; 169; 248).

Project 40.6, Calibration of Electromagnetic Effects, was designed to expand existing information on the characteristics of the electromagnetic pulse emitted upon detonation of a nuclear device. Participants were located both onsite and offsite. Nine unmanned stations and three manned stations located 30 to 40 kilometers from the point of detonation were used in this project. The stations were equipped with battery-powered electronic equipment and, in some cases, photographic equipment, to record the nuclear event (19; 188; 248; 249).

4.5 AIR FORCE SPECIAL WEAPONS CENTER SUPPORT MISSIONS AT OPERATION TEAPOT

The Air Force Special Weapons Center (AFSWC) played a major operational and support role in many of the scientific and military test programs conducted at the NTS during the TEAPOT Series. Based at Kirtland AFB in Albuquerque, New Mexico, AFSWC used Indian Springs AFB in Nevada as its principal staging area. AFSWC provided much of the aircraft and personnel required for cloud-sampling missions, courier missions, cloud-tracking missions, terrain surveys, weather reconnaissance missions, air-drop delivery missions, and other air support as requested by the Test Manager. The 4925th Test Group (Atomic) was the principal AFSWC unit involved in the series. Through its Field Test Group 5 (Provisional), the 4925th Test Group exercised operational control over all aircraft involved in the TEAPOT Series and provided aircrews and aircraft for radiological surveys of the terrain. The 4925th was assisted by other Air Force units which provided support to both the Test Manager and Exercise Desert Rock VI. Two principal units were the 4926th Test Squadron (Sampling) and the 4935th Air Base Squadron. Two other units involved in the TEAPOT Series were the 4900th Air Base Group from Kirtland AFB and the 55th Weather Reconnaissance Squadron from McClellan AFB. The 4900th Air Base Group was the 4901st Air Base Wing until 5 May 1955. AFSWC participation during TEAPOT is summarized in table 4-13 (97; 1193).

The 4926th Test Squadron (Sampling), the principal mission unit of the 4925th Test Group (Atomic), gathered radioactive samples from nuclear clouds for analysis by various test group laboratories. The 4926th Test Squadron operated and maintained

Table 4-13: AFSWC MISSION SUPPORT AT OPERATION TEAPOT

Mission	Project	WASP	MOTH	TESLA	TURK	HORNET	BEE	ESS	HADR	APPLE 1	WASP PRIME	HA	POST	MET	APPLE 2	ZUCCHINI
Cloud Sampling	11.2	●	●	●	●	●	●			●	●	●	●	●	●	●
	21.2			●	●		●						●		●	
	40.8	●		●	●	●	●			●	●	●	●	●	●	●
Courier Service		●	●	●	●	●	●	●		●	●	●	●	●	●	●
Cloud Tracking		●	●	●	●	●	●	●		●	●	●	●	●	●	●
Terrain Surveying			●	●	●	●	●	●		●	●	●	●	●	●	●

the aircraft, usually F-84Gs, T-33s, B-36s, and B-57As, that conducted cloud sampling for LASL and the LJCRL Test Groups and for Air Force Project 40.8. Other sampling aircraft, the B-36s, were maintained and operated by the Strategic Air Command. The Filter Recovery Section of the 4926th Test Squadron removed both the pilots and samples from the aircraft, using procedures detailed in chapter 5 of this report. The 4926th Test Squadron was stationed at Kirtland AFB, New Mexico, but most of the squadron remained at Indian Springs AFB, about 38 kilometers (24 miles) from Camp Mercury, to fulfill operational requirements for Operation TEAPOT. This forward element of the 4926th Test Squadron averaged about 25 officers and 120 airmen. The squadron operated independently on temporary duty for extended periods of time during testing periods (7; 97; 112; 284).

The 4935th Air Base Squadron was based at Indian Springs AFB. It provided regular airbase functions for nuclear testing. In addition, it furnished aircrews and aircraft for security-sweep missions over the NTS and Emergency Air Evacuation missions for the JTO. When the TEAPOT Series began in January 1955, the 4935th Air Base Squadron had a station complement of about 15 officers and 380 enlisted men at Indian Springs AFB (7; 97; 112; 284; 286).

The 4901st Air Base Wing, based at Kirtland AFB, New Mexico, provided courier-mission services between Kirtland AFB and Indian Springs AFB, sample-return missions, air taxi services between Indian Springs AFB and Yucca Lake airstrip, and other courier services for JTO as requested. The personnel strength of the 4901st Air Base Wing is unknown (97; 112; 129; 284).

The 55th Weather Reconnaissance Squadron provided aircrews and aircraft on a temporary dutv basis for cloud-tracking missions. Based at McClellan AFB, this squadron was detached to Kirtland AFB for the length of the Series (97-100; 112; 128).

The Air Operations Center, located at the Control Point in Yucca Pass, maintained operational control over all military aircraft flying in the area of the NTS during the operational phase of the Series (97-100; 112; 128).

The AFSWC aircraft participation that involved the 4926th Test Squadron, 4935th Air Base Squadron, and 4901st Air Base Wing is discussed in the following section.

Cloud-sampling Missions

An important objective of the TEAPOT nuclear weapons testing series was obtaining samples of fission products from nuclear detonations so that LASL and UCRL could determine the yield and efficiency of the nuclear devices. For this analysis, the 4926th Test Squadron collected particulate-type samples by using specially modified wing-tip tanks on F-84G, T-33, B-36, and B-57A aircraft. Except for the T-33s, these aircraft contained valves that could be opened to allow an airstream to pass through the wing-tip tank. The airstream, containing radioactive particulate samples from the nuclear cloud, would strike against a filter paper held by a grid within the tip-tank. An ion chamber located in the wing-tip tank and connected to an instrument in the cockpit indicated to the pilot the size and quantity of the sample collected. After the sampling was completed, the aircraft returned to Indian Springs AFB.

In addition to particulate sampling, gaseous cloud samples were also obtained. These sampling missions, which were required for Air Force operational training Project 40.8, Calibration of Bomb Debris, were performed along with the sampling required for Programs 11 and 21, sponsored by LASL and UCRL, respectively. The gas collection device, installed in F-84G aircraft, was a steel bottle located forward of the cockpit. The gaseous cloud samples were forced into the bottle by means of a high-speed compressor.

After the sampling missions were complete, the gaseous and particulate samples of the nuclear cloud were promptly forwarded to UCRL, LASL, and Air Force scientists for analysis (7; 97).

Sampling aircraft were equipped with various types of radiological instruments that provided data on the exposures of the pilot and other crew-members during flight. F-84 aircraft, for instance, were equipped with a wing-tip ion chamber, a rate meter called the "Rascal," and an "Integron." The "Rascal" had a logarithmic scale and read from background to 500 R/h. Its purpose was to furnish the crew of a sampling aircraft with a peak reading of the radiation intensities experienced while in the nuclear cloud, and readings of aircraft contamination at all other times. The "Integron" indicated accumulated radiation exposure of the pilot and crew of sampling aircraft. In addition, crewmen of sampling aircraft were required to wear film badges (7; 97).

Approximatelv 15 minutes before a detonation, a B-50 aircraft was to take off from Indian Springs AFB, Nevada, climb to an altitude of 20,000 feet, and fly a holding pattern about 20 miles south of the point of detonation until detonation. This R-50 aircraft, the sampler control aircraft, was manned by an aircraft commander, a pilot, a flight engineer, two scanners, a radio operator, a sampler controller, a technical operations advisor, and a scientific advisor from LASL or UCRL, depending on the sponsor of the detonation. The sampler controller was an Air Force pilot who relayed the scientific advisor's instructions to each sampler pilot. The technical operations advisor was an AFSWC flight surgeon. The sampler control aircraft directed the sampling aircraft toward various areas of the nuclear cloud from which particulate and gaseous samples were to be collected.

After detonation, the B-50 control aircraft followed and observed the formation and dissipation of the nuclear cloud. During this time, the scientific advisor evaluated the cloud structure and determined the cloud areas from which sampler aircraft were to collect particulate and gaseous samples.

Sampler aircraft were alerted for takeoff by the Air Operations Center on advice from the sampler control aircraft and notified of the approximate geographic location of the cloud at which sampling would occur. Sampler aircraft left Indian Springs AFB, Nevada, sometimes as late as two to three hours after a detonation. These aircraft were under radar surveillance of the Air Operations Center, which would vector the aircraft to the approximate location of the B-50 sampler control aircraft by placing the aircraft within range of a low-frequency homing device installed on the B-50 sampler-control aircraft.

As each sampling aircraft rendezvoused with the B-50 control aircraft, the control aircraft would direct each sampler aircraft to make one or more penetrations of the nuclear cloud at varying altitudes and areas to gather particulate and gaseous nuclear debris.

After the sampling mission was completed, the sampling aircraft were returned to the control of the Air Operations Center and directed to Indian Springs AFB, where the samples were removed and packaged for delivery to LASL, UCRL, or Air Force laboratories for analysis. The sampler control aircraft was the last aircraft to land (7; 97; 112; 284).

Courier Service

The purpose of AFSWC courier service, which was provided by the 4901st Air Base Wing, was to deliver radioactive samples and data from the TEAPOT research projects to laboratory facilities, such as the Los Alamos Scientific Laboratory, the University of California Radiation Laboratory, and the Naval Research Laboratory. The 4900th Air Base Group was assisted in its courier activities by the Air Research Development Command, Tactical Air Command, Air Training Command, Air Defense Command, and Air Photographic and Charting Service. These Air Force commands provided aircraft and aircrews to the 4901st Air Base Wing on a temporary basis, rotating the aircrews and aircraft every seven to 15 days. The Air Force commands furnished the following aircraft at TEAPOT:

- Five C-47 aircraft, Air Research Development Command
- Four C-119s, Tactical Air Command, from the 463rd Troop Carrier Wing, Ardmore AFB, Oklahoma
- Two B-25s, C-47s, or C-45s, Air Training Command
- One C-47 or one B-25, Air Defense Command
- One RC-47 aircraft, Air Photographic and Charting Service (97).

The courier aircraft left the airbase for their missions several hours and sometimes a day after the detonation. A total of 58 courier sorties were flown during Operation TEAPOT. The total number of personnel involved is unknown (7; 97).

Cloud Tracking

Cloud tracking was conducted by the Air Force Special Weapons Center. Its objective was to record the path of a nuclear cloud and to monitor its radiation intensity. This information was used by the Civil Aeronautics Administration to direct commercial aircraft away from the cloud. Cloud tracking was planned for all shots except HADR, the non-nuclear test, and HA, whose height of detonation and small nuclear yield precluded the necessity of cloud-tracking (7; 97).

A total of 28 sorties were flown in the AFSWC cloud-tracking program during Operation TEAPOT, using B-50, B-25, and B-29, aircraft. At Shot WASP PRIME, the mission was aborted because of a mechanical malfunction in the principal aircraft shortly after takeoff. The B-50s and B-29s operated out of Kirtland AFB, while the B-25s flew from Indian Springs AFB. Although AFSWC Operation Order l-54 called for two B-50s (or B-29s) and a B-25 to perform cloud-tracking missions after detonation, the types and numbers of aircraft varied for each shot. Factors such as the anticipated mass and height of a nuclear cloud, wind direction, and velocity influenced AFSWC aircraft assignments (7; 97).

The number of DOD personnel involved in the TEAPOT cloud-tracking program is estimated at about 110. The B-25s were operated by AFSWC personnel, while the B-50s and B-29s were operated by the Air Weather Service.

The AFSWC Operation Plan l-54 outlines standard procedures for TEAPOT's cloud-tracking missions (7). The missions began with the departure of a B-50 or B-29 from Kirtland AFB about two hours and 45 minutes before detonation. If a second B-50 (or B-29) was scheduled for the shot, it left Kirtland ten minutes later. The aircraft then held a position to the southwest of the NTS, establishing contact with the Air Operations Center. The holding altitude of the aircraft was 23,000 to 30,000 feet. Upon permission from the Air Operations Center, the aircraft began cloud-tracking. The B-25 aircraft departed from Indian Springs AFB 20 minutes after detonation. It immediately contacted the Air Operations Center and flew into a position to begin cloud-tracking.

After the Air Operations Center had given clearance to proceed, the cloud tracker intercepted the nuclear cloud, visually tracking it at altitudes from 15,000 to 27,000 feet until the sampling aircraft had completed their mission. When the samplers were finished and had cleared the area, the cloud tracking aircraft began full operations at altitudes ranging from 8,000 feet for the B-25 to 30,000 feet for the B-50 and B-29. At frequent intervals, the tracking aircraft approached the edge of the visible cloud in a cloverleaf pattern and recorded its position and radiation intensity. This information was relayed by radio to the Air Operations Center.

To avoid deep penetrations of the nuclear cloud, tracking aircraft approached the cloud at about a 30-degree angle. They continued on this course until the radiac meter onboard, either the AN/PDR-27C or the AN/PDR-T1B, registered a gamma radiation intensity of 0.01 R/h. At that time, the aircraft turned out as sharply as possible. By repeating this procedure throughout the mission, the cloud trackers determined the progression and extent of the cloud. The cloud was tracked either until it dissipated or until the Test Manager directed the trackers to stop. The H-25 then returned to Indian Springs AFB, and the B-50s and B-29s flew back to Kirtland AFB (7; 97).

Terrain Surveys

Following each nuclear event, several support aircraft made low-altitude radiological surveys of the terrain in and around the NTS to determine when recovery parties could safely enter the shot areas after each detonation and to determine the safety of personnel in the surrounding country. Aircraft usually made measurements over the scientific stations in the shot areas. Initial radiation surveys for recovery parties that did not need to enter soon after the detonation were made by vehicle-borne radiological safety monitors. AFSWC provided several types of aircraft for terrain surveys, including H-19 helicopters and L-20, C-45, and C-47 aircraft. These aircraft were to operate from the time of detonation to three hours after the detonation or as long as required, up to 160 kilometers from ground zero, The standard operating procedure for terrain surveys was as follows. After each detonation, the various aircraft were to take low altitude surveys of the immediate target area to determine radiological conditions at critical recovery areas. The departure times of these aircraft and patterns of flight were determined by the Test Manager. Constant radio contact with the Air Operations Center was mandatory during these missions. H-19 aircraft took off from the Control Point area (7; 97; 248).

CHAPTER 5

RADIATION PROTECTION AT OPERATION TEAPOT

To minimize exposures received by TEAPOT participants from the radiation associated with the detonation of a nuclear device, Exercise Desert Rock VI, the Joint Test Organization (JTO), and the Air Force Special Weapons Center (AFSWC) each developed procedures to ensure the radiological safety of its members. The purpose of the various radiation protection procedures was to minimize the amount of ionizing radiation individuals were exposed to while performing the military and scientific activities conducted by Exercise Desert Rock VI and the test groups.

The radiological safetg plans developed by Exercise Desert Rock VI, the JTO, and AFSWC were designed to avoid unnecessary individual exposures to ionizing radiation. The mission of each organization required different types of participation. Although these differences required Exercise Desert Rock VI, the JTO, and AFSWC to form separate radiation protection staffs and plans, many of the procedures were similar and were performed by two or more of the groups. These procedures included (45; 63; 133; 145):

- Orientation and training: prepare radiation monitors for their work and familiarize other participants with radiological safety procedures

- Personnel dosimetry: issue, process, develop, and determine gamma exposure recorded on film badges

- Use of protective equipment: provide protective equipment, including clothing and respirators

- Monitoring: perform onsite radiological surveys and control access to all contaminated areas

- Briefing: inform observers and project personnel of radiological hazards and current status of contamination in the test area

- Decontamination: contain and remove contaminated material from personnel, vehicles, and equipment to prevent its spread into uncontaminated areas.

