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SHOTS WASP TO HORNET

The First **Five** TEAPOT Tests

18 FEBRUARY -12 MARCH 1955



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United States Atmospheric Nuclear Weapons Tests
Nuclear Test **Personnel** Review

Prepared by the Defense **Nuclear Agency** as Executive Agency
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes the activities of DOD personnel, both military and civilian, in Shots WASP, MOTH, TESLA, TURK, and HORNET, the first five events of the TEAPOT atmospheric nuclear weapons test series. The tests were conducted from February 18 to March 12, 1955 and involved participants from Exercise Desert Rock VI, AFSWP, AFSWC, AEC nuclear weapons development laboratory test groups, and the Civil Effects Test Group. This volume also describes the radiological safety activities undertaken at each of these five shots.		

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18. S U P - NOTES (Cont.)

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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 weapons test, the Center for Disease Control* noted a possible leukemia cluster among a small group of soldiers 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 nuclear 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 nuclear weapons tests 15 to 30 years earlier. DOD organized an effort to :

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

*The Center for Disease Control, an agency of the U.S. Department of Health and Human Services (formerly the U.S. Department of Health, Education, and Welfare).

- 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 the first five shots of Operation TEAPOT is based on the historical record of military and technical documents associated with each of the nuclear weapons tests. These reports provide a public record of the activities and possible radiation exposure of DOD personnel for ongoing public health research and policy analysis.

Many of the documents pertaining specifically to DOD involvement during the first five TEAPOT tests were found in the Defense Nuclear Agency Technical Library, the National Federal Archives Record Center, the Department of Energy Nevada Operations Office, and the Los Alamos Scientific Laboratory (LASL).

In some cases, the surviving historical documentation of activities conducted at Shots WASP, MOTH, TESLA, TURK, and HORNET addresses test specifications and technical information rather than the personnel data critical to the study undertaken by the Defense Nuclear Agency. 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.

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 Parson's 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. Fackler's Technical Air Operations report is a detailed document chronicling only the air operational activities of the Air Force, Army, Navy, and Marine Corps. 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.

For several of the Desert Rock VI and Joint Test Organization (JTO) projects discussed in the TEAPOT volumes, the only historical documents available are the Sixth Army's Desert Rock VI Operations Orders and the Test Director's schedule of events from "Operation Order 1-55." These sources detail the plans developed by DOD and AEC personnel prior to the TEAPOT Series; they do not 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. Therefore, it is not known if all of the projects addressed in the planning documents and discussed in this volume were conducted exactly as planned.

ORGANIZATION AND CONTENT OF TEAPOT SERIES REPORTS

This volume details participation by DOD personnel in the first five events of the Operation TEAPOT nuclear weapons testing series. Four other publications address DOD activities during the TEAPOT Series:

- Series Volume: Operation TEAPOT, Atmospheric Nuclear Weapons Tests, 1955
- Shot Volume: Shot BEE
- Multi-shot Volume: Shots ESS to MET and Shot ZUCCHINI, the Final TEAPOT Tests
- Shot Volume: Shot APPLE 2.

The volumes addressing the test events of Operation TEAPOT are 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, the TEAPOT Series volume contains a bibliography of works consulted in the preparation of all five Operation TEAPOT reports. The 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 VI maneuvers involving large numbers of DOD participants. 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 the TEAPOT Series volume.

One supplement to the information in this report is the Reference Manual: Background Materials for the CONUS

Volumes, which summarizes information on radiation physics, radiation health concepts, exposure criteria, and measurement techniques, as well as listing acronyms and a glossary of terms used in the DOD reports addressing test events in the continental U.S.

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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"
CBR	Chemical, Biological, Radiological
CETG	Civil Effects Test Group
CONUS	Continental United States
DOD	Department of Defense
DWET	Director Weapons Effects Tests
EG and G	Edgerton, Germeshausen, and Grier
FCDA	Federal Civil Defense Administration
GZ	Ground Zero
IBDA	Indirect Bomb Damage Assessment
JTO	Joint Test Organization
LASL	Los Alamos Scientific Laboratory
MEG	Military Effects Group
MSL	Mean Sea Level
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

CHAPTER 1

INTRODUCTION

Shots WASP, MOTH, TESLA, TURK, and HORNET were tests of nuclear devices conducted from 18 February to 12 March 1955 at the **Nevada** Test Site (NTS), the U.S. Atomic Energy Commission (AEC) continental nuclear test site located northwest of Las Vegas. These were the first five nuclear detonations of Operation TEAPOT, a series of 14 nuclear weapons tests and one non-nuclear test performed from 18 February to 15 May 1955.

The five nuclear devices were tests sponsored and developed for the AEC by either the Los Alamos Scientific Laboratory (LASL) or the University of California Radiation Laboratory (UCRL), the two AEC nuclear weapons development laboratories. The primary objective of the five tests was to study the nuclear yield and the blast, thermal, and radiation phenomena produced by the devices. To fulfill this objective, LASL and UCRL test groups conducted scientific experiments to measure the physical characteristics of the detonations. The Armed Forces Special Weapons Project (AFSWP) Field Command Military Effects Group conducted effects tests to evaluate the utility of the five devices for military applications, and to investigate additional specifications for future nuclear weapons development.

A number of other test activities related to the conditions and phenomena produced by a nuclear detonation were also conducted at the tests. The Department of Defense (DOD) conducted operational training projects and the Federal Civil Defense Administration (FCDA) Civil Effects Test Group conducted projects to assess the effects of nuclear detonations on civilian populations, products and food supplies, and to evaluate Civil Defense emergency preparedness plans. The armed services also

fielded projects to evaluate military equipment and tactics as part of Exercise Desert Rock VI, the Army technical testing and training program at Operation TEAPOT.

Table 1-1 summarizes the first five tests of the TEAPOT Series including sponsors, detonation dates, the UTM coordinates* of the detonation points, and the heights of burst.+ Figure 1-1 displays a map of the NTS in 1955, with the positions of each of the TEAPOT tests.

1.1 DEPARTMENT OF DEFENSE INVOLVEMENT IN JOINT TEST ORGANIZATION ACTIVITIES AT THE FIRST FIVE TEAPOT EVENTS

The Joint Test Organization was established for planning, coordinating, and conducting all nuclear weapons tests during Operation TEAPOT.

All activities were under the control of an AEC-appointed Test Manager. Comprised of personnel from the AEC, the DOD, and the FCDA, the JTO included representatives from the AFSWP Field Command Military Effects Group, the LASL test group, the UCRL test group, and the FCDA Civil Effects Test Group.

In addition to scientific experiments and effects, the DOD conducted operational training projects and support activities. Two areas of support for JTO in which DOD personnel were active were the 1st Radiological Safety Support Unit of Fort McClellan,

*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 refer to a point on a north-south axis. The point so designated is the southwest corner of an area 100 meters square.

+Altitudes are measured from mean sea level (MSL) while heights are measured from the ground. All vertical distances are given in feet. Yucca Flat, the area of the NTS where these five events were tested, is about 4,000 feet above mean sea level.

Table I-I: SUMMARY OF THE FIRST FIVE OPERATION TEAPOT EVENTS

1955

Shot	WA	MO	T ES	TURK	HORNET
Sponsor	LASL	LASL	UCRL	UCRL	LASL
Planned Date	18 Feb	22 Feb	25 Feb	15 Feb	8 March
Actual Date	18 Feb	22 Feb	1 March	7 March	12 March
Local Time	1200	0545	0530	0520	0520
NTS Location	Area 7	Area 3	Area 9	Area 2	Area 3
UTM Coordinates	869047	871004	844090	784104	867996
Type of Detonation	Airdrop	Tower	Tower	Tower	Tower
Height of Burst (Feet)	762	300	300	500	300
Yield (Kt.)	1	2	7	43	4

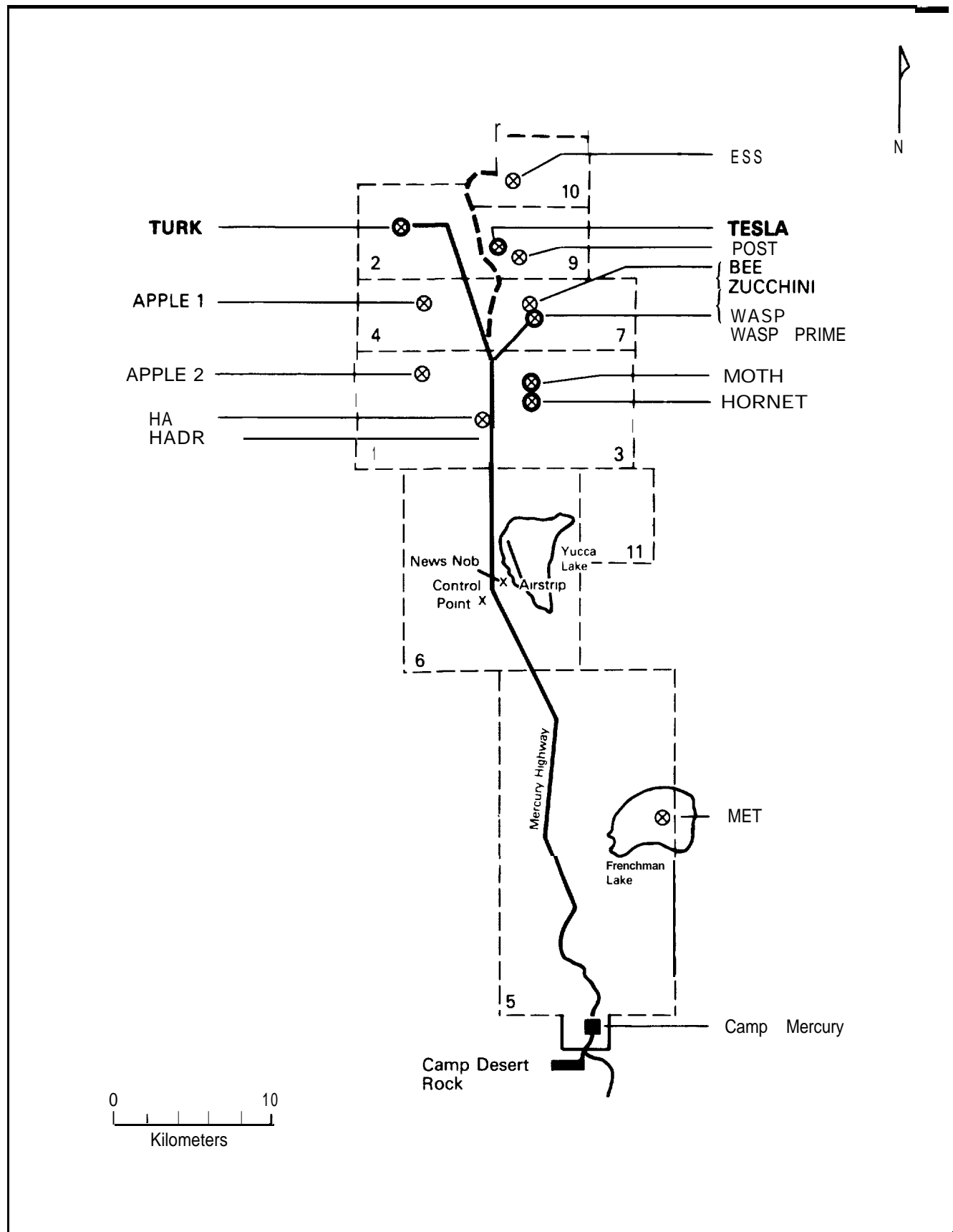


Figure I-I: LOCATION OF SHOTS WASP, MOTH, TESLA, TURK, AND HORNET AT THE NEVADA TEST SITE IN RELATION TO OTHER SHOTS IN THE TEAPOT SERIES

Alabama, with 112 soldiers providing onsite radiological safety monitoring, and AFSWC air and ground personnel providing air traffic control and air support.