The Department of Defense (DOD) supported the Test Manager in all onsite radiological safety procedures during Operation TEAPOT. The 50th Chemical Service Platoon implemented procedures for Exercise Desert Rock VI, and the 1st Radiological Safety Support Unit implemented overall procedures for the JTO, which included the Field Command Military Effects Group, the Test Groups of the AEC nuclear weapons design laboratories, the Civil Effects Test Group (CETG), and AFSWC.

For the TEAPOT Series, the Army established criteria for positioning troops at nuclear detonations. These positions were based upon the distance necessary to avoid the thermal and blast effects, and to minimize personnel exposure to the initial radiation associated with a nuclear detonation. For most shots, DOD personnel were far enough from the point of detonation to avoid prompt neutron and gamma exposure. However, at Shots MOTH, TESLA, BEE, and APPLE 2, some participants may have been within the range of prompt radiation (133; 243; 265). These circumstances are addressed in more detail in the volumes dealing with these shots.

Sections 5.1, 5.2, and 5.3 of this chapter discuss the radiological safetv plans of Exercise Desert Rock VI, the JTO and AFSWC, respectively. Each section addresses maximum permissible levels of exposure, the structure of the radiological safety organizations, and the procedures used by each organization to control individual exposures to ionizing radiation. The material in this chapter, as well as the discussions of radiological safety procedures in the shot volumes of Operation TEAPOT, is supplemented by the Reference Manual, Background Material for the CONUS Volumes, which discusses basic radiation concepts, dosimetry, and protection.

5.1 RADIATION PROTECTION FOR EXERCISE DESERT ROCK VI

The DOD established safetv criteria to protect participants of Exercise Desert Rock VI from the thermal, blast, and radiation effects of nuclear detonations they might encounter during their activities at the Nevada Test Site (NTS). The safety of Desert Rock participants was addressed in a directive dated 8 December 1954 from the Office, Chief of Army Field Forces (OCAFF). The radiation exposure limit established in this directive for Exercise Desert Rock VI troops was (243):

> Six roentgens during Operation TEAPOT, with no more than three roentgens of prompt radiation.

One exception to this criterion was for Project 40.9, Navy Passive Defense Training, for which the radiation exposure limit was 3.9 roentgens, the same limit used for the JTO. To protect participants from the blast and thermal effects of nuclear detonations, the DOD also established the following additional exposure limits for Desert Rock participants:

- Five pounds per square inch of overpressure
- One calorie per square centimeter of thermal radiation.

Based on these exposure limits, OCAFF set minimum distances for the positioning of Exercise Desert Rock troops and observers during the TEAPOT Series. These criteria, presented in table 5-1, applied to all Desert Rock troops except the ten volunteer officer observers. From the table, it can be seen that troops involved in maneuvers (troop tests) could be positioned closer to ground zero than troops involved in orientation and indoctrination (observation). This program is discussed later in this section (135-140; 243).

Table 5-l: CRITERIA FOR PLACEMENT OF TROOPS DURING THE TEAPOT SERIES

For Tower Shots*					
Max. Predicted Yield (KT)	Troops in Open	Troops in Trenches		Troops in Armored Vehicles	
		Observation	Troop Tests	Obaervation	Troop Tests
10	4,938	3,200	2,286	3,200	2,469
20	6,949	3,200	2,469	3,200	2,652
30	8,504	3,200	2,560	3,200	2,743
40	9,601	3,200	2,652	3,200	2,035
50	10,790	3,200	2,743	3,200	2,926
60	11,887	3,200	2,835	3,200	3,018

For Aircraft Delivered Devices'		
Max. Predicted Yield (KT)	Troops in Open	Troops in Trenches or Armored Vehicles
10	7,681	4,572
20	9,693	4,572
30	11,247	4,572
40	12,344	4,572
50	13,533	4,572
60	14,630	4,572

*Distances given in meters and measured from intended ground zero.

According to these criteria, for example, for a tower shot with a predicted maximum yield of 30 kilotons, maneuver troops in the open would be positioned at least 8,500 meters from ground zero. Troops in trenches at such a shot would be positioned at least 2,560 meters from ground zero, and troops participating in an armored troop test would be at least 2,740 meters from ground zero.

To comply with these criteria, trenches were to he at least 1.8 meters deep. Participants were required to crouch in these trenches, so that their heads were at least 0.6 meters below ground level. Positioning troops in armored vehicles was authorized only if the radiation shielding provided by the vehicle's armor reduced the ionizing radiation by at least a factor of six below intensities outside the vehicle. Recommended safe distances for armored vehicles not providing this amount of shielding protection had to be approved by the Department of the Army before their use in Desert Rock VI operations (243).

OCAFF also authorized one exception to the distance criteria. The Army volunteer officer observer program was designed to provide volunteers with an opportunity for close observation of the detonation of a nuclear device. The OCAFF granted the Exercise Director discretionary authority to permit these individuals to position themselves closer to ground zero than the standard distance criteria prescribed. For the volunteer officer observer program, the following exposure limits were established (243):

- 10.0 roentgens per test, with no more than 5.0 roentgens of prompt radiation, and no more than a total of 25.0 roentgens during the entire series
- Eight pounds per square inch of overpressure
- One calorie per square centimeter of thermal radiation.

No more than 12 volunteers could take part at any nuclear event. Volunteer officer observers were briefed to inform them of the risks involved in such close observation of a nuclear detonation. The volunteer officers had been trained in the effects of nuclear weapons. They each calculated the distance at which they could view a detonation with the expected yield of APPLE 2. By comparing these calculations, they agreed, by group consensus, on the location from which they would view the detonation. Their positioning was approved by both the Exercise Director and the Test Director (47; 133).

The volunteer officer observers participated only at Shot APPLE 2, where they positioned themselves 2,380 meters from the shot-tower, a location closer to ground zero than permitted by the standard Desert Rock VI distance criteria. Each of these officer volunteers wore at least one film badge and a pocket dosimeter (133; 135; 136; 265).

The remaining paragraphs of section 5.1 describe the organization and procedures of the radiation safety program for Exercise Desert Rock VI.

5.1.1 Organization

At Operation TEAPOT, Exercise Desert Rock VI activities were conducted so that the troop maneuvers and indoctrination projects did not interfere with the technical and diagnostic tests conducted by the test groups at each event (102; 133).

Although the AEC was responsible for the overall operation at the NTS, the Exercise Director assumed full responsibility for the radiological safety of Desert Rock participants during the military activities of Exercise Desert Rock VI. The Exercise

Director delegated the operational aspects of this responsibility to the Radiological Safety Section, part of his S-3 Section. The Radiological Safety Section, whose main operating unit was the 50th Chemical Service Platoon, implemented radiation protection procedures for all Exercise Desert Rock VI participants. The 232nd Signal Companv, part of the S-4 Section, provided photodosimetry services, including issuing, receiving, and processing film badges. The 232nd recorded and maintained records of individual exposure (133; 243).

5.1.2 Orientation and Training

The orientation provided by the Desert Rock Radiological Safety Section was designed for troops and official observers. Orientation included an explanation of:

- Restrictions placed on the movements of troops and observers in the forward area
- The effects of a nuclear detonation
- The radiation protection methods used by the Camp Desert Rock Radiological Safety Section
- The cooperation required of troops and observers during the radiological safety procedures.

The Radiological Safety Section also trained Desert Rock radiation monitors, who were drawn primarily from the 50th Chemical Service Platoon (62). 410ng with the 50th Chemical Service Platoon monitors, the Radiological Safety Section trained an additional 42 Camp Desert Rock support troops as radiation monitors during Operation TEAPOT. The Radiological Safety Section directed the training of the monitoring teams in Project 40.19, Sixth Army Chemical, Biological, and Radiological (CBR) Defense Team Training, which tested the ability to locate, plot, and assess radiological hazards (133; 165).

The two objectives of monitor training were to teach personnel to:

- Calibrate and operate a radiac meter
- Assess the hazard associated with the radiation intensity registered on the radiac survey meter.

Students from the 50th Chemical Service Platoon and from Camp Desert Rock were considered qualified monitors only when they had learned to use radiac meters to determine necessary radiological safety actions, such as determining how long to stay within a radiation area without exceeding exposure limits. Students took both written and performance proficiency examinations at the completion of their training. To ensure that previously trained monitors were still able to interpret the radiac readings, the Radiological Safety Section also provided a refresher training course for experienced monitors from the 50th Chemical Service Platoon (133).

5.1.3 Briefing

Before entering radiation areas, Exercise Desert Rock VI personnel were briefed on the safety measures required within those areas. Personnel entering areas where radiation was greater than 0.1 roentgens per hour (R/h) of gamma radiation, were required to have access permits and to be accompanied by a Desert Rock radiological safety monitor. Personnel entering areas in which gamma radiation intensities were between 0.01 and 0.1 R/h, had to wear film badges and receive permission to enter the area from the Radiological Safety Officer, hut it was not necessary for them to be accompanied into the area by monitors. In areas where gamma radiation intensities were below 0.01 R/h, no special procedures were required (54; 133; 141-149).

5.1.4 Personnel Dosimetry

Film badges were issued to some Desert Rock personnel to record their exposure to ionizing radiation. One badge was issued per squad. Cumulative film badge readings provided an indication of the effectiveness of Desert Rock radiation protection procedures at keeping authorized exposures to radiation as low as operationally necessary. Most of these film badge readings are missing.

The 232nd Signal Company was responsible for issuing film badges to Camp Desert Rock support troops and exercise troops. The 232nd Signal Company also processed the exposed badges, determining individual exposures to radiation. Individual records of cumulative exposure to gamma radiation were recorded on Form 102R, as shown in figure 5-1 (16; 133).

Support Troops

Support troops were assigned to Camp Desert Rock, usually for the duration of Exercise Desert Rock VI, to provide services to the exercise troops. Each of the Camp Desert Rock support troops who entered the forward area was required to wear a film badge, and cumulative totals of individual exposures were maintained and monitored by the Radiological Safety Section (133; 141-149).

Observers

Participation in the Army Troop Orientation and Indoctrination Program included volunteer officer observers, troop observers, service observers, and Camp Desert Rock observers, as detailed in chapter 3 of this report.

Upon arrival at Camp Desert Rock, the troop observers submitted a roster of personnel, indicating squad leaders, to the Dosimetry Section. The S-4 Dosimetry Section issued Form R101 and film badges to the unit. Each squad leader was responsible for picking up forms and badges prior to the participation of his men in an exercise and for returning these forms and badges at

DOE, JOHN J. M/SGT

FORM 102R **INDIVIDUAL ACCUMULATIVE RADIATION EXPOSURE RECORD**

DATE 1955	NUMBER	FILM BADGE DENSITY W	FILM BADGE DENSITY S	FILM BADGE MILLIROENTGENS W	FILM BADGE MILLIROENTGENS S	FILM BADGE MILLIROENTGENS CUM	DOSIMETER (mr) DAY	DOSIMETER (mr) CUM	REMARKS
22 Feb	05206				0				OK Smith, Surgeon
28 Feb	06 299				100	100			OK Smith, Surgeon
7 March	10684				1700	1800			OK Smith, Surgeon
21 Mar	09567				145	1945			Ok Smith, Surgeon
29 Mar	08239				10	1955			OK, Smith, Surgeon
12 Apr	7 529				60	2015			OK, Smith, Surgeon
16 Apr	39747				255	2Q70			Ok, Smith, Surgeon
5 May	39910				165	2435			OK, Smith, Surgeon

NAME: (Last, First, Middle Initial) DOE, JOHN J.

RANK: M/SGT

ASN: RA 99999999

HOME ORG: DR 976, 6th A Hq Co, 6000 SU Det #1, PSF, Cal.

Figure 5-1: SAMPLE FILM BADGE RECORD

the end of the exercise. Form R101 listed the names of all men in the troop observer packets as follows (144):

- One squad, consisting of a squad leader and not more than 11 men, was entered on one sheet
- Officers and men not assigned to specific squads were listed on separate sheets.

Although officers and squad leaders were required to wear film badges, they were not worn by the other members of a squad. Personnel wearing film badges had an asterisk placed after their names on Form R101. The names of individuals not participating in the observation program were removed from the list, and no additions were permitted once the form had been filled out. The squad leader was also responsible for keeping the squad together so that his one film badge exposure would represent the entire squad (144).

Service observers were military and civilian DOD personnel who came to Camp Desert Rock as individuals, rather than in groups. Service observers reported to the Visitors' Bureau, where they were organized into groups of 12. Personnel at the Visitors' Bureau filled out Form R101, listing the 12 observers in each group. The senior person in each group served as the group leader, wore a film badge, and had an asterisk placed after his name on Form R101. Observer film badges were issued and returned in numerical order to the Visitors' Bureau (144).

In addition to these troop and service observers, the ten volunteer officer observers described earlier in this chapter and in chapter 3, witnessed Shot APPLE 2. These ten men were in a trench 1.8 meters deep, 2,380 meters from the APPLE 2 shot-tower. Each volunteer officer wore at least one film badge (149).

Tactical Exercise Troops

During Operation TEAPOT, two tactical exercises were conducted to test doctrine and techniques being developed for the nuclear battlefield. These tests were Project 41.6, Marine Brigade Exercise, at Shot BEE and Project 41.2, Test of an Armored Task Force, Task Force RAZOR, at Shot APPLE 2. One film badge and one pocket dosimeter were issued to each platoon of Marine Corps personnel. During Task Force RAZOR, a radiological monitor in each armored vehicle wore a film badge (4; 20; 21; 114; 133; 149; 248).

Additional Troop Test and Technical Service Projects

According to the TEAPOT Final Report of Operations, film badges were issued to all individuals who were not members of a group. It is likely that grouped participants were divided into squads by the S-4 Dosimetry Section, and officers and squad leaders were issued film badges. This was a film badge packet consisting of DuPont Types 502 and 606 film with an exposure range of 0.02 to 300.0 roentgens (63).

5.1.5 Protective Equipment

The only information available on the use of protective equipment comes from Operations Orders. According to these plans, all Desert Rock support troops entering the forward area on shot-days were to carry respirators. These personnel were further instructed to put on their respirators if breathing became difficult due to excessive dust, or if dust affected their vision or comfort. Field protective masks were used as alternatives. This limited reference to the planned use of respirators indicates that the use of these devices was based on personal prerogative. No mention has been found in Desert Rock documentation on the use of respirators by Desert Rock participants other than by Camp Desert Rock support troops (142-144).

In addition to dust respirators or field protective masks, certain personnel were issued goggles through which they could safely view a nuclear detonation and avoid flash blindness. Those participants without goggles were instructed to face away from ground zero and cover their eyes at the time of the detonation (141-149).

5.1.6 Monitoring

Radiation. monitors conducted surveys for training and exercise support purposes at Shots MOTH, TURK, TESLA, APPLE 1, MET, ESS, BEE, and APPLE 2. The type of monitoring they performed depended on the method of troop participation and the type of project being conducted. Figure 5-2 shows two officers and one monitor from the 50th Chemical Service Platoon holding radiac survey instruments (U.S. Army photograph).

For observers in trenches or in the open, monitors were present during and after the detonations to check for radiological hazards and to aid in evacuation procedures, if required. No evacuations were required during Desert Rock VI (133).

Before observers could move toward the equipment display areas, monitors surveyed the area. Once the Radiological Safety Officer determined that the nuclear cloud was moving away from the observation area, two two-person monitoring teams in radio-equipped jeeps began their surveys from opposite sides of the vehicle revetments near the observer area. Figure S-3 shows the typical paths these teams followed as they surveyed the wedge-shaped segment leading towards ground zero. While enroute, the

Figure 5-2: TWO OFFICERS AND ONE MONITOR FROM THE 50th CHEMICAL SERVICE PLATOON, WITH RADIATION SURVEY METERS

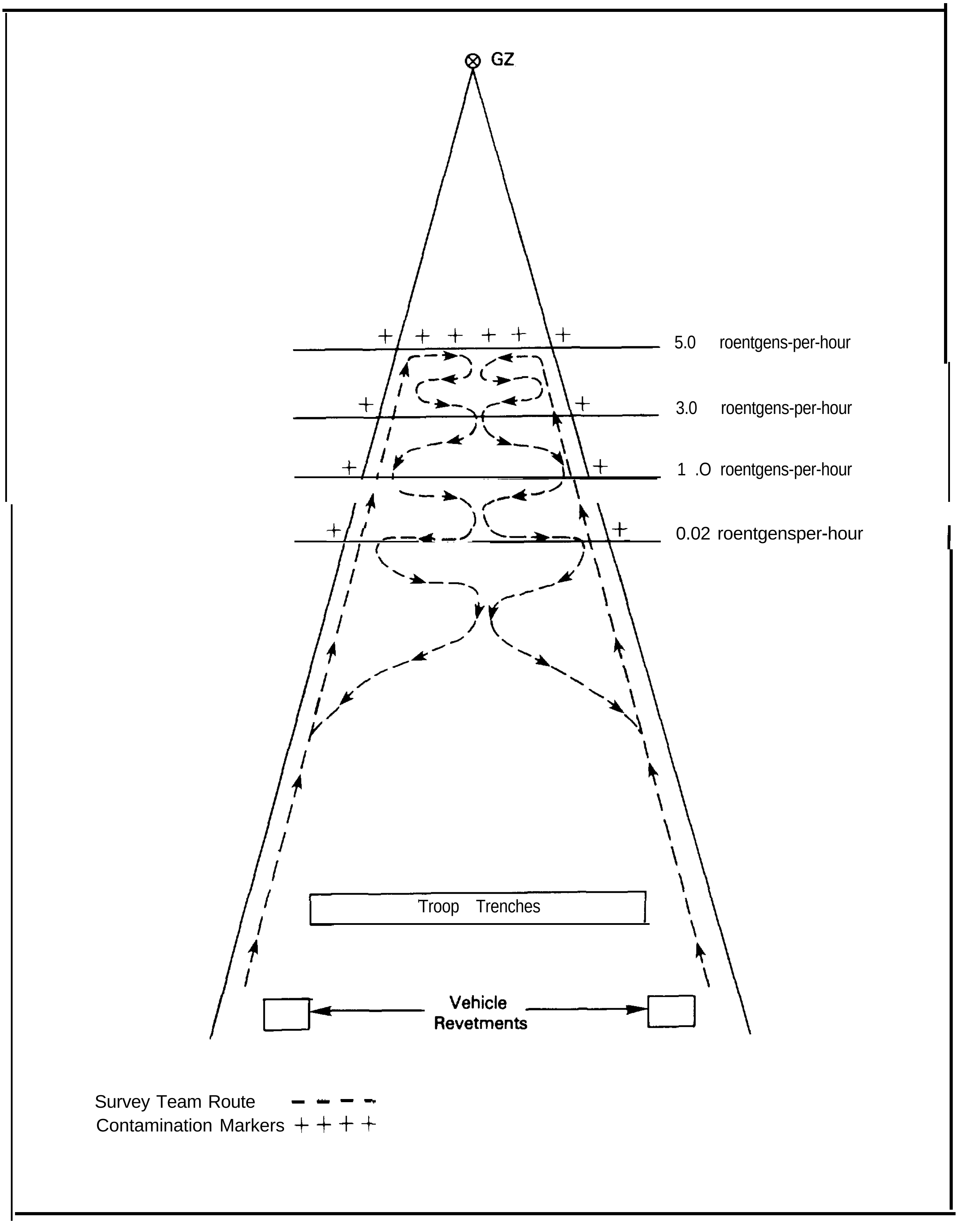

Figure 5-3: TYPICAL ROUTE OF DESERT ROCK'S RADIOLOGICAL SURVEY TEAM

teams continuously monitored radiation intensities with AN/PDR-27A and AN/PDR-T1B radiac survey meters. The teams placed contamination signs at points marking the 0.02, 1.0, 3.0, and 5.0 R/h isointensity lines. The forward limit for all buses and other personnel vehicles was the 0.02 R/h line. Upon reaching the 5.0 R/h isointensity line, the teams began crossing the wedge-shaped segment, stringing engineer tape on stakes to mark the area. The stakes, spaced at 45-meter intervals, had 5.0 R/h contamination markers on them. No troops or observers were permitted forward of the 5.0 R/h area (133).

Following the marking of the 5.0 R/h line, the jeeps proceeded away from ground zero, each team surveying half of the wedge-shaped segment, as shown in figure 5-3 (U.S. Army photograph). The teams marked any isolated areas of high intensity (hot spots) with tape and markers which indicated the radiation intensity.

Soon after the two monitoring teams began their survey of the wedge-shaped segment, the observers were permitted to walk towards the equipment display areas. A vehicle with a public address system preceded the observers. The control officer, using the public address system, warned observers not to touch equipment or pick up souvenirs. The two radiation survey teams were slightly ahead of the sound truck, flanking its left and right side (141-149).

The surveys of a wedge-shaped segment and the marking of isointensity lines were for Desert Rock purposes only. The complete initial surveys, resurveys, and posting of contaminated test areas for reentry, recovery, and official reporting purposes were accomplished by the Test Manager's radiological safety organization.

5.1.7 Decontamination

Desert Rock personnel and vehicles were monitored and decontaminated before they were allowed to leave the forward test area. The objective of decontamination procedures at Exercise Desert Rock VI was to ensure that no persons or vehicles left the forward areas of the NTS with material, other than authorized test samples, contaminated in excess of 0.02 R/h. Members of the 50th Chemical Service Platoon operated the main decontamination facility 900 meters north of the Control Point at Yucca Pass, at UTM coordinates 848888. This facility was the center of decontamination activities for both personnel and vehicles. The initial decontamination procedure involved brushing clothing, equipment, and vehicles to remove contaminated dust and debris. If this initial procedure failed to reduce radiation intensities to 0.02 R/h or lower, individuals were to shower and change clothing, and vehicles and equipment were to be either washed or quarantined until radiation intensities decayed to permissible levels.

After observers had toured display areas to view damaged equipment displavs, they returned to an area outside the 0.02 R/h line to board buses for Camp Desert Rock. Before boarding, however, personnel and equipment were swept with brooms to remove contaminated dust. Members of the 50th Chemical Service Platoon then surveyed the personnel and vehicles for radiation using AN/PDR-27A or AN/PDR-T1B survey meters held about five centimeters from the surfaces being surveyed. Figure 5-4 shows members of the 50th Chemical Service Platoon performing this activity (U.S. Army photograph). Further decontamination was necessary only when radiation intensities remained above 0.02 R/h after the initial brushing procedure. During the TEAPOT Series, no individuals or buses required further decontamination. However, other vehicles, such as jeeps used in radiological surveys, did require additional decontamination (141-149).

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Figure 5-4: **MEMBERS OF THE 50th CHEMICAL SERVICE PLATOON SWEEPING DUST FROM PERSONNEL AND SURVEYING PERSONNEL FOR CONTAMINATION**

Vehicles with radiation levels exceeding 0.02 R/h were driven onto a rock bed at the decontamination station at Yucca Pass and washed with detergent and water. After each washing, monitors measured the contamination level with portable survey instruments. If repeated washing would not reduce contamination to permissible levels, the vehicles were isolated and allowed to stand until decay reduced contamination to 0.02 R/h or lower. They then were returned to service at Camp Desert Rock. Approximately 75 vehicles required this additional decontamination during Operation TEAPOT (133).

5.2 RADIATION PROTECTION FOR THE JOINT TEST ORGANIZATION

The Test Director was responsible for the radiological safety of all members of the JTO involved in onsite and offsite activities during Operation TEAPOT (28; 63). JTO onsite radiological safety operations were performed by a radiological safety group composed of Department of Defense personnel and headed by the Chief of the Radiological Safety Branch, Field Command, AFSWP. This radiological safety group worked within guidelines recommended by the AEC Division of Biology and Medicine and accepted by the Test Manager. The Division of Biology and Medicine established an exposure limit at 3.9 roentgens of gamma radiation for all personnel involved in JTO activities at Operation TEAPOT. Since the TEAPOT operational period lasted approximately 13 weeks, this 3.9-roentgen exposure limit was similar to the then current 0.3 roentgens per week occupational exposure recommendation of the National Committee on Radiation Protection.

The operational responsibilities of the JTO onsite radiological safety organization were to (63; 265):

- Provide radiac equipment and maintenance services
- Maintain dosimetry and records service for all organizations participating in the operation

- Provide courses and guidance on radiological procedures and situations
- Conduct radiation surveys and plot isointensity maps
- Provide monitors to projects without monitors
- Conduct personnel and vehicle decontamination.

While section 5.1 discussed the radiation protection procedures planned for Exercise Desert Rock VI participants, section 5.2 discusses the procedures conducted to ensure the radiological safety of JTO participants and the control of radioactive contamination at the NTS. Information presented in this section has been obtained from both planning documents and from an after-action report of onsite activities (63; 233; 265):

5.2.1 Organization

At the start of the TEAPOT Series, the manager of the AEC Las Vegas Field Office delegated responsibility for the management of JTO radiological safety activities at the NTS to the Test Manager. The Test Manager authorized the Test Director to administer onsite radiological safety operations and the Support Director to oversee the offsite radiological safety activities. At the conclusion of the TEAPOT Series, all radiological safety responsibilities at the NTS reverted back to the AEC Las Vegas Field Office (47; 63; 104).

Based upon a 16 February 1953 memorandum of agreement between the AEC and the DOD, the Chief of the Radiation Safety Branch of AFSWP Field Command was appointed as the JTO Onsite Radiological Safety Officer for Operation TEAPOT. His duties included organizing and directing the Onsite Radiological Safety Organization, composed entirely of DOD personnel and divided into five sections, as depicted in figure 5-5. The 1st Radiological Safety Support Unit, Fort McClellan, Alabama, provided the main

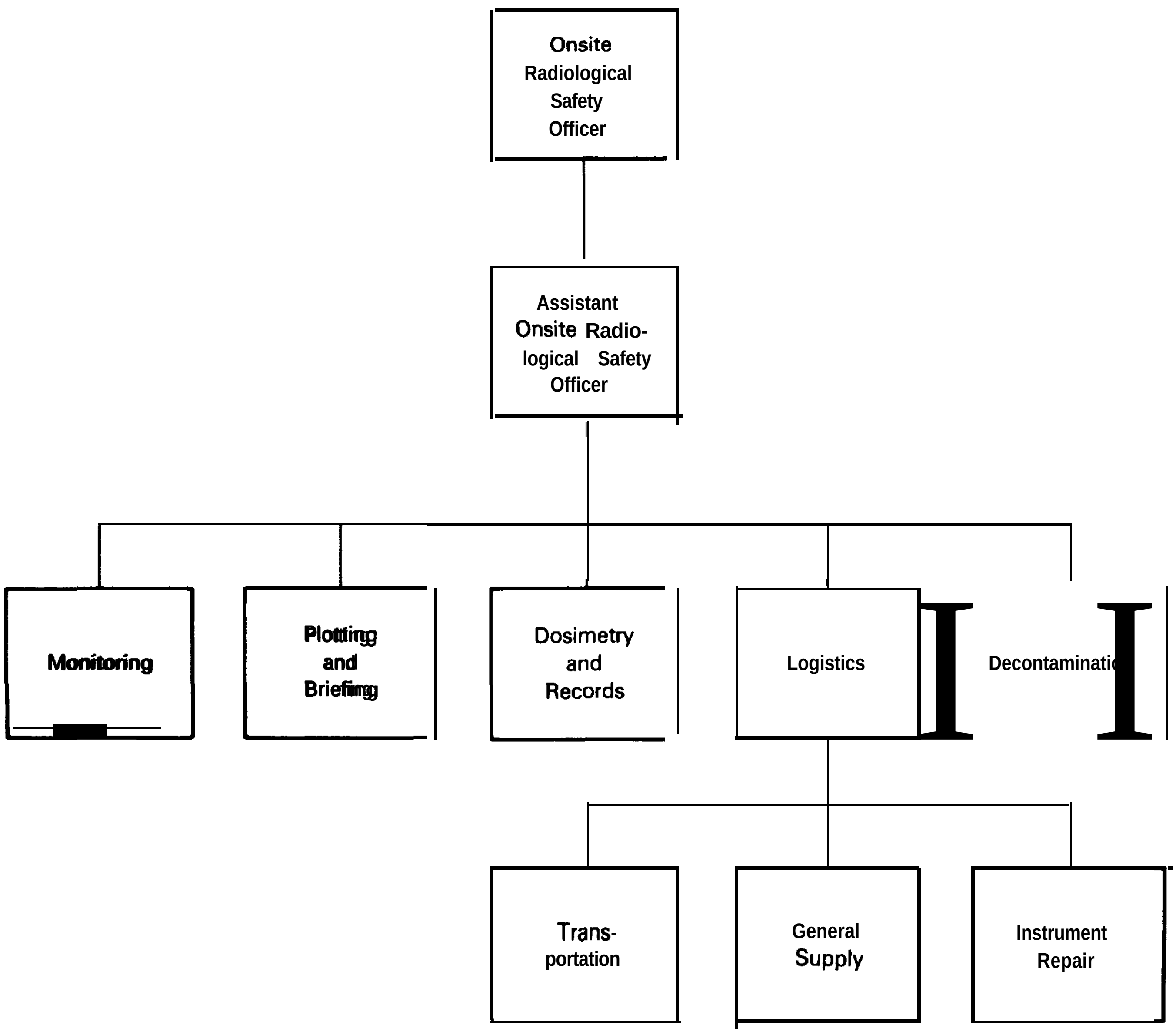

Figure 5-5: JOINT TEST ORGANIZATION RADIOLOGICAL SAFETY ORGANIZATION

support for the onsite organization, and the Commanding Officer of that unit was appointed as the Assistant Onsite Radiological Safety Officer (63; 265).

In the summer of 1954, the AEC developed plans for onsite radiological safety procedures to he used for JTO members during the TEAPOT Series. In addition to the monitors provided for projects conducted during the series, 150 more monitors were needed to meet the radiological safety requirements of Operation TEAPOT. Arrangements for more personnel, who were to be trained by the onsite radiological safety group, were made with the following groups (63):

ORGANIZATION	OFFICERS	ENLISTED MEN
Field Command, AFSWP, Directorate of Weapons Effects Test	2	2
1st Radiological Safety Support Unit	15	100
Air Materiel Command	4	13
9th Air Force	4	7
Office of the Chief, Chemical Corps	2	0
Chemical Corps School	3	0

Under the terms of an agreement between the AEC and the FCDA, the FCDA sponsored a demonstration and observer program at the open shot, APPLE 2 (177; 237). Both male and female volunteers witnessed this shot, either from a trench 3,200 meters from ground zero or from a location almost 13 kilometers from ground zero. The FCDA program was subject to the review and approval of the AEC, and FCDA participants were required to comply with the same exposure criteria that the AEC had established for other JTO participants. No FCDA participant could receive more than 3.9 roentgens of exposure to ionizing radiation during this project (248).

5.2.2 Training

Prior to Operation TEAPOT, it was determined that two general indoctrination courses were necessary for training project monitors: a four-day course for individuals without previous monitoring experience, and a one-day refresher course for personnel who did have previous monitoring experience. The purposes of these monitor training courses were to (63; 248):

- Familiarize monitors with radiological safety procedures at the NTS
- Ensure that monitors could evaluate the hazards associated with various radiation intensities measured on their radiac survey meters.