Overall, the most extensive DOD participation in the JTO test groups was in the Military Effects Group, designed to study yield and weapons effects characteristics in order to understand the militarily useful effects of nuclear weapons for offensive and defensive deployment. Personnel from DOD agencies and the four armed services participated in the experiments conducted by LASL, UCRL, and CETG, but participation was limited and difficult to determine. The major portion of DOD participation in these three civilian test groups was performed by the AFSWC 4926th Test Squadron (Sampling) in LASL and UCRL radiochemistry cloud sampling projects.

The DOD operational training projects, designed to test service tactics and materiel, and to train military personnel in nuclear detonation effects, were performed at each of the five shots. Most of the projects were conducted from aircraft and often involved only the aircraft pilots and air-crews.

The Air Force Special Weapons Center (AFSWC), based at Kirtland Air Force Base, New Mexico, exercised operational control of all aircraft flying during the TEAPOT Series and provided air support to the JTO and the various JTO Test Manager and test group projects. AFSWC was composed of units of the 4925th Test Group (Atomic), including the 4926th Test Squadron (Sampling) and the 4935th Air Base Group. These units operated out of Indian Springs Air Force Base, about 38 kilometers southeast of the NTS, and were supported by the 4900th Air Base Group* stationed at Kirtland AFB.

*Prior to 5 May 1955, the 4900th Air Base Group was called the 4901st Air Base Wing. Because the group ended the series as the 4900th, it will be called the 4900th Air Base Group throughout the volume.

Radiation protection procedures established by the JTO are detailed in the accompanying TEAPOT Series volume. These safety procedures were designed to minimize exposure to ionizing radiation by limiting exposures to 3.9 roentgens of whole-body gamma for any 13-week period and 15 roentgens annually. The 1st Radiological Safety Unit controlled access to radiation areas within the NTS after each detonation. JTO project personnel recovering test instruments from radioactive areas were accompanied by radiological safety monitors who continuously surveyed the radiation intensity in the recovery area and alerted project leaders if intensities were too high or the length of time in the area was too long. To monitor cumulative exposures, project personnel were issued film badges to wear at all times when in the shot areas. These film badges were collected, developed, and evaluated at certain intervals. Any individual whose accumulated dose approached or exceeded the established limits was barred from further access to the forward test area. The 1st Radiological Safety Support Unit also implemented personnel decontamination procedures and prepared emergency evacuation plans for all test events, although none were necessary (19).*

The radiation protection procedures for AFSWC included the same exposure limits for aircrews and ground-crew personnel as those established for JTO personnel during these five tests. Complete decontamination, including removal of protective clothing and showers, was required of all aircrew members after each project mission, regardless of the exposure received on the flight. Aircraft were decontaminated by washing or were isolated until radiation intensities had decayed to acceptable levels.

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

1.2 EXERCISE DESERT ROCK VI ACTIVITIES AT THE FIRST FIVE TEAPOT EVENTS

Most of the DOD personnel involved in Shots WASP, MOTH, TESLA, TURK, and HORNET were participants in the projects fielded by Exercise Desert Rock VI, the Army training program conducted during Operation TEAPOT. These projects included troop orientation and indoctrination projects, troop tests, and technical service projects.

In addition to the Desert Rock Exercise troops, Camp Desert Rock troops from various Army units provided communications, transportation, traffic control, and radiological safety monitoring for Desert Rock projects at the five shots. Soldiers from the 50th Chemical Platoon (Service) provided radiological safety monitoring for Desert Rock personnel in the shot areas following each detonation.

Radiation protection procedures for Exercise Desert Rock VI, as well as those for the JTO, are detailed in the TEAPOT Series volume. They were designed to minimize potential exposure to ionizing radiation, while allowing participants to accomplish their project objectives. Camp Desert Rock personnel and exercise participants were limited to six roentgens of gamma radiation during any six-month period. The radiation protection procedures of Exercise Desert Rock VI included provisions for (19; 42):

- Maintaining minimum safe distances from nuclear detonations
- Enforcing protective procedures for personnel observing the detonation
- Controlling access to radiation areas
- Monitoring individuals working in radiation areas
- Film badging and monitoring the cumulative exposure of Desert Rock personnel
- Decontaminating all equipment and personnel leaving the shot area after each detonation (19; 42).

The remaining five chapters of this report address each of the first five TEAPOT tests in turn. Each chapter describes the specific setting and characteristics of the detonation, details DOD personnel activities in the military effects, scientific, training and support activities performed by Exercise Desert Rock VI, JTO test groups, and the Air Force Special Weapons Center, and discusses the radiological protection procedures implemented to minimize the potential for unauthorized exposures to ionizing radiation. Details of the overall radiological protection program at Operation TEAPOT are provided in the Series volume.

WASP

SHOT SYNOPSIS

AEC TEST SERIES: TEAPOT
DOD EXERCISE: Desert Rock VI
DATE/TIME: 18 February 1955, 1200 hours
YIELD: 1 kiloton
HEIGHT OF BURST: 762 feet (airdrop)

Purpose of Test: To test nuclear weapons for possible inclusion in the nuclear arsenal.

DOD Objectives: (1) To study the effects of a nuclear weapon on military equipment, materiel, structures, and ordnance
(2) To allow DOD personnel to observe a nuclear detonation
(3) To evaluate military equipment as affected by the nuclear environment.

Weather: At shot-time, the temperature was - 5.5°C; pressure was 846 millibars surface winds from the northwest at 23 knots and 96 knots from the northwest at 20,000 feet.

Radiation Data: At the time of the initial survey, 1248 to 1315 hours on shot-day, onsite fallout greater than 0.01 R/h was confined to a relatively circular area extending up to two kilometers from ground zero. Fallout of 10.0 R/h was detected about 300 meters around ground zero.

Participants: Exercise Desert Rock VI participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 2

SHOT WASP

Shot WASP, the first nuclear test of Operation TEAPOT, was detonated with a yield of one kiloton on 18 February 1955 at 1200 hours (29; 34). Developed by the Los Alamos Scientific Laboratory (LASL), WASP was the first of three airdropped nuclear devices in the TEAPOT Series. A B-36 aircraft staging from Indian Springs Air Force Base (AFB) delivered the WASP device, which was detonated at an altitude of 762 feet above Area 7 of the Nevada Test Site (NTS), at UTM coordinates 869047. The actual ground zero was 129 meters from the intended ground zero (29; 32; 34).

The WASP nuclear cloud top reached a height of 21,500 feet MSL. Radioactivity of 0.01 R/h (roentgens per hour) was limited to an area extending 1,800 meters* to the north of ground zero (29; 32; 34).

Department of Defense participants at Shot WASP took part in Exercise Desert Rock VI activities, scientific and military effects experiments, and support missions, as described in this chapter. An account of the radiological situation created by Shot WASP, along with the procedures used to minimize the exposure of DOD participants to ionizing radiation, is summarized at the end of the chapter.

*Throughout this report, surface distances are given in metric units. The metric conversion factors include: 1 meter = 3.28 feet; 1 meter = 1.09 yards; 1 kilometer = 0.62 miles.

2.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT WASP

Desert Rock exercise and support troops took part in five troop orientation and indoctrination projects and two technical service projects conducted at Shot WASP. Table 2-1 lists Desert Rock VI programs and presents the numbers and titles of the projects, the estimated numbers of DOD participants, and the participating units involved in the projects.

Table 2-1: EXERCISE DESERT ROCK VI PROJECTS, SHOT WASP

Program Type	Project	Title	Estimated Personnel	Participants
Troop Orientation and Indoctrination	41.3	Army Observers	697	Army
	41 4	Navy Observers	146	Navy
	40 11	Marine Corps Doctrine and Tactics (Observers)	28	Marine Corps
	41 8	Air Force Observers	105	Air Force
		Camp Desert Rock Observers	47	Camp Desert Rock Support Troops
Technical Service	40 19	Sixth Army CBR Defense Team Training	24	Sixth Army
	40 21	Ordnance Vehicular Equipment Test	*	Ballistic Research Laboratories, 573rd Ordnance Company, Chemical Warfare Laboratory, Detroit Arsenal

* Unknown

2.1.1 Troop Orientation and Indoctrination Projects

More than 1,000 Desert Rock exercise and support troop observers took part in the Troop Orientation and Indoctrination Program at WASP. All observers, including the Camp Desert Rock

support troops who were not assigned to a specific project, took part in the same orientation and training activities for the event. The observers were scheduled to view the detonation from trenches 4,500 meters south of ground zero and then tour the equipment display area. Because of a change in the wind direction, the observer trenches were in the predicted path of fallout, and the observation point was changed on shot day. Observers witnessed Shot WASP from News Nob, near the Control Point at Yucca Pass, approximately 14 kilometers south of ground zero. The equipment display area was also in the path predicted for the fallout and the postshot tour of the display area was canceled (35; 42; 46).

2.1.2 Technical Service Projects

Project 40.19 Sixth Army CBR Defense Team Training, was designed to determine the radiological capabilities of Chemical, Biological, and Radiological (CBR) defense survey teams and to test CBR radiological monitoring equipment.

On 24 February, six days after the WASP detonation, two CBR teams, totaling 24 individuals, performed a radiological defense survey at areas around ground zero. The teams, who concurrently surveyed the Shot MOTH site, monitored the area to establish the 2.0 and 1.0 R/h lines. They found that the 2.0 R/h line was located 90 meters from ground zero. The two teams then proceeded to survey the Shot MOTH area located to the south (49).