Project officers and agencies nominated individuals for these two courses. Radiological safety personnel who rotated through were also trained at the one-day courses. Although the purpose of these courses was the same as those for Camp Desert Rock, that is, to train individuals to assess radiological hazards, the JTO and Exercise Desert Rock VI trained their monitors separately.

The four-day course covered basic radiation physics, radiation measurement and instrumentation, medical aspects of radiation, use of protective clothing and equipment, and radiological safety procedures at the NTS. The one-day course considered medical aspects of radiation, measurement, instruments, and radiological safety procedures.

Monitors took both written tests and field tests to determine their proficiency after completing these courses. Officers of the 1st Radiological Safety Support Unit provided administration and instruction of these courses. During the TEAPOT Series, 105 people attended the four-day course, and 227 people took the one-day course (63; 248; 265).

5.2.3 Personnel Dosimetry

The primary mission of the Dosimetry and Records Section was to provide dosimetry service and cumulative exposure records for all JTO test personnel, both civilian and DOD. A secondary mission was to provide dosimetry services for experimental studies, such as Project 2.7, Shielding Studies. For this project, film badges were placed in armored vehicles to determine radiation levels inside the vehicle. The Dosimetry and Records Section consisted of two officers and 19 enlisted men on a permanent basis, and two additional officers on a temporary basis. All permanent members were from the 1st Radiological Safety Support Unit.

To accomplish its primary mission, the Dosimetry and Records Section issued individuals a numbered film badge and kept a record of the individual and his film badge number. Participants returned the badges to the Dosimetry and Records Section, where they were processed to determine the radiation exposure received. Each film badge reading was then recorded on a form for later transcription onto the participant's cumulative exposure card, which provided a permanent record of the individual's total radiation exposure (63).

The film badge packet worn by JTO participants consisted of Dupont Types 502 and 606 film with an exposure range of 0.02 to 300.0 roentgens. This packet of films, which had a lead shield covering both sides, was enclosed in a waterproof plastic covering, which comprised the film badge. Each film badge had an alligator clip for fastening it to clothing. In addition to film badges, self-reading pocket dosimeters were also used as exposure indicators for some personnel working in radiation areas (63).

Not all NTS personnel wore film badges during Operation TEAPOT. Film badges were only issued to personnel when they were to enter areas where exposure to radiation was anticipated.

The Dosimetry and Records Section submitted a cumulative exposure report each Monday, listing the names and exposures of personnel with 2.0 to 3.9 roentgens of exposure. Exposures greater than 3.9 roentgens were reported separately. The Dosimetry and Records Section reported the names of individuals receiving these high exposures to project directors by telephone as soon as the badges had been processed, so that actions could be taken immediately to prevent the individuals' entry into radiation areas for the remainder of the series (52; 63).

During the TEAPOT Series, about 30,000 film badges were issued and processed. At the completion of the series, the Dosimetry and Records Section prepared a total exposure report for individuals participating in the JTO and forwarded the report to each individual's home station or organization. A complete summary of total exposures for monitored civilian and Department of Defense personnel working under the auspices of the JTO was also prepared. This report was sent to the Test Manager, to the AEC Division of Biology and Medicine, and to the Chief, AFSWP. The final dosage report summarized total exposures recorded up to 15 May 1955. Because not all film badges had been turned in and processed by that date, an addendum was prepared summarizing total readings from 17 May to 30 May 1955. The original film badges and records for JTO/DOD personnel were sent to the Chief, AFSWP, while all other JTO original records and films were sent to the manager of the AEC Las Vegas Field Office (63; 257).

The Dosimetry and Records Section issued badges in bulk lots to many organizations, including Indian Springs AFB, operational training groups, and other offsite groups. These organizations were responsible for the individual issue and return of these badges. The Dosimetry and Records Section supplied Indian Springs AFB with approximately 500 film badges per month. Although the Dosimetry and Records Section processed and recorded these film badges, the Indian Springs radiological safety group also kept records of the badges. Tactical and Strategic Air Command bases throughout the U.S., participating in operational training programs, also were furnished 1,764 film badges, 116 zero-to-one roentgen pocket dosimeters, and 13 pocket dosimeter chargers (63).

According to a 12 November 1954 internal memorandum of the Test Director's Office, the onsite radiological safety organization was instructed to discontinue the practice of recording pocket dosimeter readings along with film-badge readings. The pocket dosimeters were useful for estimating short-term exposures, erring on the safe side by indicating more exposure than had actually occurred (101).

5.2.4 Logistics

The Logistics Section was responsible for procuring and maintaining equipment and supplies for the JTO radiological safety organization during the TEAPOT Series. This support included the procurement, issue, repair, maintenance, and storage of all radiac devices and equipment used by the Onsite Radiological Safety Organization and project personnel, and the provision of military and civilian vehicles to support the activities of the Onsite Radiological Safety Organization.

The Logistics Section was composed of a General Supply, an Instrument Repair, and a Transportation Section. The General Supply Section was composed of an officer and 18 enlisted men from the 1st Radiation Safety Support Unit. The Instrument Repair Section had nine enlisted men, whose agency affiliation is still unknown, while the Transportation Section had seven enlisted men, all from the 1st Radiation Safety Support Unit (63).

General Supply

Preliminary logistical support for Operation TEAPOT began in December 1954. At that time, the General Supply Section moved all supplies stored at Camp Mercury after previous operations to the supply room of Building Two (CP-2) at the Control Point, where the equipment was inventoried. A stock record accounting system was used to keep a running check on all supplies.

The General Supply Section at CP-2 followed the procedures described below for the issue and return of supplies. The issue of coveralls, respirators, and other frequently used equipment was recorded on a mimeographed hand receipt. Hand receipts for personnel entering contaminated areas were taken over the receiving counter, and the receipts were returned when the items were returned. Booties, gloves, and head coverings were not listed on the hand receipts, since these items were turned in at the forward check point, where conditions made it difficult to keep records. All other nondisposable supplies were issued with hand receipts.

The General Supply Section was also responsible for all laundry equipment in the radiological safety building. All contaminated clothing was separated during processing through the personnel decontamination station, deposited in special receptacles, handled with rubber gloves, and laundered in separate batches (63).

Instrument Repair

In preparation for the TEAPOT Series, the Instrument Repair Section moved the repair facilities from Camp Mercury into Building 2 at the Control Point. The repair of radiac instruments and the survey of replacement parts and batteries began in July 1954. By the end of January 1955, most of the instruments were serviceable, and the stock of parts and batteries was considered satisfactory to fulfill the requirements of the operation. Additional instruments to support the operation were borrowed from the 1st Radiological Safety Support Unit of the AEC. By 15 February 1955, the calibration of all but a few instruments was complete. The types of instruments calibrated and serviced during the pre-operational period were the AN/PDR-39, the MX-5, the Juno 15, the Victoreen Thyac 389, and the PeeWee Alpha Survey Meter (63).

Transportation

The Transportation Section coordinated and supervised transportation for the radiological safety organization. The Transportation Section used three AEC buses to transport most of the radiological safety personnel from Camp Mercury to CP-2 and back. Additional vehicles were obtained from the 1st Radiological Safety Support Unit whenever necessary (63).

5.2.5 Monitoring

Unlike monitoring personnel from Camp Desert Rock, who surveyed only exercise areas, the JTO's General Monitoring Section, consisting of 7 officers and 22 enlisted men, performed other required monitoring assignments. These assignments included (63):

- Performing initial surveys and resurveys of all areas around the ground zeros
- Establishing and operating main and area access checkpoints
- Marking contaminated areas
- Serving as party monitors for project personnel who did not have their own radiological monitors.

During reentries after test events, monitoring personnel, with assistance from NTS security force personnel, controlled access to contaminated areas, according to the schedule of events and with the use of access permits (188; 220). The initial ground survey provided data for the isointensity contour maps developed by the Plotting and Briefing Section. Prior to the detonations, the General Monitoring Branch also briefed ground survey teams on the expected fallout pattern for the TEAPOT shots.

The Air Force and Sandia Base also provided additional personnel who rotated through the Monitoring Section as follows (63):

PERIOD OF DUTY	HOME UNIT	OFFICERS	ENLISTED MEN
4 Feb - 16 March	9th Air Force	3	7
4 Feb - 6 March	Air Materiel Command	3	17
6 March - 9 April	Air Materiel Command	2	15
15 March - 9 April	9th Air Force	4	7
1 March - 20 March	Sandia Base	1	2
9 April - 9 May	Air Materiel Command	5	15

Surveys

Prior to each detonation, Plotting and Briefing Section personnel laid out lines of numbered stakes on approximate 45-degree radials from ground zero. The numbered stakes were placed at 90-meter intervals, with the beginning and ending of each line of stakes dependent upon the Radiological Safety Officer's estimate of the spread of contamination. The initial survey party generally consisted of one officer with driver, and four or five two-person survey teams. These teams performed postshot radiological surveys from 3/4-ton military trucks, using the numbered stake lines as reference points. In areas where roads ran near the survey lines, the survey lines followed the roads, making it easier for the initial survey teams to cover the area rapidly by minimizing cross-country driving. Rapid surveys helped reduce the teams' radiation exposures. Teams also conducted periodic resurveys of these areas to monitor changes in radiation intensities. The vehicles used by the survey teams were radio-equipped, and the teams relayed their results to the Plotting and Briefing Section as they proceeded through the survey. The teams reported gamma intensity levels of 0.01, 0.1, 1.0 and 10 R/h (63).

In addition to ground surveys, helicopter surveys were used to obtain rapid readings in high intensity areas and to monitor areas for recovery work or parties. For surveys, the helicopter hovered, taking readings with a Jordan survey instrument attached to a probe suspended from a 150-meter cable. Later in TEAPOT, this cable was extended to 460 meters. Inside the helicopter, the crew monitored their exposure rates with an AN/PDR-39 survey instrument. The helicopter crew relayed its survey information by radio to the Plotting and Briefing Office as the survey proceeded (63).

Marking Radiation Areas

A team, usually consisting of two personnel, posted signs indicating the location of the 0.01, 0.1, and 1.0 R/h isointensity lines established by the survey parties. This team relocated the signs to mark new isointensity lines as measured in area resurveys (63).

Checkpoints

Checkpoint crews followed the initial survey teams and established main and area access checkpoints. The main checkpoint provided monitoring services for personnel and vehicles returning from contaminated areas. Contaminated vehicles were marked with a "C" on the windshield and were directed to the equipment decontamination station at Building 6 of the Control Point, a short distance from Building 2 at the Control Point, the radiological safety building.

Area access checkpoints were located outside the 0.01 R/h areas, on the main access roads to shot areas. At these locations, checkpoint crews examined the access permits issued to project or party personnel who had to enter contaminated areas. The time of entry and expected time of departure were recorded on these forms by the checkpoint crew. On leaving the area, project personnel returned the access permits to the checkpoint crews, who verified the time in the area. The entry and departure of parties were reported by radio to the Plotting and Briefing Section to provide a running account of personnel in contaminated areas. Although personnel without access forms were not permitted past checkpoints, some personnel did enter contaminated areas without access forms. NTS security force personnel assisted in these instances, and checkpoint crews reported these people, by vehicle number, to the Radiological Safety Officer (63; 188).

Upon request, the checkpoint crews were available to provide advice on radiological safety, showing the entering parties the approximate location of isointensity lines or advising parties on their length of stay in contaminated areas (63; 188).

Providing Qualified Monitors

Two monitors stationed inside the entrance to Building CP-2 checked personnel returning from contaminated areas. Generally, only contaminated personnel who had been referred to the personnel decontamination station from the main checkpoint used this service. At the building, personnel removed all protective clothing, which they deposited in the receptacles provided. An additional monitor stationed at the other side of the decontamination station, monitored personnel after they had removed their protective clothing and showered if necessary. The personnel monitors used MX-5 instruments, with the probe window open, to detect both beta and gamma radiation.

Monitors from the radiological safety group were also assigned to entry parties either on request or by previous arrangements, according to the schedule of events. During TEAPOT, monitors were provided for 420 parties. Ten standby monitors were available at the radiological safety building to meet nonscheduled monitoring requirements. These monitors made arrangements for entry into contaminated areas and monitored the sites while the groups remained in these areas. Each monitor was issued field survey instruments prior to his assignment and was responsible for checking the calibration of these instruments before using them (63).

5.2.6 Plotting and Briefing

The Plotting and Briefing Section acted generally as a radiological safety control point and information center for test participants. Specifically, the Plotting and Briefing Section performed the following functions (63):

- Advising the Test Director of the radiological aspects of test recoveries within contaminated areas
- Planning with the Monitoring Section the survey requirements for each shot, based on recovery requirements
- Planning with the Monitoring Section the location of all checkpoints and signs
- Indicating to the Monitoring Section the position and extent of required stake lines
- Preparing permanent records of all survey data, and developing isointensity situation maps showing the locations of the 10.0, 1.0, 0.1, and 0.01 R/h lines
- Furnishing the Dosimetry and Records Section with individual names to facilitate assignment of film badges and equipment
- Issuing access permits
- Briefing recovery personnel on current radiological situations.

The Plotting and Briefing Section developed isointensity situation maps from the survey data which the Monitoring Section radioed to them. As an aid to both plotters and monitors, a numbering system was used which identified each location by a three-digit number. The first digit indicated the stake line. For example, stake line one was approximately 45 degrees from north and stake line two was approximately 90 degrees from north. Stake lines extended from ground zero, but not necessarily in straight lines since they often followed available roads. The last two digits indicated the distance along the stake line from ground zero to the survey location, in 90-meter (100-yard) intervals. For example, stake marker 213 indicated a location 1,190 meters (1,300 yards) from ground zero along line 2.

The Plotting and Briefing Section advised all monitors and party leaders of the radiological environments they might encounter. After all personnel were properly instructed and outfitted with protective equipment, the section issued access permits for entry into contaminated areas. At area checkpoints, described above, recovery and monitoring personnel entering a contaminated area gave the access forms to the checkpoint crews. The forms signified that these personnel had been properly briefed on the radiological environment within the shot area and specified the amount of time they were permitted to be in the area.

During Operation TEAPOT, the Plotting and Briefing Section, organized on 1 February 1955, consisted of three officers and eight enlisted men. All hut two of the officers were from the 1st Radiological Safety Support Unit. A total of 1,165 parties were briefed and given permission to enter contaminated areas (63).

5.2.7 Decontamination

The Vehicle and Equipment Decontamination Section was responsible for decontaminating all vehicles and equipment used in contaminated areas and for clearing for shipment all radioactive samples removed from the test area. The section consisted of one officer and seven enlisted men, all from the 1st Radiological Safety Support Unit; In addition to their decontamination duties, all personnel were available for assignment as monitors, if needed by the Monitoring Section (63).

The protective equipment worn by these personnel consisted of knee-length rubber boots and heavy rubber gloves worn over protective coveralls. In addition, decontamination personnel were issued film badges on a weekly basis by the Dosimetrv and Records Section.

All vehicles and equipment leaving the test area were stopped and monitored for contamination at designated checkpoints. Vehicles and equipment registering less than 1,000 counts per minute of alpha contamination per 55 square centimeters,* less than 0.007 R/h of gamma radiation outside, and less than 0.007 R/h of gamma plus beta radiation inside were passed through the checkpoints. All vehicles and equipment exceeding these radiation levels were sent to the decontamination station with a "C" marked on the windshields.