Project 40.21, Ordnance Vehicular Equipment Test, was sponsored by the Ballistic Research Laboratories. Its objectives were to determine how well roll-over safety bars minimized damage to wheeled vehicles, to obtain experimental design data for the future development of ordnance equipment, and to investigate the shielding effect of armor against gamma radiation. To achieve

the desired objectives, the following equipment was displayed at various positions in the display area (42):

- Three M48 tanks
- One M59 armored infantry vehicle
- One T97 self-propelled gun
- Six jeeps
- Six 2.5-ton cargo trucks
- Four 5-ton trucks.

The principal participant in the project was a detachment from the 573rd Ordnance Company, which placed the test equipment. Ballistic Research Laboratories personnel from AFSWP Project 3.1 recorded blast pressures with gauges located near the Project 40.21 test equipment, while Chemical Warfare Laboratories personnel from AFSWP Project 2.7 took radiation measurements. Detroit Arsenal personnel helped place the test vehicles (6; 42; 75; 90).

2.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT WASP

In addition to the Exercise Desert Rock activities described in the previous section, Department of Defense personnel performed a variety of tasks during Shot WASP that required them to enter the forward area before, during, or after the shot.

DOD personnel performed the 21 projects sponsored by the Field Command Military Effects Group and assisted in other projects sponsored by the Los Alamos Scientific Laboratory (LASL) test group and the Civil Effects Test Group (CETG). The Air Force conducted two operational training projects. In addition, the Air Force Special Weapons Center (AFSWC) flew missions for both the test groups and the Test Manager.

2.2.1 Department of Defense Participation in Military Effects Group Projects

At Shot WASP, the Military Effects Group of AFSWP Field Command conducted the projects listed in table 2-2 by number and title. This table identifies the fielding agencies and the estimated numbers of DOD participants. Because in most cases, many of the same personnel performed both pre- and postshot activities, estimates reflect the maximum number of DOD participants who would have been involved in the project. For example, if the project description states that 15 individuals performed preshot activities and five performed postshot recovery, the estimate noted in the table would be 15. The Test Manager allowed recovery operations to begin at 1335 hours, 95 minutes after the shot (19).

Project 1.2, Shock Wave Photography, was conducted to photograph the progression of the blast-wave produced by Shot WASP. Two camera stations were used, one 3,100 meters and the other 4,400 meters from ground zero. The stations, which were unmanned at shot-time, were well outside the 0.01 R/h line determined by the radiological safety surveys following the detonation. Two personnel probably spent two hours recovering the film from the camera stations late on shot-day (65; 69; 76).

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was to measure air-pressure variations produced by a nuclear detonation. Self-recording pressure gauges and pressure-time instruments were placed along a line extending southwest of the intended ground zero at distances ranging from 75 to 600 meters. Preshot surveys, construction of instrumentation mounts, installation, and checks of gauges probably took five personnel two weeks. Postshot recovery of data was probably accomplished at the farthest station on shot-day, by two project personnel in four hours. Recovery of the data from the stations closer to ground zero was probably accomplished in two days by three personnel when radiation levels had decayed substantially (28; 65; 69; 89).

**Table 2-2: TEST GROUP PROJECTS WITH DEPARTMENT OF
DEFENSE PARTICIPATION, SHOT WASP**

Project	Title	Participants	Estimated Personnel
Military Effects Group			
12	Shock Wave Photography	Naval Ordnance Laboratory	2
1 14b	Measurements of Air-blast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	5
21	Gamma Exposure versus Distance	Army Signal Corps Engineering Laboratories	2
	Neutron Flux Measurements	Naval Research Laboratory	6
23a	Neutron-Induced Radioactive Isotopes in Soils	Naval Radiological Defense Laboratory	2
24	Gamma Dose Rate versus Time and Distance	Evans Signal Laboratory	*
251	Fallout Studies	Chemical Warfare Laboratory, Army Chemical Center	3
26	Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field	Naval Medical Research Institute	8
27	Shielding Studies	Chemical Warfare Laboratory, Army Chemical Center	6
2Ba	Contact Radiation Hazard Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
31	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	24
61 la	Evaluation of Military Radiac Equipment	Army Signal Corps Engineering Laboratories	*
61 lb	Evaluation of a Radiological Defense Warning System	Army Signal Corps Engineering Laboratories	*
63	Missile Detonation Locator	Army Signal Corps Engineering Laboratories	*
64	Test of IBDA Equipment	Wright Air Development Center	14
84b	Thermal Measurements from Fixed Ground Installations	Naval Radiological Defense Laboratory	6
84c	Thermal Measurements Prior to the First Minimum	Naval Radiological Defense Laboratory	*
84d	Spectrometer Measurements	Naval Radiological Defense Laboratory	*
841	Bolometer Measurements	Naval Radiological Defense Laboratory	*
91	Technical Photography	Lookout Mountain Laboratory, AFSWC, Air Force Missile Test Center, EG and G	6
94	Atomic Cloud Growth Study	Air Force Cambridge Research Center, Strategic Air Command, U S Weather Bureau, EG and G	*

**Table 2-2: TEST GROUP PROJECTS WITH DEPARTMENT OF
DEFENSE PARTICIPATION, SHOT WASP (CONTINUED)**

Los Alamos Scientific Laboratory Test Group			
11 2	Radiochemistry Sampling	4926th Test Squadron (Sampling)	11
182	High Altitude Measurements	Naval Research Laboratory	*
184	Spectroscopy	Naval Research Laboratory	*
Civil Effects Test Group			
39 6	Measurement of Initial and Residual Radiations by Chemical Methods	Army Signal Corps Engineering Laboratories	5
39 7	Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects	School of Aviation Medicine	*

* Unknown

Project 2.1, Gamma Exposure versus Distance, evaluated the gamma-radiation exposure potential at various distances from a nuclear detonation. Project participants placed canisters with film packets in the predicted upwind sector of the WASP shot area. Fourteen canister stations were located 1,820 meters to 2,700 meters from the intended ground zero. At 1505 hours, 90 minutes after recovery operations were allowed to begin, two personnel in one vehicle began recovering the dosimeters. All dosimeters were recovered. This activity took an estimated 15 minutes (37; 65; 69).

Project 2.2, Neutron Flux Measurements, evaluated the neutron-radiation exposure potential at various distances from a nuclear detonation. Neutron-detection instruments were arranged on stakes located 290, 420, 630, 790, 890, and 990 meters northwest and north of the intended ground zero. Some neutron detectors were also placed in the immediate area of ground zero and attached to a 270-meter cable laid away from ground zero. In addition, five canisters of instruments were dropped from the B-36 aircraft that delivered the WASP device.

To obtain valid results from this project, the **neutron-**detection instruments had to be analyzed as soon after exposure as possible. Therefore, the Test Manager allowed a six-man team to follow the initial **postshot** radiological survey team into the shot area ten minutes after the detonation to recover the neutron detectors. Traveling in two vehicles, the team was accompanied by the Project 39.7 recovery party. The cable was pulled out of the area before the detectors were detached and collected. Personnel also retrieved the canisters that had been dropped from the aircraft. The six project personnel spent about 30 minutes in the shot area performing recovery operations, which were completed by the day after the WASP shot. All neutron detectors were shipped to the Naval Research Laboratory for analysis (19; 39; 65; 69).

Project 2.3a, Neutron-induced Radioactive Isotopes in Soils, was designed to provide information on the gamma radiation induced in surrounding soil by neutrons produced from a nuclear detonation. Although no measurements of residual gamma spectra were made in the target area following Shot WASP, two individuals from the 1st Radiological Safety Support Unit dug soil samples from the ground in the general vicinity of ground zero within an hour after the shot. The soil samples were then transferred to sealed radiologically safe containers and returned for analysis to the laboratory at Camp Mercury (55; 65; 69).

Project 2.4, Gamma Dose Rate versus Time and Distance, was performed to evaluate the neutron-induced gamma radiation hazard at various times after a detonation. Three instrument stations were placed 395, 405, and 575 meters from ground zero. The first station was located south-southeast of ground zero, the second south, and the third north-northeast. The instruments at the two stations farthest from ground zero were recovered on shot-day to assess the influence of time and distance on gamma radiation exposures (19). The instruments placed closest to

ground zero were recovered in the days following the detonation (36; 65; 69).

Project 2.5.1, Fallout Studies, was performed to evaluate the radiation exposure potential created by fallout from a nuclear detonation. Immediately after recovery operations were permitted at 1335 hours, a helicopter with a pilot and three crew-members departed from the Control Point and proceeded to ground zero. Their first task was to obtain a sample of radioactive earth, by means of a bucket suspended from the helicopter on a 600-meter cable. Their second task was to conduct an aerial survey of the area with a probe suspended at the end of a 150-meter cable. They conducted additional radiological surveys of the shot area at two- and three-hour intervals until dark. The estimated time for this activity was one hour for the first survey and 30 minutes for each successive survey (65; 69; 84).

Project 2.6, Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field, measured radiation intensities of fallout. Participants placed masonite mannequins equipped with radiation detectors at various stations within the WASP fallout field after the detonation.

When the Test Manager allowed recovery operations to begin, two teams of project personnel, each consisting of four individuals in two vehicles, entered the shot area and placed five mannequins near the 0.2 R/h line, 520 meters from ground zero. The two teams spent about ten to 15 minutes in the fallout field. They could not place more instruments due to security restrictions in the shot area, which prevented the entry of these personnel. It is not known precisely when the party returned to recover the mannequins. However, standard procedures at other nuclear events suggest that they returned about two days after the detonation, when radiation intensities had decayed substantially (52; 65; 69; 73).

Project 2.7, Shielding Studies, was designed to evaluate the effectiveness of structures and equipment in reducing gamma and neutron hazards. Before the shot, project personnel placed two M59 armored personnel carriers with gamma film badges inside, at distances of 390 and 510 meters southwest of ground zero. At approximately 1600 hours on shot-day, four hours after detonation, three participants in one vehicle, accompanied by four Project 3.1 personnel, spent about one hour in the area recovering the film badges from the vehicles. Film badges were then sent to laboratories for processing (28; 65; 69; 90).

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was performed by at least five AFSWC personnel at Indian Springs AFB to assess the exposure potential presented by ground-crew contact with aircraft that had flown through a nuclear cloud. AFSWC F-84 sampler aircraft were tested after they completed their mission. Personnel held standard gamma-survey meters near the contaminated components of the aircraft to determine their radiation intensities. Several types of meters were used and their readings were compared. Radiation-decay studies were conducted up to 24 hours after the detonation. The general procedures for this project are described in the TEAPOT Series volume (26; 65; 69).

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, evaluated the ability of vehicles to withstand the precursor-enhanced blast effects of a nuclear detonation. Two 1/4-ton trucks were positioned at ground zero, and fourteen additional 1/4-ton trucks, 12 1/2-ton trucks, four 5-ton trucks, an M59 armored personnel carrier, and a T97 self-propelled 155mm gun were placed at distances ranging from 105 meters to 670 meters southwest of ground zero. At 2200 hours on the night before the WASP detonation, four project personnel in two vehicles entered Area 7 to activate gauges located from ground zero to 680 meters to the southwest. This task took about two-and-a-half hours to complete.

At 1600 hours on shot-day, three individuals in a vehicle spent about one hour recovering dosimeters from vehicles 390 meters and 510 meters from ground zero. This activity was performed in conjunction with Project 2.7. At 1935 hours on shot-day, five teams, totaling 20 to 24 personnel, used a bus and one other vehicle to recover instruments and photograph damage of the vehicles (6; 65; 69).

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 personnel, who checked the accuracy of the new instruments by comparing them with instruments currently in use (10; 65; 69).

Project 6.1.1b, Evaluation of a Radiological Defense Warning System (also known as Project CLOUDBURST), evaluated 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. During the WASP detonation, project personnel monitored equipment for this project at a station located west of the control point (65; 69; 78).

Project 6.3, Missile Detonation Locator, was fielded offsite and onsite to test the feasibility of a tactical range detonation-locator system. The system was designed to locate the point of a nuclear detonation by detecting and analyzing the electromagnetic radiation emitted by the detonation. The detonation locator consisted of broad-band receivers set up in California on baselines approximately 110 and 320 kilometers from the NTS. Radio links between the stations provided the time comparisons necessary to determine relative times of arrival of the electromagnetic pulse at each station. Crystal clocks were

used for accurate time-of-arrival analysis (42). Two stations at the NTS, at UTM coordinates 583408 and 583409, were manned at shot-time by project personnel (65; 69; 74).

Project 6.4, Test of IBDA Equipment, was designed to gather engineering evaluation data for an IBDA system installed in a B-50D aircraft. A second objective was to determine the maximum operating range of the yield-measuring component of the system. The B-50D IBDA system consisted of the standard radar set, AN/APQ-24; an experimental radar set, AN-APA-106 (XA-1); a recording set, light and time, AN/ASH-4 (XA-1); and a K-17 aerial camera. The B-50D usually had a crew of ten. Since engineering evaluation tests were being conducted, one additional engineer and one technician accompanied the crew to monitor and ensure the operation of the system. To accomplish the secondary objective, two F-94s, with two crewmen each, were instrumented with a recording set and a bomb-spotting camera. One F-94 aircraft aborted its mission because it was unable to get to its shot-time position due to communications problems with the Air Operations Center. The second F-94 participated; its position at shot-time was over Indian Springs AFB at an altitude of 20,000 feet. The aircraft was originally scheduled to be in a position 40 kilometers south of ground zero at shot-time, but was unable to attain this position due to communications failure (27; 65; 69).

Project 8.4b, Thermal Measurement from Fixed Ground Installations, was to measure the heat produced by a nuclear detonation. At 2330 hours on the night before the detonation, six persons in two cars calibrated and adjusted MK6F calorimeters and radiometers at stations 460 and 910 meters south of the intended ground zero in Area 7. In addition, project personnel manned instruments in Building 410 near the control point through detonation time to record data from the burst.

After the detonation, at 1335 hours, four participants in a vehicle proceeded to these two target area stations to pick up film and inspect instruments. These recovery personnel wore protective clothing and respiratory protection. Approximately one-half hour was required at each station to accomplish these activities (50; 65; 69).

Project 8.4c, Thermal Measurements Prior to the First Minimum, documented selected thermal radiation characteristics of nuclear detonations. Measurements were made at the delivery aircraft and in Building 410 near the Control Point area (51; 65; 69).

Project 8.4d, Spectrometer Measurements, was designed to measure changes in the spectral distribution of thermal radiation produced by a nuclear detonation. The recording instruments were located in Building 410, near the Control Point (65; 69; 80).

Project 8.4f, Bolometer Measurements, was to measure changes in the amount of heat produced at various times after a nuclear detonation. As with Projects 8.4c and 8.4d, all data were taken from Building 410, near the Control Point (54; 65; 69; 79).

Project 9.1, Technical Photography, provided documentary photography of the detonation. Ground photography was primarily the responsibility of Edgerton, Germeshausen, and Grier. Photographs were taken from an RC-47 aircraft. The aircraft, with a crew of three and an estimated three photographers, flew a six-minute holding-pattern ten to 16 kilometers southeast of ground zero at an altitude of 8,000 to 10,000 feet (30; 32; 65; 69). The RC-47 was operated by personnel from AFSWC and the Air Force Missile Test Center, under the supervision of the Lookout Mountain Laboratory. In addition to the RC-47, Project 9.1 arranged for aerial photographs to be taken from a B-50, possibly provided by Project 6.4.

Squadron (Sampling) aircraft at the same time that the pilots collected cloud samples for LASL Project 11.2. This activity is discussed under AFSWC operations, in the next section of this chapter (32).

2.2.5 Air Force Special Weapons Center Activities

Air Force Special Weapons Center support during the shot consisted of the airdrop mission, nuclear cloud sampling missions, sample courier flights, cloud tracking missions, and aerial surveys of terrain. The survey was not conducted by a C-47 for WASP because of the small size of the device and because the altitude of the detonation minimized the amount of contaminated earth drawn into the cloud. Instead, two H-19 helicopters were used for terrain survey activities, as described in section 2.3.

AFSWC personnel participated in these support missions. These personnel comprised ground-crews, radiological safety monitors, air-traffic controllers, and administrative staff. The following listing indicates the project, the mission, the type and number of aircraft, and the estimated number of DOD participants in AFSWC support missions at WASP (32):

PROJECT	MISSION	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	ESTIMATED DOD PERSONNEL
11.2/ 40.8	Airdrop	B-36		12
	Cloud Sampling			
	Sampler Control	B-50	1	9
	Sampler	F-84G	6	6
	Courier Service	c-47	2	6
		c-119	2	8
	Cloud Tracking	B-25	1	5
		B-50	1	12
	Aerial Surveys of Terrain	H-19	2	10

Airdrop of the WASP Nuclear Device

The WASP device was dropped from a B-36 aircraft, which probably carried 12 crewmen. The WASP detonation was originally scheduled for 0730 hours. However, the drop aircraft encountered mechanical difficulties prior to takeoff. As a result, the WASP nuclear device was transferred to an alternate B-36 aircraft, and the shot-time was postponed to 1130 hours. The aircraft left Indian Springs AFB and entered a holding pattern over the WASP target area at 20,000 feet MSL. After five dry runs over this target area, a final bombing run was attempted for the scheduled 1130 shot-time. Due to cloud coverage, however, the bombardier could not maintain visual contact with the target. The aircraft attempted two more bombing runs before the cloud coverage allowed visual contact with the target, permitting the bombardier to finally release the WASP device at 1200 hours. After completing its mission, the drop aircraft returned to Indian Springs AFB (32; 33).

Cloud Sampling

At WASP, six F-84G aircraft, each with a pilot, collected particulate and gaseous samples of the nuclear cloud for LASL Project 11.2, Radiochemistry Sampling, and Air Force Project 40.8, Calibration of Bomb Debris. A B-50 aircraft, with an estimated crew of nine, including a scientific adviser from LASL, acted as the sampler control aircraft. Four of the F-84G aircraft collected samples at altitudes between 12,000 and 17,000 feet. The first aircraft began sampling 52 minutes after the detonation, and the last aircraft began its mission one hour and 45 minutes after the detonation. There is no record of the length of time spent by the other two F-84Gs in collecting samples. The following listing presents information on the sampling mission of the six F-84Gs (32; 33).

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)*
F-84G #038	4	0:34	35.0
F-84G #043	4	1:10	10.0
F-84G #046	3	Not documented	0.5
F-84G #049	3	Not documented	0.5
F-84G #053	—	Not documented	Not documented
F-84G #054		Not documented	Not documented

Courier Service

Within four hours after the WASP detonation, four aircraft left Indian Springs AFB to transport samples to McClellan AFB, Alabama; Kirtland AFB, New Mexico; and Bolling AFB, Washington, D.C., for analysis by DOD and AEC laboratories. These courier missions were conducted by the 4901st Support Wing (Atomic) from Kirtland AFB. One C-47 transported cloud particle samples for Project 40.8 to McClellan AFB. Another C-47 flew filter samples to Bolling AFB for AFSWP Projects 2.2 and 2.7. A C-119 delivered cloud particle samples for LASL to Kirtland AFB. Another C-119 transported samples to Kirtland AFB (32; 33).

Cloud Tracking

The B-50 sampler control aircraft and a B-25 from Indian Springs AFB flew cloud-tracking missions at WASP. The B-50 after

*Roentgens per hour

completing its part of the sampling mission, tracked the cloud at an altitude of 20,000 feet, while the B-25 flew at about 8,000 feet. The aircraft followed the cloud for two hours in a southeasterly direction along U.S. Route 95 to a point southeast of Las Vegas, Nevada (32; 33)

Aerial Surveys of Terrain

No aerial surveys of terrain were performed **offsite** at Shot WASP due to the small size of the device and the altitude of the burst, which minimized the amount of contaminated earth drawn into the cloud. However, two H-19 helicopters were used to perform **onsite** surveys, as described in section 2.3 (32; 33).

2.3 RADIATION PROTECTION AT SHOT WASP

The purpose of the various radiation protection procedures for Operation TEAPOT was to ensure that individual exposure to ionizing radiation was as low as possible, while allowing participants to achieve the requirements of each activity. Some of the procedures described in the Series volume resulted in records which enabled Exercise Desert Rock, the Joint Test Organization, and AFSWC to evaluate the effectiveness of their procedures. Such records, which include film badge data, logistical data on radiological safety equipment, survey results and records, isointensity maps, and decontamination records, have been located for WASP for the Joint Test Organization only. The JTO **Onsite** Radiological Safety Organization was staffed by the Army's 1st Radiological Safety Support Unit, from Ft. McClellan, Alabama, and was managed by AFSWP.

Dosimetry

During the **period** of 13 to 20 February 1955, which covers the 18 February detonation of WASP, the Dosimetry and Records Section of the NTO radiological safety unit issued 1,373 film badges and 347 pocket dosimeters.

Available film-badge readings indicate that during this period of time, one individual accumulated an exposure greater than 2.0 roentgens but less than the JTO-authorized limit of 3.9 roentgens. Another individual had a total exposure greater than 3.9 roentgens, and he was excluded from entry into radiation areas for the remainder of the operation. Documentation concerning the extent and circumstances of this individual's overexposure has not been found (19).

Two pilots from the 4926th Test Squadron received exposures of 0.22 and 0.12 roentgens during the Shot WASP cloud-sampling mission. None of the four other F-84G pilots involved in cloud sampling during this shot received any detectable film-badge exposures (32).