Initial decontamination consisted of washing the contaminated item with steam and hot soapy water and then placing it on a ramp to drain. After washing, personnel monitored the vehicle or equipment with AN/PDR-39 and MX-5 instruments to determine whether the decontamination was successful. If the radiation intensities had not been reduced to less than 0.007 R/h, the washing and monitoring procedure was repeated until the contamination was successfully reduced. When even after five or six washings contamination could not be reduced, the vehicle or equipment was placed in a hot park adjacent to the CP-6 decontamination building, until radioactive decay over time reduced

*The Reference Manual discusses alpha survey meters and the units of alpha contamination.

contamination to an acceptable level. The hot park was supervised by decontamination personnel, and vehicles or equipment could not be removed without approval of the Vehicle and Equipment Decontamination Section Officer. Personnel periodically monitored vehicles and equipment in the hot park, and when the radiation intensities had decayed to less than 0.007 R/h gamma outside and gamma plus beta inside, the vehicles and equipment were available for return to service.

The Vehicle and Equipment Decontamination Section kept records indicating the type and number of vehicles and equipment decontaminated. To ensure that all contaminated vehicles and equipment had been decontaminated, section personnel compared their records with those kept at the checkpoints in the forward test areas (63).

Clearing Material for Shipment

No contaminated material or equipment could leave the NTS without approval of either the Test Director or his representative. All materials to be removed were monitored, packaged, labeled, and loaded onto vehicles according to Interstate Commerce Commission regulations for the transportation of radioactive materials. Decontamination Section personnel monitored the packaged materials before their release from the NTS, completing a form to certify that the packaged material complied with Interstate Commerce Commission regulations (63).

5.3 RADIATION PROTECTION FOR THE AIR FORCE SPECIAL WEAPONS CENTER

During Operation TEAPOT, AFSWC provided two types of air support to the JTO: test air operations and support air operations. The test air operations included all aircraft directly involved in test missions and projects, such as cloud sampling and cloud tracking. Support air operations included all other aircraft not directly involved in these test missions, such as sample couriers.

The radiological safety of air and ground personnel involved in AFSWC test and support operations was a command responsibility. Part of this responsibility was to comply with safety regulations published by the Test Director. Included in these regulations was the maximum permissible radiation exposure limit for Operation TEAPOT (7; 233):

> No person could receive more than 3.9 roentgens of gamma radiation during the entire operation unless otherwise specified by proper authorities.

This exposure limit was the same for AFSWC and JTO participants. However, in one project requiring special procedures, Project 2.8b, Manned Penetrations of Atomic Clouds, the Test Manager authorized four Air Force officers to receive up to 15 roentgens of gamma radiation during their mission (46; 306).

The information presented in the remainder of section 5.3 describes planned radiological safety activities, detailed in AFSWC Operation Plan 1-54 (7).

5.3.1 Organization

The Commander of AFSWC and the Commander of the Field Test Group-5 (Provisional) determined the measures necessary to ensure the radiological safety of their personnel, based upon information from the Advisor for Technical Operations. In addition to providing such information, the Advisor for Technical Operations was responsible for the general supervision of all technical operations, including radiation protection procedures, at both Kirtland AFB and Indian Springs AFB. Two subordinate units were responsible for implementing AFSWC prescribed radiation protection procedures: the 4901st Air Base Wing at Kirtland AFB and the Test Aircraft Branch at Indian Springs AFB. The radiation protection programs at both of these Air Force bases included:

- Providing radiological safety personnel for all ground and air monitoring duties
- Providing protective equipment, film badges, pocket dosimeters, and radiac instruments
- Operating aircraft, equipment, and personnel decontamination areas.

In addition to these regular duties, the 4901st Air Base Wing and the Test Aircraft Branch were also responsible for other radiological safety tasks. The 4901st supplied all radiation detection instruments and protective equipment to AFSWC personnel at Kirtland AFB, New Mexico. However, the Test Aircraft Branch issued equipment acquired from the 4901st to personnel based at or staging from Indian Springs AFB, Nevada. The Test Aircraft Branch, 4926th Test Squadron (Sampling) worked with the Onsite Radiological Safety Organization at the NTS to issue film badges to AFSWC personnel. Branch personnel issued film badges directly to participants at or staging from Indian Springs AFB, and they furnished film badges to the 4901st Air Base Wing for distribution to Kirtland AFB personnel. In addition to providing film badges, the Test Aircraft Branch also maintained exposure records of personnel based at or staging from both Kirtland AFB and Indian Springs AFB (7). These film badge records are included in the JTO final report of exposures, discussed in section 5.2.3 of this chapter.

5.3.2 Training and Briefing

An operational requirement of the AFSWC radiation protection plan was to provide trained monitors for air and ground operations. Either the Chief of the Nuclear Applications Division of the 4926th Test Squadron (Sampling) or the officer in charge of each project, such as cloud sampling, designated the monitors.

These monitors were trained by the Nuclear Applications Division. However, if so directed by the Chief of the Nuclear Applications Division, the monitors received additional training in one of the two courses taught by the onsite radiological safety organization.

Before each mission, the 4901st at Kirtland AFB and the Test Aircraft Branch at Indian Springs AFB, briefed AFSWC personnel on the radiation protection plans devised to minimize their operational exposures, and on the potential problems associated with their specific activities. Prior to each flight, monitors issued radiation-related equipment, such as film badges, radiac instruments, and protective equipment, to members of the aircrews. At the direction of the Chief of the Nuclear Applications Division, operational personnel could receive additional briefings (7).

In addition to flight-specific radiation protection plans, AFSWC personnel were briefed on general procedures designed to minimize the risk of exposure to gamma radiation. They were instructed, for example, that no aircraft could approach closer than four nautical miles to the visible nuclear cloud without prior approval of the Air Operations Center. AFSWC personnel were also informed that they could suffer flash blindness if they viewed the burst without eye protection. Since even a short period of flash blindness could be dangerous to the crew of an aircraft in flight, the following procedures were established for all air mission crews:

- No one could view the burst either with the naked eye or through any optical systems onboard.
- Personnel viewing the burst should wear 4.5 neutral density goggles, obtained through the Personnel Equipment Section of the Test Aircraft Branch.
- Personnel without goggles should turn away from the detonation before the detonation until five seconds after detonation.

Because 4.5 neutral density goggles were not available for all personnel and it was not always possible for aircraft pilots to turn away from the detonations, additional instructions were developed. In single-engine aircraft, the pilot was directed to keep his head low in the cockpit, with his eyes directed on the instruments, from one second prior until four seconds after detonation. For multi-engine aircraft, the pilot was directed to keep his head low in the cockpit, with his eyes directed on the instruments, from two seconds prior until five seconds after detonation. Co-pilots were instructed to cover their eyes and duck their heads from two seconds before until five seconds after detonation. In the absence of 4.5 neutral density goggles, crew members were required to wear regulation-issue sunglasses before and during the detonation. Additionally, all rear-view mirrors and similar reflecting surfaces facing to the rear were taped to prevent reflections of the burst. Before the detonation, crew members also turned on the lights of their instrument panels (7).

5.3.3 Protective Equipment and Personnel Dosimetry

The primary requirement of the AFSWC radiation protection program was to minimize the exposure of AFSWC participants to radiation. Because exposure to ionizing radiation could be received through internal or external sources, AFSWC developed procedures to minimize both types of exposure.

To minimize internal exposure, which occurs primarily through inhalation of ratlioactive material, AFSWC personnel wore respiratory protection if they worked in enclosed spaces or in activities producing heavily contaminated air, such as the unloading of cloud samples. The Chief of the Nuclear Applications Division determined the need for respirators during other activities.

Participants wore protective clothing over their regulation clothing while in contaminated areas. Upon leaving contaminated areas, personnel removed this clothing and were then monitored to assure that contamination would not be spread to other areas. The Chief of the Nuclear Applications Division determined which activities required protective clothing. These activities included operations in which contamination was expected, such as aircraft decontamination operations.

To avoid unnecessary external radiation exposure, certain areas at Kirtland AFB and at Indian Springs AFB were designated controlled access areas. All areas of gamma radiation intensities greater than 0.01 R/h were controlled areas with restricted access. In areas with exposure rates greater than 0.1 R/h, a monitor was required to accompany entering personnel. The Chief of the Nuclear Applications Division cleared personnel for entry into these areas. Areas with radiation intensities of less than 0.01 R/h of gamma radiation were unrestricted.

Personal external radiation exposure was assessed by means of film badges and pocket dosimeters. All participants in areas where gamma radiation levels were expected to exceed 0.01 R/h were required to wear film badges. In addition, personnel involved in aircraft decontamination operations wore personnel pocket dosimeters. At the direction of the Chief of the Nuclear Applications Division, other personnel were issued pocket dosimeters (7).

5.3.4 Monitoring

The monitoring of radioactive contamination at both Kirtland AFB and Indian Springs AFB was accomplished with portable radiation detection instruments or radiacs. The assessment of contamination levels was an important step in establishing restricted areas and in determining whether decontamination procedures had been successful.

At Indian Springs AFB, the Instrumentation Section of the Nuclear Applications Division dispensed radiacs to AFSWC personnel staging from Indian Springs and to members of the 4901st Air Base Wing, who distributed the instruments at Kirtland AFB. The Nuclear Research Officer of the Field Test Group-5 (Provisional), through the AFSWP Onsite Radiological Safety Organization, provided instruments that could not be obtained from the 4901st Air Base Wing.

AFSWC personnel obtained radiacs by completing Air Force Form 446 to show their name, rank, serial number, organization, and home base. The original copy was retained on file, with the duplicate given to the individual. Upon return of the instrument, the original was destroyed. People were cautioned to return or replace faulty instruments immediately (7).

5.3.5 Decontamination

To prevent the spread of contamination, and thus reduce personnel exposure to radiation, specialized contamination control procedures were developed by AFSWC for aircrews, ground crews, and aircraft. These procedures are explained below.

<u>Aircraft</u>

All test aircraft, and any other aircraft suspected of being contaminated, were surveyed by monitors as soon as possible after landing. Figure 5-6 shows an F-84 sampler parking in a restricted area at Indian Springs AFB. Radiation intensities at designated locations on aircraft were recorded on forms provided by the Decontamination Officer. After the preliminary survey, aircraft with radiation intensities greater than 0.007 R/h were parked in restricted areas, marked with radiation signs, and their radiation routinely allowed to decay at least 24 hours before active decontamination took place. However, the Commander of the Test Aircraft Branch could require the prompt decontamination of an individual aircraft (7).

Figure 5-6: REHEARSAL OF F-84 SAMPLER AIRCRAFT LANDING AND PARKING IN DESIGNATED AREA

A radiation monitor was present during all phases of aircraft decontamination, and decontamination crew members wore protective clothing, film badges, and pocket dosimeters. When operationally feasible, the aircraft that were least contaminated were decontaminated first. The decontamination procedure for aircraft involved the following steps:

- Removing the engine cowling
- Spraying and scrubbing external surfaces with cleaning solution
- Cleaning the aircraft thoroughly with detergent solution to remove cleaning solution
- Rinsing the aircraft with warm water to remove detergent
- Repeating the cleansing procedure for the engine cowling.

Figure 5-7 shows part of the decontamination operation (U.S. Air Force photograph). Following this procedure, the monitor checked the aircraft radiation intensity. If the aircraft registered less than 0.007 R/h, it was returned to operations. If the radiation intensity remained above 0.007 R/h, the Decontamination Officer ordered that the decontamination process be repeated. At Indian Springs AFB, planes usually were decontaminated at the east end of the runway reserved for that purpose. A ditch off to the side of the asphalt collected the runoff water. The ditch could be covered with fresh dirt or excavated further and the contaminated dirt buried at another location (7).

Cloud Samples

Special procedures were developed for the removal of cloud samples from sampling aircraft. This activity was performed by the five-man Filter Recovery Section, part of the 4926th Test Squadron. These procedures were designed to prevent personnel contact with contaminated surfaces. To prevent direct contact

Figure 5-7: DECONTAMINATING AN F-84 SAMPLER AIRCRAFT

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with the radioactive cloud samples, members of the Filter Recovery Section removed the particulate samples from the wing-tip chambers with long-handled tools, as shown in figure 5-8. These samples were then placed in lead containers (pigs) as shown in figure 5-9. Members of the Filter Recovery Section loaded the lead-shielded sample containers on to courier aircraft, for delivery to AEC or other laboratories where the samples would be analyzed. Figure 5-10 shows members of the Filter Recovery Section placing a compressed-gas cloud sample in a lead pig. The samples were packaged in lead shielding sufficient to ensure that no one in the courier aircraft would be exposed to radiation intensities exceeding 0.02 R/h (7) (U.S. Air Force photographs).

Personnel

Ground personnel planning to enter contaminated areas obtained protective clothing, film badges, and pocket dosimeters from the Personnel Decontamination Section. Individuals with open breaks in their skin could not enter contaminated areas unless the breaks were covered. Proper wearing of protective clothing included closing the cuffs and legs of the coveralls. Upon leaving the contaminated areas, personnel were monitored. If, after removing their protective clothing, they registered radiation intensities greater than 0.007 R/h of gamma radiation, they were decontaminated at the Personnel Decontamination Station.

AFSWC developed special procedures to prevent aircrews flying sampling aircraft from receiving any more radiation than necessary to accomplish their mission. An air flow filter was installed in the aircraft pressurization system to prevent radioactive particles from being blown into the cockpit. This filter was capable of collecting 99 percent of the particles one micron or larger in size. It was also standard practice for all sampler pilots to breathe only 100 percent oxygen before they entered the nuclear cloud and until they left the aircraft. In

Figure 5-8: REHEARSING THE REMOVAL OF A FILTER SAMPLE FROM THE WING-TIP CHAMBER OF AN F-84

Figure 5-9: REHEARSAL OF THE PLACEMENT OF A PARTICULATE CLOUD SAMPLE IN A LEAD CONTAINER

Figure 5-10: PLACING COMPRESSED GAS CLOUD SAMPLE IN A LEAD CONTAINER

addition, special procedures were used to prevent the pilot from coming in contact with the contaminated surface of the aircraft after landing. The pilot exited the aircraft by stepping onto a wooden platform that was raised to cockpit level by a forklift. The forklift was then backed away from the aircraft and lowered the pilot to the ground. Figure 5-11 shows an F-84 sampler pilot stepping out of the cockpit onto this platform (U.S. Air Force photograph).

Immediately after the crew exited, the monitor measuring the aircraft gamma contamination took radiation readings of each aircrew member. Those personnel with intensities greater than 0.007 R/h were sent to the Personnel Decontamination Station, where they were directed to remove their clothing, touching it as little as possible, and to place it in the containers provided. They showered as necessary, were remonitored as necessary, and were provided an issue of new clothing when decontamination was sufficient (7).

This concludes the discussion of the procedures established by Exercise Desert Rock VI, the JTO, and AFSWC to keep personnel exposure to ionizing radiation within authorized limits and to avoid unnecessary exposure. For AFSWC and Exercise Desert Rock VI, the procedures presented here are planned activities only. For the JTO, however, this chapter has presented both the planned and actual radiation protection activities conducted by the onsite radiological safety organization, staffed by Department of Defense personnel.

Figure 5-11: F-84 SAMPLER PILOT LEAVING THE COCKPIT OF HIS AIRCRAFT

CHAPTER 6

DOSIMETRY FOR DEPARTMENT OF DEFENSE PERSONNEL AT OPERATION TEAPOT

This chapter summarizes the data available as of November 1981 regarding the radiation doses received by Department of Defense personnel during their participation in various military and scientific activities during Operation TEAPOT. It is based on research which identified the participants, their unit of assignment, and their doses.