Logistics

The General Supply section issued 780 pieces of protective clothing and 72 respirators. In addition, the Instrument Repair Section issued 177 radiacs and radiation detection instruments (19).

Monitoring

During Shot WASP, monitoring included both ground and aerial surveys. The initial survey party consisted of five teams totaling ten personnel. The aerial survey was conducted from two H-19 helicopters by two **teams**, each consisting of two Air Force pilots, two monitors, and one probe operator from Program 2 (32).

At 1202 hours, two minutes after the shot, the initial survey party and a two-man patrol team left the Control Point to begin their surveys. The north patrol and the initial survey party were detained by security guards at a checkpoint immediately north of the Radiological Safety Building until 1231. The 0.01 R/h isointensity area extended beyond areas staked out earlier by radiological safety monitors in all directions. As a

result the survey teams used their vehicle odometers to measure distances beyond the staked lines. They completed their survey of the test area by 1315 hours. A copy of the initial isointensity map is shown in figure 2-1. The helicopter survey teams could not take accurate readings because of high winds (19; 32).

After the ground survey teams located 0.01 and 0.1 R/h isointensities on all roads leading to the shot area, two participants placed signs identifying these radiation levels. The two-man checkpoint teams set up area access checkpoints on the roads leading into the shot area, and the main checkpoint was established at 1337 hours at the BUSTER-JANGLE "Y". Three monitors remained at this checkpoint (19).

Resurveys of the shot area were conducted at about 1700 hours on 18 February and at 1000 hours on 19 February. Copies of the isointensity maps generated from these resurveys are shown in figure 2-2. In a final survey, begun at 1200 on 25 February, the maximum intensity found was 0.008 R/h. The average exposure received by personnel of the survey teams entering the shot area on both the initial and first resurvey was 0.62 roentgens. Each monitor wore a film badge (19).

In addition to its survey work, the Monitoring Section provided monitors to projects conducting recovery operations on shot-day. The assignment of these monitors is summarized below:

<u>PROJECT</u>	<u>NUMBER OF MONITORS</u>
2.2	1
2.5.1	2
3.1	4
8.4	1
39.7	5

During the two days after the shot, the Monitoring Section furnished another 15 monitors to projects. The specific projects and number of monitors involved in each project is not known (19).

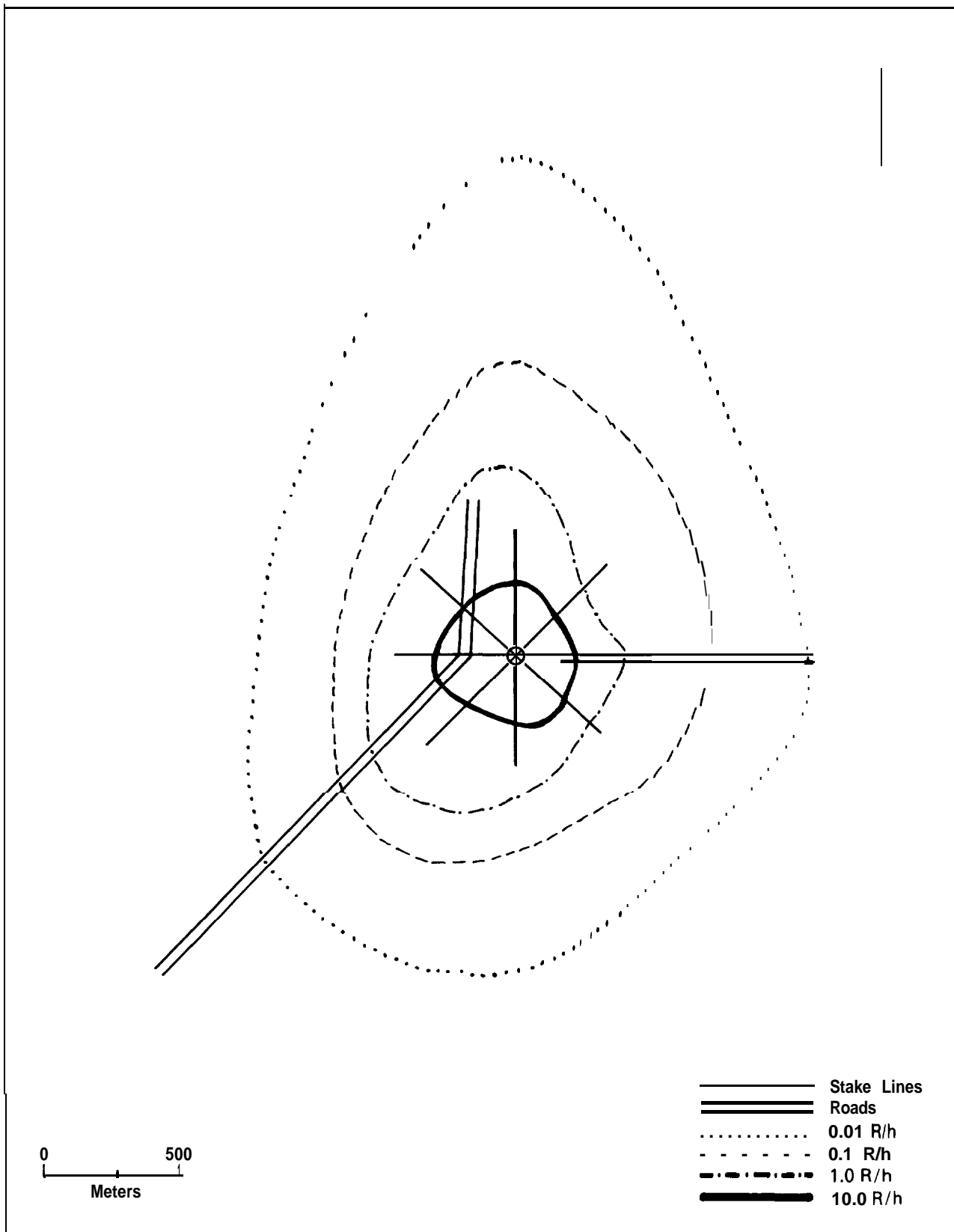
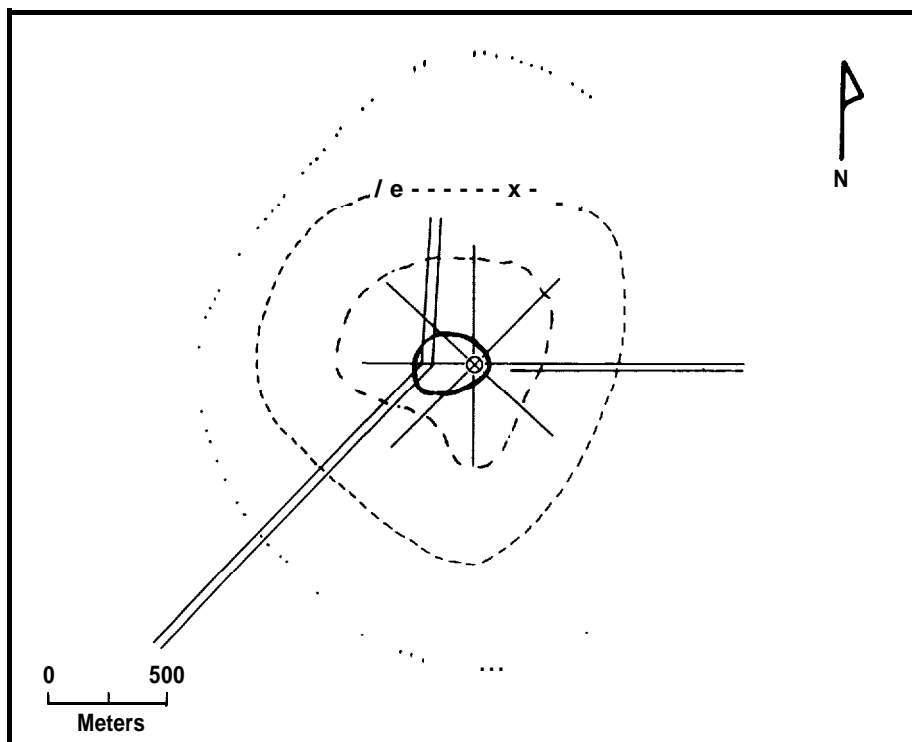
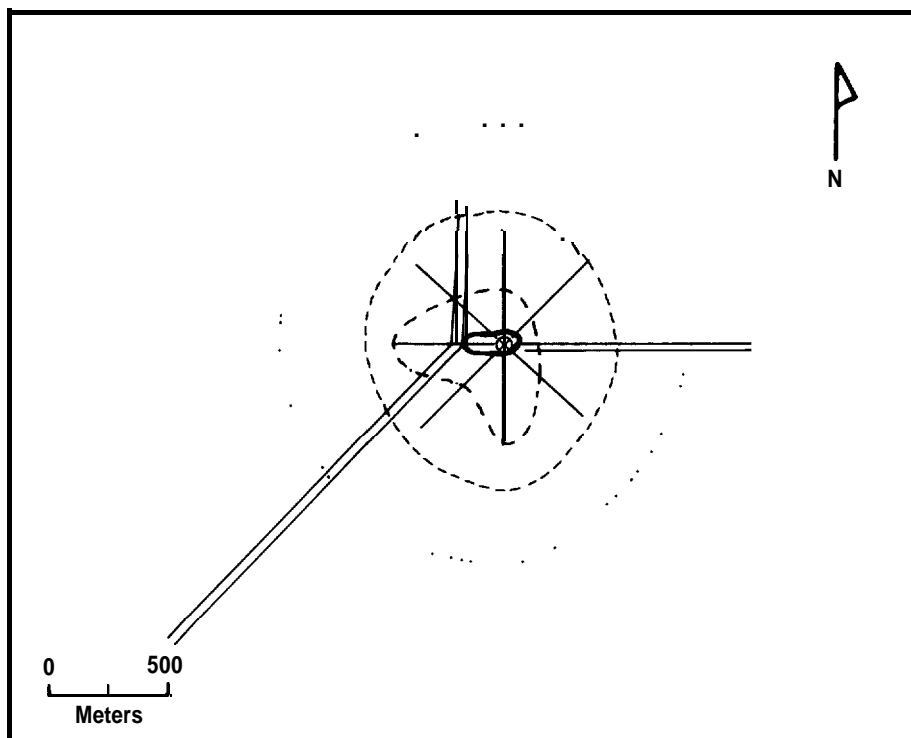


Figure 2-l: INITIAL SURVEY FOR SHOT WASP, 18 FEBRUARY 1955,
1248 TO 1315 HOURS



18 February 1955, 1650 to 1702 Hours



19 February 1955, 0944 to 1010 Hours

Stake Lines
 Roads
 0.01 R/h
 0.1 R/h
 1.0 R/h
 10.0 R/h

Figure 2-2: RESURVEYS FOR SHOT WASP

Recovery and Re-entry Procedures

The Test Manager authorized personnel from Projects 2.2 and 39.7 to enter radiation areas at 1231, sixty-four minutes before recovery hour, which he declared at 1335. In addition, he permitted these individuals to enter areas with radiation intensities exceeding 10 R/h so that they could recover Project 2.2 neutron detectors. The Onsite Radiological Safety Officer released Project 13.1 personnel to enter areas exceeding 10 R/h. Available documents do not indicate the reasons for this exception to the customary procedures (19).

The Plotting and Briefing Section cleared the following numbers of parties for entry into the WASP area (19; 59):

<u>DATE</u>	<u>NUMBER OF PARTIES</u>
18 February	21
19 Februarv	18
20 February	1
21 February	3
22 February	4

Decontamination

During the period covering Shot WASP, 18 through 21 February, members of the Vehicle and Equipment Decontamination Section decontaminated 24 vehicles and 18 pieces of test equipment (19).

MOTH

SHOT SYNOPSIS

AEC TEST SERIES: TEAPOT
DOD EXERCISE: Desert Rock VI
DATE/TIME: 22 February 1955, 0545 hours
YIELD: 2 kilotons
HEIGHT OF BURST: 300 feet (tower shot)

Purpose of Test: To test a nuclear weapon for possible inclusion in the nuclear arsenal.

DOD Objectives: (1) To study the effects of a nuclear weapon on military equipment, materiel, structures, and ordnance
(2) To allow DOD personnel to observe a nuclear detonation
(3) To evaluate military equipment.

Weather: At shot-time, the temperature was -3.9°C ; pressure was 871 millibars; surface wind calm and out of the northwest at 65 knots at 24,000 feet.

Radiation Data: Onsite fallout of 0.01 R/h extended up to about 1,500 meters west of ground zero. Fallout with intensities exceeding 10.0 R/h was detected northeast of ground zero during the initial survey, taken from 0611 to 0813 hour on shot-day.

Participants: Exercise Desert Rock VI participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 3

SHOT MOTH

Shot MOTH, the second shot of the TEAPOT Series, was detonated on 22 February 1955 at 0545 hours in Area 3 of the Nevada Test Site (NTS), at UTM coordinates 871004. The explosive yield of the MOTH device was two kilotons (29). MOTH was the first of ten tower shots in Operation TEAPOT, and the device was positioned on top of a 300-foot tower. The MOTH nuclear cloud reached a height of 24,200 feet MSL. The MOTH cloud and fallout started northeast and then drifted **offsite** in a southeasterly direction (29; 34; 56).

Department of Defense participants at Shot MOTH took part in Exercise Desert Rock VI activities, scientific and military effects experiments, and support missions, as described in this chapter. An account of the radiological situation created by Shot MOTH, along with the procedures used to minimize the exposure of DOD participants to ionizing radiation, is summarized at the end of the chapter. Figure 3-1 displays the location of DOD personnel near the shot area at the time of the detonation.

3.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT MOTH

Desert Rock exercise and support troops took part in the five troop orientation and indoctrination projects, one troop test, and two technical service projects conducted at MOTH. Table 3-1 lists Desert Rock VI programs at MOTH and presents the numbers and titles of the projects, the sponsors, the estimated numbers of DOD participants, and the service units involved in the projects.

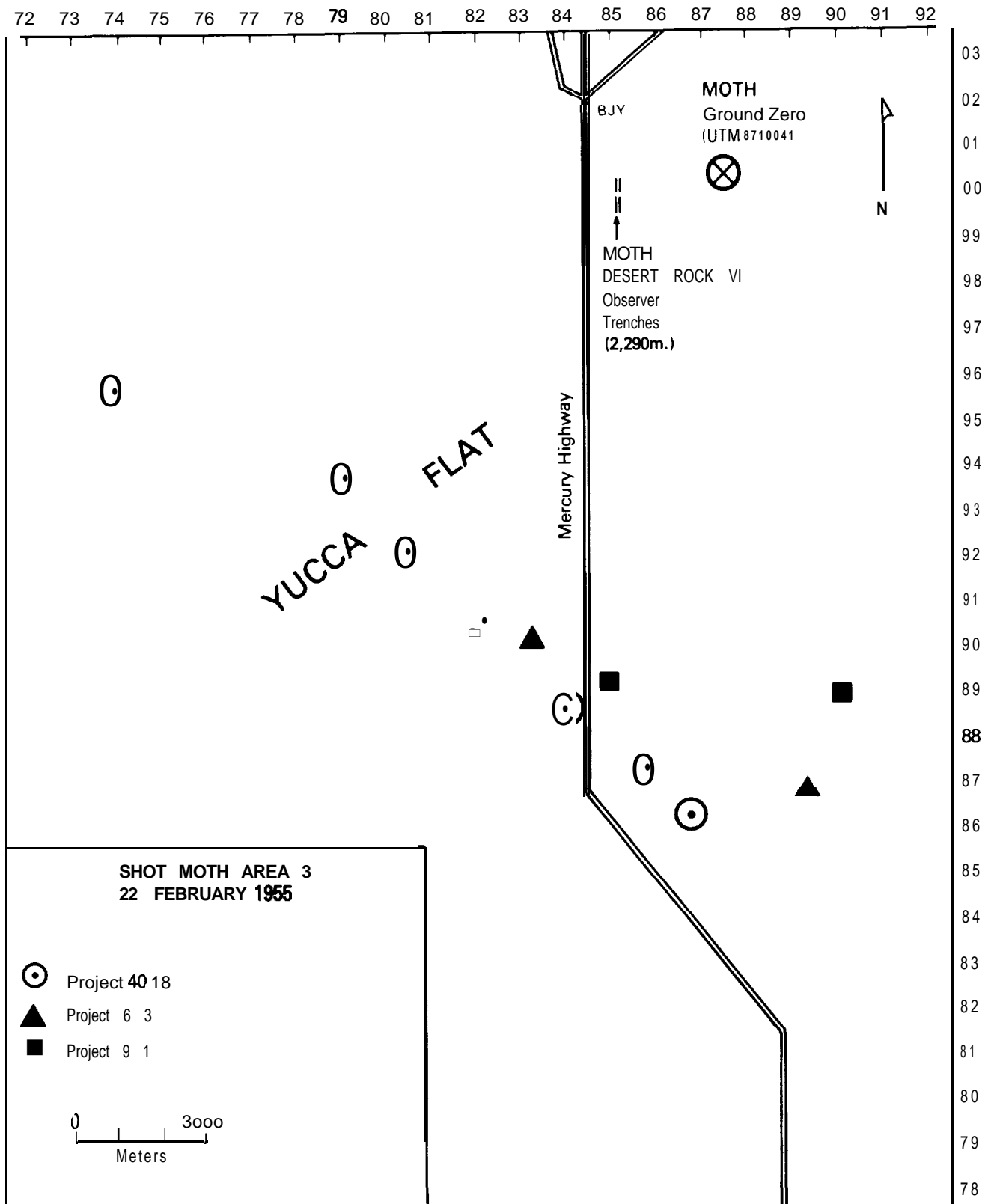


Figure 3-I: FORWARD POSITIONS OF DOD PERSONNEL AT SHOT-TIME FOR MOTH

Table 3-1: EXERCISE DESERT ROCK VI PROJECTS, SHOT MOTH

Program Type	Project	Title	Estimated Personnel	Participants
Troop Orientation and Indoctrination	41 3	Army Observers	140	Army
	41 4	Navy Observers	3	Navy
	40 11	Manne Observers	4	Manne Corps
	41.8	Air Force Observers	6	Air Force
		Camp Desert Rock Observers	40	Camp Desert Rock Support Troops
Troop Test	40 18	Location of Atomic Bursts	37	Battery C (-), 532nd Field Artillery (Observation) Battalion
Technical Service	40 19	Sixth Army CBR Defense Team Training	24	Sixth Army
	40 21	Ordnance Vehicular Equipment Test	*	Ballistic Research Laboratories, 573rd Ordnance Company, Chemical Warfare Laboratory, Detroit Arsenal

* Unknown

3.1.1 Troop Orientation and Indoctrination Projects

For Shot MOTH, observers from the four armed services and from Camp Desert Rock units participated together in the same orientation and training activities, witnessing the detonation from trenches located 2,290 meters west-southwest of ground zero. The observers arrived at the trench area between 0420 and 0430 hours on shot-day. In keeping with observer project procedures, they entered the trenches almost immediately upon arrival to await the countdown. One hour before the detonation, orientation and safety instructions were given over a public-address system, and communications systems and attendance rosters were checked. Two minutes before the detonation, personnel turned away from the shot-tower, crouched in the trenches, and shielded their eyes. Observers maintained this position during the detonation and until the blast wave had passed, when they stood to view the rising fireball. Within ten minutes after the detonation, the observers left the trenches to prepare for the return of the transport vehicles, which had been parked about eight kilometers

to the south. The trucks arrived about 15 minutes after the detonation and departed from the shot area for Camp Desert Rock within 30 minutes after the detonation (35; 43; 47).

3.1.2 Troop Test

Only one troop test, Project 40.18, Location of Atomic Bursts, was conducted at Shot MOTH. This project was conducted by 37 participants from Battery C(-) ,* 532nd Field Artillery (Observation) Battalion. The objectives of the project were to test equipment and train troops to locate the position and determine the yield of the nuclear detonation on a three-dimensional grid. Surveys were carried out with AN/TVS-1 cameras, bhang-meters, radar sets, and sound microphones. Project personnel manned eight survey stations positioned to approximate the deployment of an observation battery under tactical conditions. Figure 3-2 shows Army Signal Corps personnel positioning a long-range camera on News Nob to take infrared photographs of the MOTH detonation. The stations were located at the following locations within the NTS (70).

<u>STATIONS</u>	<u>UTM COORDINATES</u>
Flash Location 6	740958
Flash Location 5	791938
Flash Location 4	805922
Flash Location 3	822906 (two stations)
Flash Location 2	843886
Sound Control Point	858874
Flash Location 1	867868

Project personnel arrived at their positions at 1630 hours on 21 February. Available documents do not indicate when they left their stations (9; 42; 47; 70).

*Some subordinate units were not present.



Figure 3-2: SIGNAL CORPS TROOPS POSITIONING LONG-RANGE TELEPHOTO LENS TO PHOTOGRAPH MOTH DETONATION FROM NEWS NOB

3.1.3 Technical Service Projects

Project 40.19, Sixth Army CBR Defense Team Training, was to determine the capabilities of Chemical, Biological, and Radiological (CBR) defense survey teams. The project was also developed to test the adequacy of the organization and the radiological monitoring equipment used by Chemical, Biological, and Radiological defense teams.