6.1 PARTICIPATION DATA

The identity of participants was obtained from several sources:

- Final Report of Operations Exercise Desert Rock VI, provided information on unit participation and activities of Desert Rock organizations (133).
- Weapons Test Reports for AFSWP and other scientific projects often identified personnel, units, and organizations that participated in the Operation.
- After-action reports, security rosters, and vehicle loading rosters related to the military exercises identified some participants.
- Morning reports, unit diaries, and muster rolls provided identification data on personnel assigned to participating units, absent from their home unit, or in transient status for the purpose of participating in a nuclear weapons test.
- Official travel or reassignment orders provided information on the identity of transient or assigned personnel participating in the nuclear weapons tests.
- Discharge records, maintained by all services, aided in identification.

- Army official photographs sometimes showed participants wearing name tags,, identified some units in the caption, and usually acknowledged the photographer's name and unit.

- The Final Dosage Report for Operation TEAPOT supplied information on the names, units, and total gamma doses for JTO participants (257).

- Military personnel records for individuals still on active duty in some of the services provided information relative to that individual's assignment to participating units or attendance in transient status at the nuclear weapons test.

- The services' Reserve Personnel Officer provided information on participants still carried on active or inactive reserve rolls.

- More than 50,000 test participants have responded to a widely publicized national call-in campaign sponsored by the Department of Defense.

6.2 DOSIMETRY DATA

Most of the dosimetry data for Operation TEAPOT were derived from film badge records. When film badge data were not available, however, radiation doses could be calculated if sufficient information were available concerning personnel activities, the radiological environment, and the time that personnel spent in that environment.

6.2.1 Film Badge Data

During Operation TEAPOT, the film badge was the primary device used to measure the radiation dose received by individual participants. Most participants from JTO and AFSWC were issued a badge, but in general, Desert Rock observer and maneuver units that performed similar duties were issued one badge per squad (133). The film badge, normally worn at chest level on the outside of clothing, was designed to measure the wearers' exposure to gamma radiation from external sources. The film badges were insensitive to neutron radiation and, like other film badges, did not measure the amount of radioactive material inhaled or ingested.

The Joint Test Organization, Exercise Desert Rock VI and AFSWC had their own radiological safety personnel who issued, received, processed, and interpreted film badges during Operation TEAPOT. The Desert Rock VI film badge program was administered by the 232nd Signal Company; the JTO badge program was administered by the Dosimetry and Research Section of the 1st Radiological Safety Support Unit; and the Nuclear Application Division of AFSWC handled the film badge program for AFSWC personnel. Desert Rock, JTO and AFSWC radiological safety personnel used manual clerical procedures to record film badge data. As described in chapter 5, Desert Rock VI radiological safety personnel used Forms R101 and R102, while JTO and AFSWC personnel used a file card to record cumulative personnel film badge data (7; 16; 63; 133).

At the conclusion of Operation TEAPOT, it was the intent of the services to send individual dose records to each participant's home station for inclusion in his records. When the individual left the service, his records were retired to a Federal records repository (310).

The film badge data summarized in this chapter were obtained from the following sources:

- Historical files of the Reynolds Electrical and Engineering Company (REECo), the prime support contractor to the Department of Energy (and previously to the AEC Nevada Operations office). REECo has provided support at the Nevada Test Site since 1952. REECo assumed responsibility for onsite radiological safety after Operation TEAPOT in July 1955, and, consequently, has collected available dosimetry records for nuclear test participants at all nuclear testing operations from 1945 to the present. REECo has, on microfilm, all available exposure records for individuals at Operation TEAPOT, consisting primarily of those participants working under the JTO (268).

- Military medical records, maintained at the National Personnel Records Center, St. Louis, Missouri,- for troops separated from military service, or at the Veterans Administration, for individuals who have filed for disability compensation or health benefits. Unfortunately, many records were destroyed in a fire at the St. Louis repository in July 1973. That fire destroyed 13 to 17 million Army records for personnel discharged through 31 December 1959, and for members of the Army Air Corps/Air Force discharged through 31 December 1963.

- Final Dosage Report for Operation TEAPOT, which contains the names, units, and total gamma doses for JTO participants (257).

- Addenda to the Final Dosage Report for Operation TEAPOT (50).

- Radiological Safety Report for Operation TEAPOT, which provides aggregate information on the number of JTO participants who accumulated gamma exposures over 2.0 roentgens for specific events of the TEAPOT Series (63).

- Final Report of Operations for Exercise Desert Rock VI, Troop Orientation and Indoctrination, which includes aggregate dose data for Desert Rock participants (133).

- Memoranda and correspondence from the Office of the Test Director (52-56; 58-61) on:

  - Exposures greater than 2.0 roentgens but less than 3.9 roentgens, sent to the JTO staff

  - The identitv of participants from JTO units and their total film badge readings, sent to the Commanding Officer of the permanent station of the individual

  - The identity of some participants receiving doses which exceeded the established limit, copies of which were sent to the permanent station of the individual.

6.2.2 Reconstructed Dose Data

In certain instances when film badge data were missing for large groups of personnel that might have been exposed, DOD conducted research to calculate radiation doses resulting from external exposure to gamma radiation. When it was apparent that DOD personnel might have been exposed to significant neutron radiation and/or airborne radioactive material, doses from these sources were also calculated. Based on reconstructions of the troop activities and the radiation environment, these calculations consider the following (114):

- Shot characteristics (yield, height of burst, and weapon type/design)
- Residual radiation survey data
- Personnel activities
  - Distance from burst and shielding
  - Time, positions, and activities in radiologically contaminated areas.

6.3 DOSIMETRY DATA FOR OPERATION TEAPOT PARTICIPANTS

This section presents data on the doses that DOD participants received during Operation TEAPOT. Beginning with a presentation of external gamma radiation doses organized by unit, service, and activity, the section proceeds to a discussion of the circumstances surrounding specific instances of overexposure. Finally, the section discusses doses that have been reconstructed for Desert Rock participants.

6.3.1 External Gamma Exposure Data

Tables 6-1 through 6-6 present the gamma exposure data available from film badge records for DOD participants at Operation TEAPOT.* The tables indicate the following information by service or unit:

- The number of personnel identified by name
- The number of personnel identified by both name and film badge

*All tables are located at the end of the chapter.

- The average gamma exposure in roentgens
- The distribution of'these exposures.

Note that, in table 6-1, about 72 percent of the estimated 11,000 DOD participants were identified by name and 41 percent by name and film badge reading (86).

Table 6-l summarizes all exposures for each service affiliation. In addition to the Army, Navy, Marine Corps, and Air Force designations, the table includes data for scientific personnel, contractors, and affiliates, and participants whose service affiliation is unknown. Tables 6-2 through 6-6 provide information about the gamma exposures received by the various participants. In these tables, distributions and averages are given by unit, home station or organizatiton. For a unit to be represented in the table, it must meet at least one of the following criteria:

- Records are available for ten or more individuals from the unit
- At least one individual in the unit had a gamma exposure of 1.0 roentgen or more.

Units not meeting these criteria are consolidated in tables 6-2 through 6-6 in the "other" category, and a distribution of cumulative exposures with an average is provided for them. Tables 6-2a through 6-6a list the individual units that comprise the "other" category in tables 6-2 through 6-6 (86).

Note that in table 6-2, film badge data for Desert Rock VI participants are not available. However, some aggregate dosimetry information for Desert Rock participants is provided in the Desert Rock VI Final Report (133). The report indicates that 97 individuals received gamma exposures between 3.0 and 6.0 roentgens, while 17 received exposures greater than the 6.0 roentgen limit. These overexposures and others are described in the following section.

6.3.2 Instances of Gamma Exposure Exceeding Prescribed Limits

The prescribed limits of gamma radiation exposure were 6.0 roentgens for Desert Rock VI participants and 3.9 roentgens for JTO personnel. For certain areas of research, the Test Manager allowed selected individuals to exceed the JTO or Desert Rock exposure limits while performing their tasks. After careful review, the Test Manager allowed a special exposure limit of 10.0 roentgens of gamma radiation for the ten volunteer officer observers in Desert Rock Project 40.22, and a limit of 15.0 roentgens for the pilots of Military Effects Group Project 2.8b, Manned Penetrations of Atomic Clouds. Despite these exceptions, the standard policy for Exercise Desert Rock VI, JTO and AFSWC was to minimize individual exposure, while allowing participants to accomplish the operational requirements of each activity or mission (46; 63; 243; 265).

The Exercise Desert Rock VI Final Report (133) indicates that 17 participants exceeded the 6.0-roentgen exposure limit. Two of these individuals had gamma exposures exceeding 20.0 roentgens. Information regarding the units and activities of these overexposed personnel is not included in the Final Report. However, the unit affiliation of some of these participants may be identified in a press release dated 31 March 1955, prepared by the Joint Office of Test Information before the completion of Operation TEAPOT. This press release reports that seven personnel "were members of Chemical Corps Radiation Monitoring Teams" (178). However, the release does not indicate the actual exposures received by these individuals. The JTO personnel who received overexposures during Operation TEAPOT included AFSWC pilots and support personnel, AFSWP project participants, and members of the 1st Radiological Safety Support Unit.

Table 6-7 is a list of units with JTO and AFSWC personnel who received gamma radiation exposures in excess of the 3.9-roentgen limit during Operation TEAPOT. Also included are the doses of two AFSWC pilots who exceeded the special 15.0-roentgen limit authorized for Project 2.8b. In addition to the unit name, the table lists the number of personnel whose doses exceeded the limit and the individual doses they received (50; 56; 59; 86; 257).

Several of the overexposed personnel participated in Military Effects Group projects that required them to enter radiation areas to retrieve instruments and experimental data. These participants were from the following units (188):

- Chemical and Radiological Laboratories
- Evans Signal Laboratory
- Headquarters, Chemical Corps Training Command
- Naval Radiological Defense Laboratory
- Naval Research Laboratory
- Engineer Research and Development Laboratories.

These personnel entered the area at recovery hour or when radiological safety personnel allowed them through the checkpoints. Recovery teams, who were usually accompanied by radiological safety personnel, always traveled by vehicle. Factors that could have contributed to overexposure of some project personnel during critical recovery operations included higher than anticipated radiation levels, difficulty in maneuvering vehicles over rough terrain or unforeseen obstacles, and increased time spent in radiation areas while searching for equipment (18; 114; 189; 190-201).

Members of the 1st Radiological Safety Support Unit provided radiological safety monitors for all shots. These monitors accompanied AFSWP project personnel on many of the recovery missions. In addition, 1st Radiological Safety Support Unit personnel surveyed the shot area after each detonation and manned the checkpoints to the radiation areas. Members of the 1st Radiological Safety Support Unit spent more time in or near radiation areas than other personnel, especially because they repeated their activities during several shots (63).

Several Air Force personnel, in addition to the sampler pilots who exceeded the special 15.0-roentgen limit, received exposures in excess of the 3.9-roentgen limit. Some personnel from the following Air Force units were assigned to transport project personnel between Camp Desert Rock and the operational areas:

- 345th Troop Carrier Squadron
- 346th Troop Carrier Squadron
- 347th Troop Carrier Squadron
- 644th Troop Carrier Squadron.

Some of these personnel may have observed several of the shots, affording them an opportunity for repeated exposure.

Some personnel from the 3083rd Aviation Depot Group were assigned to the 1st Radiological Safety Support Unit to assist in radiological survey and monitoring activities. Personnel from other Air Force units that may have participated in these activities include the following (309):

- 3080th Aviation Depot Group
- 3081st Aviation Depot Group
- 3082nd Aviation Depot Group
- 3084th Aviation Depot Group.

The 4926th Test Squadron (Sampling), one of the principal units of the 4925th Test Group (Atomic), gathered radioactive samples from nuclear clouds for analysis by various JTO Test Groups (306). Because this task required the pilots to fly near or through the nuclear clouds, their opportunities for exposure were also increased (46; 112; 265).

Documented activities of the representatives from Bendix Aviation, Headquarters 312th Fighter Bomber Group, the 479th Supply Squadron, and the U.S. Air Force Test Unit, as well as those in the unknown category, have not been found.

6.3.3 Reconstructed Doses

Because film badge data were not available for most of the Exercise Desert Rock VI participants, estimates of their external gamma and neutron doses were calculated. These calculations were based on the activities performed by the troops and observers, which included witnessing the shot, performing a troop maneuver, and touring the equipment display areas before and after the shot.

Observers representing each of the armed services participated in most of the TEAPOT shots. The observer groups at TEAPOT consisted of the following personnel:

- Camp Desert Rock support personnel who remained at the camp throughout the operation
- Personnel who were normally with the Desert Rock maneuver troops
- Personnel from the various military services who were assigned or who volunteered to witness a specific shot or shots.

Because the service observers and maneuver troop observers had first priority for observing the shots, it appears that only a few support personnel from Camp Desert Rock participated as observers in more than one shot. With the exception of the volunteer observers in Army Project 40.22 at Shot APPLE 2, observers witnessed a particular shot from the same general area (114; 133).

The reconstructed radiation doses of Exercise Desert Rock VI observers are shown in table 6-8. The calculated film badge dose is the dose that would have been recorded on a film badge worn at chest level. The radiological environment encountered by the troops and observers and considered in the reconstruction of their doses included possible initial radiation from the observed test as well as residual radiation from the observed test and earlier tests. Table 6-S also shows the calculated neutron doses for these participants. Gamma and neutron dose are listed separately to facilitate comparison with existing film badge data, which indicate gamma dose only (114).

The parameters used to reconstruct doses for observers at Shot TESLA are typical of those used for each of the shots listed in table 6-8. At Shot TESLA, for example, 523 Desert Rock observers witnessed the shot from trenches located 2,190 meters southwest of ground zero. They remained in the trenches for five to ten minutes after the detonation, then walked to the equipment display line located 910 meters southwest of ground zero. About 30 minutes elapsed between the time the observers departed from the trenches and their arrival at the display line, which at that time had a gamma intensity of 5.0 R/h. The observers remained at the display line about 15 minutes, then returned to the trench area where they boarded vehicles and returned to Camp Desert Rock. By relating these troop activities to the radiological environment (initial and residual radiation), a dose was calculated for the group of observers. Based upon the data presented above, dose reconstruction indicates that the TESLA observers received 1.4 rem gamma and 1.4 rem neutron doses (114).

Table 6-1: DISTRIBUTION OF GAMMA RADIATION EXPOSURES FOR OPERATION TEAPOT PARTICIPANTS BY AFFILIATION

Service	Personnel Identified By Name	Personnel Identified By Name and By Film Badge	Average Gamma Exposure (Roentgens)	Gamma Exposure (Roentgens) < .1	.1-1.0	1.0-3.0	3.0-5.0	5.0+
Army	2,144	761	1.083	400	121	126	96	18
Navy	407	160	1.121	61	48	31	16	4
Air Force	603	603	0.879	290	154	97	53	9
Marine Corps	2,305	510	0.317	117	391	2	0	0
Scientific Personnel, Contractors, and Affiliates	123	122	0.437	74	28	18	2	0
Service Unknown *	2,348	2,348	0.282	1,449	681	196	22	0
TOTAL	7,930	4,504	0.535	2,391	1,423	470	189	31

*Film badge data are available, but service affiliation is not.