The first field monitoring began the day after Shot MOTH, on 23 February, and continued through 24 February. Two radiological defense survey teams, totaling 24 personnel, surveyed the areas around both the WASP ground zero and the MOTH ground zero. The WASP survey is described in chapter 2 of this volume. Neither the time involved in the surveys, nor the length of stay in the forward area is documented. Both teams used the grid system to establish and conduct their surveys. The grid-square in the MOTH test area covered about 6.5 square kilometers, stretching about 1.6 kilometers east and about one kilometer west of ground zero.

The teams determined the 0.25 R/h and 2.0 R/h lines. On 23 February, the first team located the 2.0 R/h line at 270 meters on the downwind side of ground zero, which was as near as they approached ground zero that day. The second team determined the 2.0 R/h line at 135 meters on the upwind side of ground zero. On 24 February, both teams found that the 2.0 R/h line was 40 meters from ground zero (49).

Project 40.21, Ordnance Vehicular Equipment Test, was sponsored by the Ballistic Research Laboratories. Its objectives were to determine how well roll-over safety bars minimized damage to wheeled vehicles, to obtain experimental design data for future development of ordnance equipment and to investigate the shielding effect of armor against gamma radiation. To achieve

the desired objectives, the following equipment was placed at various positions in the display area (42):

- Three M48 tanks
- One M59 armored infantry vehicle
- One T97 self-propelled gun
- Six jeeps
- Six 2.5-ton cargo trucks
- Four 5-ton trucks.

The principal participant in the project was a detachment from the 573rd Ordnance Company, which fielded the test equipment. Ballistic Research Laboratories personnel from AFSWP Project 3.1 recorded blast pressures with gauges located near the test equipment, while Chemical Warfare Laboratories personnel from AFSWP Project 2.7 took radiation measurements. Detroit Arsenal personnel helped place the test equipment (6; 42; 75; 90).

3.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT MOTH

In addition to the Exercise Desert Rock activities described in the previous section, Department of Defense personnel performed a variety of tasks during Shot MOTH that required them to enter the forward area before, during, or after the shot.

DOD personnel performed the 17 projects sponsored by the Field Command Military Effects Group. DOD personnel assisted in three other test group projects, one sponsored by the LASL test group and two by the Civil Effects Test Group. The Air Force conducted three operational training projects. In addition, support activities accounted for a number of DOD participants at Shot WASP. The Air Force Special Weapons Center (AFSWC) flew missions for both the test groups and the Test Manager.

3.2.1 Department of Defense Participation in Military Effects Group Projects

The Military Effects Group performed 17 projects at Shot MOTH, as shown in table 3-2. Table 3-2 lists the test group projects with DOD participation, including the fielding agency and when available, the estimated number of DOD personnel. Because in most cases, many of the same individuals performed both **pre-** and post shot activities, estimates reflect the maximum number of DOD personnel who would have been involved in the project. For example, if the project description states that 15 participants performed preshot activities and five performed **postshot** recovery, the estimated listed in the table would be 15. The Test Manager allowed recovery operations to begin at 0710 hours, 85 minutes after the detonation (19).

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was conducted to measure blast forces produced **by** a nuclear detonation. Self-recording pressure gauges and pressure-time instruments were placed on two lines, one extending south of the shot-tower with instruments at distances ranging from 200 to 680 meters, and the other extending southwest of the shot-tower with instruments at distances ranging from 910 to 1,370 meters. Preshot surveys, construction of instrumentation mounts, and installation and checks of gauges probably took six participants two weeks. **Postshot** recovery of data was probably accomplished at the stations farthest from ground zero, where it was radiologically safe, on shot-day **by** two individuals in four hours. Recovery of the data from the stations closest to ground zero was probably accomplished by three individuals in the two days following the detonation, when radiation levels had decayed substantially (7; 62; 70; 89).

Project 2.1, Gamma Exposure versus Distance, was conducted to evaluate the gamma-radiation exposure potential at various distances from a nuclear detonation. Project participants placed film packets at 14 stations along the south side of the main

**Table 3-2: TEST GROUP PROJECTS WITH DEPARTMENT OF
DEFENSE PARTICIPATION, SHOT MOTH**

Project	Title	Participants	Estimated Personnel
Military Effects Group			
1 146	Measurements of Air-blast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	6
2.1	Gamma Exposure versus Distance	Army Signal Corps Engineering Laboratories	4
2.2	Neutron Flux Measurements	Naval Research Laboratory	4
2 3a	Neutron-induced Radioactive Isotopes in Soils	Naval Radiological Defense Laboratory	2
2.3b	Gamma Radiation Fields Above Fallout Contaminated Ground	Naval Radiological Defense Laboratory	*
2.4	Gamma Dose Rate versus Time and Distance	Evans Signal Laboratory	*
251	Fallout Studies	Chemical Warfare Laboratory, Army Chemical Center	*
2 8a	Contact Radiation Hazard Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
31	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	29
61 1b	Evaluation of a Radiological Defense Warning System	Army Signal Corps Engineering Laboratories	3
6 3	Missile Detonation Locator	Army Signal Corps Engineering Laboratories	4
6 4	Test of IBDA Equipment	Wright Air Development Center	14
84b	Thermal Measurements from Fixed Ground Installations	Naval Radiological Defense Laboratory	3
84d	Spectrometer Measurements	Naval Radiological Defense Laboratory	*
8 4f	Bolometer Measurements	Naval Radiological Defense Laboratory	*
91	Technical Photography	Lookout Mountain Laboratory, AFSWC, Air Force Missile Test Center, EG and G	6
9 4	Atomic Cloud Growth Study	Air Force Cambridge Research Center, U S Weather Bureau, EG and G	*
Los Alamos Scientific Laboratory Test Group			
112	Radiochemistry Sampling	4926th Test Squadron (Sampling)	13
Civil Effects Test Group			
396	Measurement of Initial and Residual Radiations by Chemical Measurements	Army Signal Corps Engineering Laboratories	5
397	Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects	School of Aviation Medicine	1

* Unknown

access road, on a line in the upwind sector of the MOTH shot area. The stations were between 370 and 1,800 meters west of the shot-tower, along the Project 2.2 instrument line. At 0810 hours, one hour after recovery operations were allowed, a team of three personnel began to collect dosimeter packets from the instrument line. They started at the farthest station and worked toward ground zero. The dosimeter packets within 365 meters of ground zero were destroyed. One radiological safety monitor was furnished by the Army Signal Corps Engineering Laboratories to accompany the project team (37; 62; 70).

Project 2.2, Neutron Flux Measurements, was fielded to evaluate the neutron-radiation exposure potential at various distances from the nuclear detonation. Neutron detection instruments were arranged on stakes located between 365 and 1370 meters east of the shot-tower. Because neutron detectors had to be analyzed promptly, the Test Manager allowed a three-man team, accompanied by a radiological safety monitor, to enter the test area 20 minutes after the detonation, behind the initial radiological survey team, to recover the neutron detectors. The detectors located 90 to 180 meters from ground zero were destroyed. After recovering the detectors, which took about 30 minutes, project personnel transported the remaining instruments to Camp Mercury for shipment to the Naval Research Laboratory for analysis (39; 62; 70).

Project 2.3a, Neutron-induced Radioactive Isotopes in Soils, was conducted to provide information on the gamma radiation induced in surrounding soil by neutrons produced from a nuclear detonation. Participation during Shot MOTH was not originally planned; however, some soil samples were exposed to obtain better understanding of the induced activity detected during WASP. Sometime within the first day after the detonation, two participants probably recovered samples and transported them to the laboratory for analysis (55; 62; 70).

Project 2.3b, Gamma Radiation Fields above Fallout Contaminated Field, addressed gamma radiation resulting from fallout on the soil surface surrounding a nuclear detonation. Data were obtained by teams of project participants who measured preshot radiation levels near the point of detonation (91).

Project 2.4, Gamma Dose Rate versus Time and Distance, was to evaluate the neutron-induced gamma-radiation hazard at various times after a nuclear detonation. The gamma detection instruments used were film-badge packets that project personnel placed in three stations located approximately 180 to 280 meters northeast and southeast of the shot-tower. These packets were recovered by personnel at various times after recovery hour to assess the time-dependence of the gamma-radiation dose rate (36; 62; 70).

Project 2.5.1, Fallout Studies, was fielded to evaluate the radiation exposure potential created by fallout from a nuclear detonation. This project was an extension of fallout studies performed at previous continental and oceanic tests, and involved ground and aerial surveys, and soil sampling. At Shot MOTH, project personnel tested the aerial survey equipment to be used at the Shot ESS detonation (62; 70; 84).

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was performed by at least five AFSWC personnel at Indian Springs AFB. The objective was to determine whether there was a correlation between the contact radiation exposure potential associated with aircraft that had flown through a nuclear cloud, and the radiation dose rates indicated by standard gamma survey meters held near the contaminated components of the aircraft. Available documentation indicates that this project was similarly conducted at 11 TEAPOT events. A description of project procedures appears in the Operation TEAPOT series volume (26; 62; 70).

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, evaluated the ability of vehicles to withstand the destructive effects of the precursor-enhanced blast wave. Test vehicles included three 1/4-ton trucks, six 2 1/2-ton trucks, and two 5-ton trucks. These vehicles were placed in the region of highest expected overpressure, ranging from ground zero to 670 meters south of the shot-tower. At 2200 hours on the day before the detonation, four personnel in two vehicles entered Area 3 to set up Project 3.1 gauges. They remained in the area for about two hours. Recovery operations were not conducted on shot-day due to radiation levels, but were postponed until the radiological situation permitted entry (6; 62; 70).

Project 6.1.1b, Evaluation of a Radiological Defense Warning System, was to evaluate a new radiological defense system. It was located 1.4 to 13.7 kilometers west and southwest of the shottower. Before the detonation, three individuals spent approximately one day selecting the sites, mounting the detectors, and checking equipment. Recovery began at 0911 hours on shot-day, when a team of three participants turned off equipment and removed data records from the two stations (62; 70; 78).

Project 6.3, Missile Detonation Locator, was fielded to evaluate a tactical-range radar system used to determine the location of a nuclear detonation. Five hours before detonation, two teams, totaling five project personnel, drove to stations at UTM coordinates 830901 and 892868 to set up and check project equipment. Postshot recovery of the detector systems was probably accomplished by three individuals in one day, after radiation intensities in the area were at levels permitting entry (62; 70; 74).