Table 6-2: DISTRIBUTION OF GAMMA RADIATION EXPOSURES FOR ARMY PERSONNEL AND AFFILIATES, OPERATION TEAPOT

Units	Personnel Identified By Name	Personnel Identified By Name and By Film Badge	Average Gamma Exposure (Roentgens)	Gamma Exposure (Roentgens)				
				<.1	.1-1.0	1.0-3.0	3.0-5.0	5.0+
Army Chemical Center, Edgewood, MD	1	1	3.300	0	0	0	1	0
Ballistic Research Laboratories, Aberdeen Proving Ground	46	46	0.960	5	22	16	3	0
Chemical and Radiological Laboratories, Edgewood, MD	32	32	2.776	3	8	6	10	5
Camp Desert Rock, NV	419	0						
Detroit Arsenal	7	7	1.126	1	5	0	0	1
Development and Proving Services, Aberdeen Proving Ground	1	1	4.000	0	0	0	1	0
Directorate of Weapons Effects Tests	1	1	3.970	0	0	0	1	0
D/Engineer (sic) *	1	1	2.310	0	0	1	0	0
Engineer Research and Development Laboratories. Fort Belvoir, VA	11	11	1.350	2	5	3	0	1
Evans Signal Laboratory	22	22	1.726	1	10	6	5	0
Headquarters. Chemical Corps Training Command	3	3	1.761	0	0	3	0	0
Headquarters. Field Command AFSWP	1	1	3.465	0	0	0	1	0
Headquarters. 16th Signal Battalion	3	1	1.320	0	0	1	0	0
Provisional Troop Packet Unit	32	0						
1st Radiological Safety Support Unit	84	84	3.000	9	11	26	28	10
2nd Chemical Weapons Battalion	30	30	1.447	6	11	6	6	1
5th Army Troop Packet	96	0						
50th Chemical Platoon (Service)	16	0						

Table 6-2: DISTRIBUTION OF GAMMA RADIATION EXPOSURES FOR ARMY PERSONNEL AND AFFILIATES, OPERATION TEAPOT (Continued)

Units	Personnel Identified By Name	Personnel identified By Name and By Film Badge	Average Gamma Exposure (Roentgens)	Gamma Exposure (Roentgens)				
				< .1	.1-1.0	1.0-3.0	3.0-5.0	5.0+
56th Signal Company	1	1	1.170	0	0	1	0	0
90th Replacement Company	15	0						
95th Engineer Combat Battalion	43	0						
232nd Signal Company	29	0						
505th Military Police Battalion	15	0						
573rd Ordnance Company (3623rd Ordnance Company)	24	0						
723rd Tank Battalion	60	0						
3084th Aviation Depot Group	2	2	2.410	0	1	0	1	0
8452nd DU (sic)	5	2	1.605	1	0	0	1	0
Other **	631	4	0.480	0	4	0	0	0
Unit Unknown ***	511	511	0.688	372	44	57	38	0
TOTAL	2,144	761	1.083	400	121	126	86	18

*"Sic" indicates that table entry for the unit and/or home station could not be verified.
**For list of units in this category, see table 6-2a.
***Unit information unavailable.

Table 6-2a: DETAILED LISTING OF "OTHER" CATEGORY, ARMY PERSONNEL AND AFFILIATES, OPERATION TEAPOT

Numbered Units

First Army, Deputy Chief of Staff, Operations
Second Army, Headquarters, Fort Meade, MD
Third Army, Headquarters
Sixth Army
IV Corps Artillery, NC National Guard, Headquarters
XVIII Airborne Corps
XVIII Airborne Corps, 51st Field Artillery
XXII Corps Artillery, S2/S3
1st Armored Division Provisional Aviation Company (1st Combat Aviation Company)
1st Armored Division, 1st Medical Battalion
1st Guided Missile Brigade
1st Training Regiment (Fort Jackson, SC)
2nd Armored Division, 2nd Aviation Company
2nd Armored Division, 24th Engineer Battalion
2nd Division, 72nd Tank Battalion
2nd Infantry Division
2nd Missile Command (Fort Lewis, WA)
2nd Signal (Photo) (sic)*
2nd Transportation Company (Fort Ord, CA)
3rd Armored Division, Headquarters and Headquarters Company
3rd Infantry Regiment, 2nd Battalion
4th Armored Division
4th Armored Division Helicopter Unit
4th Armored Division, 510th Armored Infantry Battalion Company "C"
4th Armored Division, 24th Engineer Battalion
4th Armored Division, 22nd Field Artillery Battalion, Battery A
5th Ordnance Battalion
6th Antiaircraft Artillery Group
6th RBLL Grd (Fort Bragg, GA) (sic)
8th Infantry Division, 12th Engineer Battalion
8th Infantry Division, Provisional Communication Company
8th Infantry Division, 155th Infantry Regiment
10th Infantry Division
10th Ordnance Battalion (Special Weapons)
11th Airborne Division
11th Armored Cavalry Regiment, Troop "G"
12th Evacuation Hospital (Fort Ord, CA)
13th Antiaircraft Artillery Group
13th Infantry, 1st Battalion, Headquarters and Headquarters Company
16th Armored Group
16th Base Post Office
17th Field Artillery Group, Headquarters and Headquarters Company
18th Infantry Battalion (sic)

*"Sic" indicates that the table entry for the unit and/or home station has not been verified.

Table 6-2a (Continued)

18th Ordnance Company
23rd Tank Battalion (sic)
23rd Transportation Truck Company
26th Guided Missile Group
26th Transportation Battalion, Headquarters and Headquarters Company
27th Engineer Combat Battalion
28th Division, PA National Guard
28th Transportation Battalion
32nd Infantry Division
34th Engineer Group, 98th Engineer Battalion
34th Quartermaster Battalion
36th Artillery Battalion, 1st Battery
36th Signal Battalion
36th Transportation Battalion, Headquarters Company
38th Transportation Company (Sixth Army)
41st Infantry Division, OR National Guard
41st Tank Battalion, Fort Carson, CO
44th Infantry, Engineers (Fort Lewis, WA)
46th Ordnance, Headquarters and Headquarters Company
50th Medical Clearing Company
50th Signal Battalion
52nd Artillery Brigade (Fort Wadsworth, NY)
53rd Armored Division
53rd Quartermaster Company
56th Field Artillery
59th Antiaircraft Artillery Battalion
61st Ordnance (Explosive) Group
61st Engineer Battalion
68th Medical Group
69th Engineer Detachment
69th Infantry (Fort Dix, NJ)
71st Replacement Company (Fort Lewis, WA)
78th Infantry Division
82nd Airborne Division
83rd Infantry Division
87th Engineer Battalion, Headquarters Company (Fort Belvoir, VA)
91st Division (sic)
91st Engineer Combat Battalion
94th Veterinary Food Inspection Service Detachment
96th Infantry Division (Fort Douglas, UT)
102nd Infantry Division (Reserve)
107th Antiaircraft Brigade (Sanford)
108th Training Division (Reserve) Charlotte, NC
110th Military Police Unit
128th Quartermaster Company (Fort Lewis, WA)
145th Infantry (sic)
163rd Quartermaster Company, Fort Lewis, WA
169th Engineer Battalion
188th Airborne Infantry Regiment, Company "C"

Table 6-2a (Continued)

188th Ordnance Battalion (Fort Riley, KS)
191st Field Artillery (Camp Drum, NY) (sic)
198th Tank Battalion
216th Chemical Service Company
231st Engineer Combat Battalion
237th Engineer Battalion
271st Engineer Battalion, Company "C"
271st Engineer Combat Battalion
278th Regiment Combat Team
281st Engineer Battalion
323rd Tank Battalion
325th Tank Battalion
330th Ordnance Battalion
337th Field Artillery Battalion, Battery A
359th Engineer Combat Battalion, Company "A"
378th Medical Company (Fort Meade, MD)
396th Truck Company
414th Field Artillery Group
417th Infantry Regiment (Reserve), Company "D"
433rd Army Band
498th Engineer Combat Battalion
501st Armored Infantry Battalion
502nd Infantry Regiment, Headquarters Company
508th Airborne Regiment Combat Team
509th Ordnance Company
511th Airborne, Headquarters Company
521st Military Police Company
522nd Infantry Battalion (Camp Lawton, WA)
524th Quartermaster Company (Petroleum Depot)
525th Military Intelligence Group (Fort Bragg, GA)
529th Signal Corps (sic)
532nd Field Artillery Battalion (Observation), Battery C
542nd Engineer Battalion (Fort Winfield Scott, CA)
546th Antiaircraft Artillery Battalion
553rd Field Artillery Battalion
555th Engineer Battalion
555th Ordnance Company
601st Supply Company
602nd Field Artillery Battalion
623rd Quartermaster Supply Company
649th Quartermaster Company (Petroleum)
701st Military Police Company
705th Engineer Combat Company
720th Field Artillery Battalion
754th Tank Battalion
762nd Quartermaster Battalion
763rd Transportation Battalion
2053rd Army Signal Unit (Fort Meade, MD)
2304th Service Unit, Virginia Military District

Table 6-2a (Continued)

3082nd ADG (sic)
3083rd ADG (sic)
3400th Service Unit, Headquarters Section
6017th SU HG Dept (sic)
6019th Support Unit (Detachment #3)
6517th Army Signal Unit
7062nd Quartermaster Company
8457th ARDU (sic)
8461st DU (sic)
8462nd DU (sic)
9301st Technical Service Unit
9677th Technical Service Unit

Department of the Army

Office of the Chief of Staff
Office of the Deputy Chief of Staff, Logistics
Office of the Deputy Chief of Operations
Chief, Psychological Warfare
Office of the Chief of Information
Office of the Quartermaster General
Department of the Army (Observer)

Commands

Army Caribbean Command, Panama
Continental Army Command, Fort Monroe, VA
Western Area Command, Hamilton Air Force Base, CA

Schools

Antiaircraft and Guided Missile School (Fort Bliss, TX)
Army Air Defense School (Fort Bliss, TX)
Army General School (Fort Riley, KS)
The Armored School (Fort Knox, KY)
Chemical School (Fort McClellan, AL)
Command and General Staff College (Fort Leavenworth, KS)
Field Artillery School (Fort Sill, OK)
The Infantry School (Fort Benning, GA)
Ordnance School (Aberdeen Proving Ground, MD)
United States Military Academy (West Point, NY)

Table 6-2a (Continued)

Locations

Camp Hanford, WA
Camp Irwin, CA
Camp Lucas, MI
Dugway Proving Ground, UT
Fort Benning, GA
Fort Bliss, TX
Fort Carson, CO
Fort Devins, MA
Fort Hood, TX
Fort Huachuca, AZ
Fort Jackson, SC
Fort Lawton, WA
Fort Leonard Wood, MO
Fort Lewis, WA
Fort MacArthur, CA
Fort Meade, MD
Fort Myer, VA
Fort Ord, CA
Fort Riley, KS
Fort Rucker, AL
Fort Sill, OK

Miscellaneous

Adjutant General's Office - Personnel (sic)
Army Aviation Test Board
Army Chemical Corps
Army Corps of Engineers
Army Map Service
Chemical, Biological, and Radiological Teams
Engineer Development Board (Fort Belvoir, VA) (sic)
Human Resources Research Office
Joint Task Force 7, Eniwetok (sic)
Joint Task Force 1321 (sic)
Mobile TV Unit #1, Signal Corps (Long Island, NY)
Mountain and Cold Weather Training Company
National Guard (Fort Benning, GA)
Office, Chief Army Field Forces, Board #2
Provisional Aviation Flight Detachment
Quartermaster Research and Development Center (Natick, MA)
Research and Development Command (sic)
Savannah River Plant, Army Corps of Engineers

Table 6-3: DISTRIBUTION OF GAMMA RADIATION EXPOSURES FOR NAVY PERSONNEL AND AFFILIATES, OPERATION TEAPOT

Units	Personnel Identified By Name	Personnel Identified By Name and By Film Badge	Average Gamma Exposure (Roentgens)	Gamma Exposure (Roentgens)				
				.1	I-I.O	1.0-3.0	3.0-5.0	5.0+
Bureau of Ships	11	0						
Civil Effects Test Group, Oak Ridge National Laboratory	1	1	2.620	0	0	1	0	0
Charleston Naval Shipyard	10	0						
Long Beach Naval Shipyard	10	0						
Mare Island Naval Shipyard	10	0						
Naval Air Special Weapons Facility, Kirtland AFB	15	14	0.067	12	2	0	0	0
Naval Administrative Unit, Sandia Base	9	a	0.501	3	3	2	0	0
Naval Electronics Laboratory	11	a	0.228	2	6	0	0	0
Naval Medical Research Institute	7	7	2.524	0	0	5	2	0
Naval Ordnance Laboratory	17	11	0.129	6	5	0	0	0
Norfolk Naval Shipyard	11	0						
Naval Radiological Defense Laboratory	88	50	1.662	13	7	16	14	0
Naval Research Laboratory	26	26	2.401	7	a	7	0	4
New York Naval Shipyard	10	0						
Philadelphia Naval Shipyard	10	0						
Puget Sound Naval Shipyard	10	0						
San Francisco Naval Shipyard	12	0						
Other *	74	25	0.110	15	10	0	0	0
Unit Unknown **	65	10	0.236	3	7	0	0	0
TOTAL	407	160	1.121	61	48	31		

* For list of units in this category, see table 6-3a.
** Unit information unavailable.

Table 6-3a: DETAILED LISTING OF "OTHER" GATEGORY,
NAVY PERSONNEL AND AFFILIATES,
OPERATION TEAPOT

Amphibious Construction Battalion; Port Hueneme, CA
Boston Naval Shipyard; Roston, MA
Bureau of Yards and Docks; Washington, DC
Bureau of Medicine and Surgery; Washington, DC
Bureau of Supplies and Accounts; Washington, DC
Chief of Naval Operations; Washington, DC
Commander, Naval Air Pacific; San Diego, CA
Commander, 9th Naval District; Great Lakes, IL
David Taylor Model Basin; Washington, DC
Naval Administrative Unit, Lake Mead Base, NV
Naval Civil Engineering Research Laboratory; Port Hueneme, CA
Naval Engineering Experimental Station; Annapolis, MD
Naval Gun Factory; Washington, DC
Naval Hospital, Chelsea; Boston, MA
Naval Hospital, St. Albans; NY
Naval Post Graduate School; Monterey, CA
Naval Repair Facility
Naval Underwater Sound Laboratory; San Diego, CA
Navy Air Missile Test Center; Point Uugu, CA
Navy Mine Countermeasure Station; Panama City, FL
New York Naval Shipyard Materiel Laboratory; Brooklyn, NY
Office of Naval Research; Washington, DC
Pearl Harbor Naval Shipyard; Pearl Harbor, HI
Portsmouth Naval Shipyard; Portsmouth, VA
3d Marine Corps Provisional Atomic Exercise Brigade;
Camp Pendleton, CA

Table 6-4: DISTRIBUTION OF GAMMA RADIATION EXPOSURES FOR MARINE PERSONNEL AND AFFILIATES, OPERATION TEAPOT

units	Personnel Identified By Name	Personnel Identified By Name and By Film Bedge	Average Gamma Exposure (Roentgens)	Gamma Exposure (Roentgens) : .1	I-I.0	I.0-3.0	3.0-5.0	5.0+
Company A, 1st Infantry Battalion Marine Corps Training Unit #1	179	68	0.414	0	68	0	0	0
Company B, 1 st Infantry Battalion Marine Corps Training Unit Cl	180	73	0.420	1	72	0	0	0
Company C, 1 st Infantry Battalion Marine Corps Training Unit XI	213	21	0.240	9	12	0	0	0
Company D, 1st Infantry Battalion Marine Corps Training Unit #1	166	a5	0.404	1	a4	0	0	0
Headquarters and Maintenance Squadron 36-Marine Helicopter Transport Group, Air Fleet Marine Force Pacific	32	2	0.000	2	0	0	0	0
Headquarters and Service Company. 1st Infantry Battalion, Marine Corp Training Unit #1	316	115	0.236	43	72	0	0	0
Marine Attack Squadron 223 Marine Air Group 15	118	5	0.133	4	1	0	0	0
Marine Attack Squadron 224 Marine Air Group 15	42	1	0.000	1	0	0	0	0
Marine Attack Squadron 323 Marine Air Group 15	166	11	0.062	11	0	0	0	0
Marine Fighter Squadron (Night) 542 Marine Air Group 15	175	9	0.012	8	1	0	0	0
Marine Helicopter Transport Squadron 362-Marine Helicopter Transport Group 36, Air Fleet Marine Force Pacific	76	12	0.236	5	7	0	0	0
Marine Helicopter Transport Squadron 363-Marine Helicopter Transport Group 36, Air Fleet Marine Force Pacific	a2	4	0.153	2	2	0	0	0
Observers	77	26	0.378	7	18	1	0	0
Service Squadron, Air Force Marine Fleet Pacific	1	1	1.160	0	0	1	0	0
Subunit XI, Headquarters and Service Company, Marine Corps Training Unit #1	326	27	0.370	3	24	0	0	0
75mm Pack Howitzer Battery Marine Corps Training Unit XI	93	36	0.277	a	28	0	0	0
Other *	21	14	0.079	12	2	0	0	0
TOTAL	2,305	510	0.317	117	391	2	0	0

* For list of units in this category. see table 6.4a.

Table 6-4a: DETAILED LISTING OF "OTHER" CATEGORY MARINE PERSONNEL AND AFFILIATES, OPERATION TEAPOT

Company C, Headquarters Battalion, Washington, D.C.
Headquarters and Maintenance Squadron 25 - Marine Helicopter Transport Group 25, El Toro, CA
Headquarters, 1st Battalion, 4th Marines
Headquarters Company, Marine Corp School, Quantico, VA
Headquarters Company, 1st Combat Service Group
Headquarters Company, 7th Engineer Battalion, Fleet Marine Force, Pacific
Maintenance Company, 1st Combat Service Group
Marine Air Support Squadron 3, Marine Air Control Group 3
Marine Corps Air Station, Quantico, VA
Marine Corp Training Unit #1
Subunit #1, Headquarters and Service Company, 3d Marine Corp Provisional Atomic Exercise Brigade
Training and Test Regiment, Marine Corp School
VAP 62 DET 35 (sic)
1st Communication Specialty Company, Fleet Marine Force
2nd Topographic Company, Camp Lejeune, NC

*"Sic" indicates that table entry for the unit and/or home station has not been verified.

Table 6-5: DISTRIBUTION OF GAMMA RADIATION EXPOSURES FOR AIR FORCE PERSONNEL AND AFFILIATES, OPERATION TEAPOT

Units	Personnel identified By Name	Personnel Identified By Name and By Film Badge	Average Gamma Exposure (Roentgens)	Gamma Exposure (Roentgens)				
				< .1	.1-1.0	1.0-3.0	3.0-5.0	5.0+
Air Force Cambridge Research Center	2	2	0.985	0	1	1	0	0
Air Force Headquarters	5	5	0.554	2	2	1	0	0
Air Force Special Weapons Center Kirtland Air Force Base	19	19	2.623	6	6	3	2	2
Fairfield-Suisun (Travis) Air Force Base, CA	2	2	2.015	0	0	2	0	0
Headquarters, Chemical Corps Training Command	7	7	2.194	0	1	4	2	0
Headquarters Squadron Section 363rd Air Base Group	1	1	2.470	0	0	1	0	0
Headquarters Squadron Section 479th Air Base Group	1	1	2.370	0	0	1	0	0
Headquarters, 312th Fighter Bomber Group	2	2	4.165	0	0	0	2	0
Lookout Mountain Laboratory	12	12	1.155	4	3	4	1	0
U.S. Air Force Radiological Laboratory	1	1	4.220	0	0	0	1	0
Wright Air Development Center	31	31	0.232	19	9	3	0	0
6th Weather Squadron	15	15	0.256	9	5	0	1	0
29th Tactical Reconnaissance	1	1	2.770	0	0	1	0	0
345th Troop Carrier Squadron	3	3	3.969	0	0	1	0	2
346th Troop Carrier Squadron	3	3	3.483	0	0	1	1	1
347th Troop Carrier Squadron	2	2	4.943	0	0	0	1	1
366th Fighter Bomber Squadron	4	4	2.018	0	1	2	1	0
387th Fighter Bomber Squadron		1	3.120	0	0	0	1	0
436th Fighter Bomber Squadron	1	1	1.110	0	0	1	0	0
456th Field Maintenance Squadron	3	3	2900	0	0	1	2	0
452nd Fighter Day Squadron	1	1	1.155	0	0	1	0	0
461 st Bomber Wing	4	4	2.740	0	0	2	2	0
463rd Troop Carrier Wing	14	14	0.049	12	2	0	0	0
479th Supply Squadron	1	1	4.690	0	0	0	1	0
492nd Bomber Squadron	19	19	0.059	15	4	0	0	0
511 th Fighter Bomber Squadron	21	21	0.010	21	0	0	0	0
644th Troop Carrier Squadron	13	13	2.362	0	2	6	5	0

Table 6-6: DISTRIBUTION OF GAMMA RADIATION EXPOSURES FOR AIR FORCE PERSONNEL AND AFFILIATES, OPERATION TEAPOT (Continued)

Units	Personnel Identified By Name	Personnel Identified By Name and By Film Badge	Average Gamma Exposure (Roentgens)	Gamma Exposure (Roentgens)				
				<.1	.1-1.0	1.0-3.0	3.0-5.0	5.0+
766th Bomber Squadron	1	1	1.360	0	0	1	0	0
1090th Special Reporting Group	21	21	0.826	6	9	4	2	0
1352nd Motion Picture Squadron	2	2	0.655	0	1	1	0	0
1360th Motion Picture Squadron	2	2	1.605	0	0	2	0	0
3031 st AFSWC Research (sic) *	1	1	1.550	0	0	1	0	0
3080th Aviation Depot Group	12	12	1.822	3	2	3	4	0
3081 st Aviation Depot Group	12	12	2.452	0	1	6	5	0
3082nd Aviation Depot Group	10	10	2.658	0	0	7	3	0
3083rd Aviation Depot Group	8	8	2.200	0	2	4	1	1
3084th Aviation Depot Group	8	8	1.779	0	3	4	1	0
3215th Drone Squadron	12	12	0.047	10	2	0	0	0
4909th Test Squadron	10	10	0.182	4	6	0	0	0
4925th Test Group (Atomic)	33	33	0.607	18	5	10	0	0
4926th Test Squadron	109	109	1.132	38	41	15	13	2
4827th Test Squadron	6	6	0.327	4	1	1	0	0
4928th Test Squadron	17	17	0.055	15	2	0	0	0
4929th Test Squadron	5	5	0.355	2	2	1	0	0
6571st Support Group	14	14	0.033	13	1	0	0	0
8452nd Duty Unit, Sandia Base	8	8	0.902	1	5	1	1	0
Other **	123	123	0.122	88	35	0	0	0
TOTAL	603	603	0.879	290	154	97	53	9

""Sic" indicates that table entry for the unit and/or home station could not be verified.
**For list of units in this category. see table 6-5a.

Table 6-5a: DETAILED LISTING OF "OTHER" CATEGORY, AIR FORCE PERSONNEL AND AFFILIATES, OPERATION TEAPOT

3rd Airways and Air Command Service (Mobile) Squadron
27th Air Division
405th Fighter Bomber Squadron
435th Fighter Day Squadron
722nd Troop Carrier Squadron
728th Aircraft Control and Warning Squadron, Detachment 5
772nd Troop Carrier Squadron
774th Troop Carrier Squadron
809th Air Base Group, Headquarters
1094th Special Reporting Squadron
3089th Aviation Depot Group
3345th Technical Training Wing
3415th Technical Training Wing
3598th Combat Crew Training Squadron
4091st Air Base Group
4924th Technical Air Command Squadron
4934th Armament and Electronics Maintenance
4935th Air Base Group
4957th Test Group
6515th Flight Maintenance
6520th Flight Test Squadron
8459th Division, Sandia Rase (sic)*

Ardmore Air Force Base, OK
Air Training Center
Cambridge Research Laboratory
Flight Test (Wright Patterson Air Force Base)
Griffith Air Force Base, NY
Hollaman Air Force Base, NM
Headquarters, Air Force Armament Center
Headquarters, Air Materiel Command, Wright Patterson AFB
Headquarters, Air Research and Development Center
Headquarters, Strategic Air Command
Headquarters, Sacramento Air Materiel Center
Headquarters, Special Weapons Center
Headquarters, Tactical Air Command
Headquarters, U.S. Air Force
Kelly Air Force Base, TX
Kirtland Air Force Base, NM
Langley Air Force Base, VA
Naval Ordnance Laboratory
Office of General Surgeon, USAF
Offutt Air Force Base, NB
Reese Air Force Base
Sandia Base
Tactical Control Squadron
Test Aircraft Branch, USAF

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*"Sic" indicates that table entry for the unit and/or home station has not been verified.

Table 6-6: DISTRIBUTION OF GAMMA RADIATION EXPOSURES FOR SCIENTIFIC PERSONNEL, CONTRACTORS AND AFFILIATES

Affiliation	Personnel Identified By Name	Personnel Identified By Name and By Film Badge	Average Gamma Exposure (Roentgens)	Gamma Exposure (Roentgens)				
				<.1	.1-1.0	1.0-3.0	3.0-5.0	5.0+
Armed Forces Special Weapons Project	6	6	0.510	3	2	1	0	0
Armour Research Foundation	4	4	0.430	3	0		0	0
Bendix Aviation	7	7	0.631	5	1	0	1	0
General Dynamics, Convair Division	1	1	3.270	0	0	0	1	0
Radiation, Inc.	19	19	0.025	17	2	0	0	0
Stanford Research Institute	20	20	1.058	7	2	11	0	0
University of California, Los Angeles	30	30	0.473	14	11	5	0	0
Other*	36	35	0.143	25	10	0	0	0
TOTAL	123	122	0.437	74	28	18	2	0

*For list of units in this category, see table 6.6a

TABLE 6-6a: DETAILED LISTING OF "OTHER" CATEGORY, SCIENTIFIC PERSONNEL, CONTRACTORS AND AFFILIATES

Allied Research Associates
Bell Telephone Laboratories
Columbia University
Directorate of Weapons Effects Tests
Eberline Institute
(The) Los Angeles Examiner
(The) New York Times
Office of Civil Effects - Armed Forces Special Weapons Project
Office of Civil Engineers
Radiation Safety - Off Site (sic)*
Raydist Navigation Corporation
Reeves Instrument Corporation
Review Journal, Las Vegas, NV
Scripps Institute of Oceanography
University of Illinois
University of Rochester
Unknown
Western Air Defense Command
World News

*"Sic" indicates that table entry for the unit and/or home station has not been verified.

Table 6-7: FILM BADGE READINGS EXCEEDING ESTABLISHED LIMITS FOR JTO PARTICIPANTS AT OPERATION TEAPOT

Unit	Number of Personnel	Total Exposures (Roentgens)*
Air Force Special Weapons Center	2	12.3. 21.8””
Bendix Aviation	1	4.1
Chemical and Radiological Laboratories	12	4.0, 4.0, 4.1, 4.2, 4.4, 4.5, 4.9, 5.9, 5.9, 6.2, 6.5, 8.4
Detroit Arsenal	1	5.8
Development and Proving Services, Aberdeen Proving Ground	1	4.0
Directorate of Weapons Effects Test	1	4.0
Engineering Research and Development Laboratory	1	6.0
Evans Signal Laboratory	1	4.3
Headquarters, Chemical Corps Training Command	1	4.0
Headquarters, 312th Fighter Bomber Group	1	4.4
Naval Medical Research Institute	1	4.4
Naval Radiological Defense Laboratory	3	4.0, 4.1, 4.2
Naval Research Laboratory	4	10.8, 11.5, 12.1, 12.4
U.S. Air Force Radiological Laboratory	1	4.2
1st Radiological Safety Support Unit	18	4.2, 4.2, 4.3, 4.4, 4.5, 4.5, 4.6, 4.9, 5.0, 5.0, 5.7, 6.7, 7.2, 7.7, 8.0, 9.6, 16.0, 19.3
2nd Chemical Weapons Battalion	1	7.1
345th Troop Carrier Squadron	2	5.3. 5.6
346th Troop Carrier Squadron	1	6.2
347th Troop Carrier Squadron	1	6.5
479th Supply Squadron	1	4.7
644th Troop Carrier Squadron	1	4.0
3080th Aviation Depot Group	2	4.0, 4.1
3081 st Aviation Depot Group	1	4.0
3082nd Aviation Depot Group	1	4.4
3083rd Aviation Depot Group	2	4.1, 5.1
3084th Aviation Depot Group	1	4.0
4926th Test Squadron	4	4.2, 4.2. 10.6. 21.7**
Unit Unknown, Army	4	4.0, 4.0, 4.2, 4.6
TOTAL	71	

* Exposures rounded to nearest tenth of a roentgen.
** Special 15.0-roentgen limit authorized by the test manager.

OPERATION TEAPOT BIBLIOGRAPHY

The following bibliography represents all the documents cited in the TEAPOT Series volumes. When a DASA-WT or DNA-WT document is followed by an EX, the latest version has been cited.

AVAILABILITY INFORMATION

An availability statement has been included at the end of the reference citation for those readers who wish to read or obtain copies of source documents. Availability statements were correct at the time the bibliography was prepared. It is anticipated that many of the documents marked unavailable may become available during the declassification review process. The Coordination and Information Center (CIC) and the National Technical Information Service (NTIS) will be provided future DNA-WT documents bearing an EX after the report number.

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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 — Phone: (702) 734-3194
Las Vegas, Nevada 89114 — FTS: 598-3194

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Springfield, Virginia 22161 — (Sales Office)

Additional ordering information or assistance may be obtained by writing to the NTIS, Attention: Customer Service, or by calling (703) 487-4660.

1. "Report of the Committee to Study Nevada Proving Grounds." C. L. Tyler, Chairman. 02/01/54. 62 Pages.**

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ATTN: Gov Docs Coll

Hawaii State Library
ATTN: Fed Docs Unit

University of Hawaii at Monoa
ATTN: Dir of Libraries (Reg)

University of Hawaii
Hilo Campus Library
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Haydon Burns Library
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Hennepin County Library
ATTN: Gov Docs

Henry Ford Community College Library
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OTHER (Continued)

Herbert H. Lehman College
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Hofstra University Library
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Hollins College
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Hopkinsville Community College
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Wagner College
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University of Houston Library
ATTN: Docs Div

Houston Public Library
ATTN: Librn

Tulane University
ATTN: Docs Dept

Hoyt Public Library
ATTN: Librn

Humboldt State College Library
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Huntington Park Library
ATTN: Librn

Hutchinson Public Library
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Idaho Public Library & Information Center
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Idaho State Library
ATTN: Librn

Idaho State University Library
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University of Idaho
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University of Illinois Library
ATTN: Docs Sec

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Illinois Valley Community College
ATTN: Library

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Indiana State Library (Reg)
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Lakewood Regional Library
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Jersey City State College
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Doc Sec

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Kansas State Library
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Affairs Library

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Lancaster Regional Library
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Brigham Young University
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Lewis University Library
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Little Rock Public Library
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Long Beach Public Library
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Nebraska Public Clearinghouse
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Nebraska Western College Library
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New York Public Library
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New York State Library
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University of Denver
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Providence Public Library
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Public Library of Nashville and Davidson County
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University of Puerto Rico
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Auburn University
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University of Vermont
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Wayne State University Law Library
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Weber State College Library
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West Chester State College
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West Hills Community College
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West Texas State University
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West Virginia College of Grad Studies Library
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University of West Virginia
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Western Carolina University
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Westmoreland City Community College
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William College Library
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Williamantic Public Library
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Winthrop College
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University of Wisconsin at Whitewater
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University of Wisconsin at Milwaukee
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University of Wisconsin at Oshkosh
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University of Wisconsin at Platteville
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