Project 6.4, Test of IBDA Equipment, was to gather engineering evaluation data for an Indirect Bomb Damage Assessment (IBDA) system, which was installed in an B-50D aircraft. The system

consisted of the standard radar set, AN/APQ-24; an experimental radar set, AN/APA-106 (XA-1); a recording set, light and time, AN/ASH-4 (A-1); and a K-17 aerial camera. A secondary objective was to determine the maximum operating range of the AN/ASH-4 recording set, the yielding-measuring component of the system. This was accomplished by placing a recording set and an A-4 bomb-spotting camera in an F-94 aircraft staging from Indian Springs AFB with two crewmen. The B-50D, which staged out of Kirtland Air Force Base, usually carried a crew of ten men. Since engineering evaluation tests were being conducted, one additional engineer and one technician accompanied the crew to monitor and ensure the operation of the system. The procedure was the same for most of the TEAPOT projects, as described in chapter 4 of the series volume (27; 32; 62; 70).

Project 8.4b, Basic Thermal Measurements from Fixed Ground Installations, was to measure the heat produced by a nuclear detonation. Project equipment, including MK6F calorimeters and radiometers, was positioned at ground installations located 840 meters south and 1,510 meters west of the shot-tower. No documentation has been found to indicate the number of personnel or the time required to field this experiment. However, it is estimated that preshot selection of sites and placement of instrumentation probably took two individuals four hours. Postshot recovery of data was probably accomplished by two project personnel and a radiological safety monitor in one hour on shot-day (50; 62; 70).

Project 8.4d, Spectrometer Measurements, was designed to measure changes in the thermal radiation produced by a nuclear detonation as a function of time. The recording spectrometer was located in Building 410, above the Control Point at Yucca Pass (62; 70; 80).

Project 8.4f, Irradiance Measurements with High Time Resolution, was designed to determine the distribution of thermal radiation as a function of time during a nuclear detonation. All project activities were performed at Building 410 (54; 62; 70).

Project 9.1, Technical Photography, provided a photographic record of the detonation. Although MOTH's Operation Order 1-55 indicates that four participants were to operate a photography station at UTM coordinates 900890, east of Yucca Lake, the MOTH Post-Shot Report does not list this project. Five project personnel were to occupy a photography station 180 meters west of Observer Area 1, which was probably the area located 7,250 meters west-southwest of ground zero. Three additional personnel were to operate a photography station at News Nob, 11 kilometers south of the MOTH ground zero. All the stations were to be manned at 0245 hours on shot-day. These individuals were probably employees of Edgerton, Germeshausen, and Grier, the contractor primarily responsible for field work in Project 9.1. An officer, probably from Lookout Mountain Laboratory, directed field operations for Project 9.1 (62; 70).

In addition to the ground photography missions, aerial photographs were taken during Shot MOTH. One RC-47 aircraft was used to photograph the nuclear cloud. The plane, with three crew members and an estimated three photographers, flew a holding pattern oriented from 10 to 16 kilometers southeast of ground zero, at an altitude of 8,000 to 10,000 feet. Personnel from AFSWC and the Air Force Missile Test Center operated the RC-47 under the supervision of Lookout Mountain Laboratory personnel, who took the photographs (30; 32; 62; 70).

Project 9.4, Atomic Cloud Growth Study, was to study the development of the nuclear cloud. Project personnel obtained theodolite measurements on the rate of cloud rise and maximum cloud height. The theodolite was located at the north fence of the Control Point area, Building 1, at Yucca Pass (32; 38; 62; 70).

3.2.2 Department of Defense Participation in LASL Test Group Projects

Only one of the two AEC nuclear weapons development laboratories participated at Shot MOTH. The Los Alamos Scientific Laboratory (LASL) Test Group conducted 14 projects. DOD personnel took part in only one, Project 11.2, Radiochemistry Sampling. Project 11.2, performed by aircraft of the AFSWC 4926th Test Squadron (Sampling), is addressed in section 3.2.5 of this chapter.

3.2.3 Department of Defense Participation in CETG Projects

The Civil Effects Test Group (CETG) conducted seven projects at Shot MOTH. Of these seven projects, only two involved DOD personnel: Projects 39.6, Measurement of Initial Residual Radiations by Chemical Methods; and 39.7, Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects.

Project 39.6, Measurement of Initial Residual Radiations by Chemical Methods, was performed to evaluate comparative data on various methods of gamma-radiation measurement and to obtain dosimetric data at stations where biological specimens were positioned. DOD participation included five individuals from the Evans Signal Laboratory, part of the Army Signal Corps Engineering Laboratories. The Evans Signal Laboratory group supplied preshot data used to select locations for specimen stations to obtain the desired levels of gamma radiation exposure. In addition, DOD personnel occasionally assisted in station placement and recovery, and furnished a 72 curie Cobalt-60 source to use for pre- and postshot calibration of instruments. However, Evans Signal Laboratory participation in field operations for Project 39.6 is not documented.

Project personnel installed lithium-shielded chemical dosimeters at three stations ranging from 370 meters to 730 meters from ground zero. Before the MOTH detonation, personnel also placed gamma chemical dosimeters at 14 locations ranging from 180 to 1,520 meters from ground zero.

By the day after the MOTH burst, project personnel had recovered all surviving instruments from the target area for analysis (22; 62; 86).

Project 39.7, Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects, used physical and biological methods to correlate neutron to gamma radiation dose and effect on laboratory animals exposed to nuclear devices expected to yield high ratios of neutron to gamma radiation. DOD participation was probably limited to one participant from the Air Force School of Aviation Medicine. Although the nature of his involvement is unclear, it is probable that he served as a consultant to CETG project personnel (22).

According to the Test Director's Operation Order 1-55, at 1800 hours on 21 February, the day before the detonation, five project teams placed small animals and equipment at ranges of 80 to 890 meters from ground zero. These individuals left the area by 2400 hours. Ten minutes after detonation, five teams recovered animals and equipment northwest to southwest of ground zero. Each team travelled in one vehicle and was accompanied by one radiological safety monitor. Recovery of all project equipment and instruments was completed by 1200 hours on the day after the MOTH event (22; 40; 62; 70).

3.2.4 Department of Defense Operational Training Projects

The Air Force conducted three DOD operational training **projects** at Shot MOTH. These projects were designed to test service tactics and equipment and to train military personnel in the effects of nuclear detonations. The information below indicates the number of DOD personnel, excluding the recovery crews for each project, as well as the type and number of aircraft involved, the fielding agency, and the staging base (3; 32).

PROJECT	TITLE	FIELDING AGENCY	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	STAGING BASE	ESTIMATED NUMBER OF PERSONNEL
40.3	Crew Indoctrination	Tactical Air Command	F-84	6	George AFB, California	6
40.6	Calibration of Electro-magnetic Effects	Air Force	Helicopter	1	Camp Mercury	
40.8	Calibration of Bomb Debris	Air Force	F-84	1	Indian Springs AFB	

Project 40.3, Crew Indoctrination, sought to train Tactical Air Command **aircrews** in the effects of a nuclear detonation while flying simulated tactical delivery maneuvers. Six F-84 aircraft from George Air Force Base, California, with a total of six crew members, performed bomb delivery maneuvers during the shot. Three of the F-84s performed the dive bomb maneuvers. They established their positions by orbiting eight kilometers from the shot-tower, at altitudes of 25,000 to 28,000 feet. One minute before detonation, the aircraft made a 55° delivery dive, descending to altitudes ranging from 17,000 to 20,000 feet. All

aircraft then turned away from ground zero in anticipation of the shock wave. After blast arrival, the aircraft returned to their home base (1; 3; 32; 85).

In addition to the dive bomb maneuver, three F-84 aircraft performed a BT-9 maneuver at this event as part of Project 40.3. The F-84s orbited northeast and southeast of ground zero at altitudes of 22,000 feet. They then entered a very shallow dive directly toward ground zero. At 8,000 feet, they performed their simulated bomb drop delivery. The lead F-84 aircraft executed a shallow turn, while the F-84s to his right and left veered away from him, out of formation. After the maneuver was completed, aircraft regrouped and left the NTS area for their home bases. Three other F-84s were scheduled to participate in this activity, but aborted the mission because of late takeoff from George AFB (3; 32; 70; 85).

According to the MOTH Operation Order 1-55, two personnel in a radar station south of ground zero directed Project 40.3 aircraft at 0300 hours. At the same time, ten personnel occupied another radar station south of ground zero. Both teams probably remained at their stations until after the aircraft had departed NTS air space. Although the documentation is not clear, the radar station personnel probably were from the 1st Tactical Air Command (70).

Project 40.6, Calibration of Electromagnetic Effects, was conducted by the Air Force. Its **objective** was to expand existing information on the characteristics of the electromagnetic pulse emitted by a nuclear detonation. At 0900 hours on the day before the detonation, three project personnel in a helicopter left station **40.6b** on Yucca Lake, about 11 kilometers south of the shot-tower, to service eight sets of recording equipment. This activity required about four hours. Two hours and thirty minutes before the detonation, two participants arrived at station **40.6c**, which was located about 14.5 kilometers northwest of ground zero,

at UTM coordinates 741078, to operate equipment until one hour after the detonation. In addition, a team of three men was positioned at station 40.6b on Yucca Lake, about 11 kilometers south of ground zero, until two hours after the shot (70; 77).

Project 40.8, Calibration of Bomb Debris, also sponsored by the Air Force, was conducted to determine the relative yields of nuclear products and residues for use in characterizing nuclear weapons. Project participation was integrated with the AFSWC sampling missions sponsored by LASL Project 11.2, and is discussed in the following section of this chapter (32).

3.2.5 Air Force Special Weapons Center Activities

AFSWC supervised all air activities at MOTH through its Air Operations Center. In addition, AFSWC personnel conducted cloud-sampling missions, courier service, cloud-tracking missions, and aerial surveys of terrain. Cloud sampling, which was conducted for LASL Project 11.2, enabled AEC and DOD scientists to obtain and analyze samples of the nuclear cloud. AFSWC courier service involved the delivery of the samples to the nuclear weapons development laboratories and DOD laboratories for prompt analysis. Cloud tracking allowed the Test Manager to plot the course of the nuclear cloud, and helped the Civil Aviation Administration to prevent commercial aircraft from crossing the cloud's path. Surveying allowed the Test Manager to monitor the fallout activity in the test areas.

The following listing gives the type and number of aircraft and estimated number of AFSWC personnel involved in air missions at Shot MOTH. With the exception of the B-50 cloud-tracking aircraft, which staged out of Kirtland AFB, AFSWC aircraft staged from Indian Springs AFB (32; 33).

PROJECT	TITLE	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	NUMBER OF PERSONNEL
11.2	Sampling Sampler Control Sampler	B-50	1	9
		F-84G	8	8
	Courier Service	c-119	2	8
		c-47	2	6
	Cloud Tracking	B-50	1	12
		B-25	1	5
	Aerial Surveys of Terrain	c-47	1	3
		H-19	2	10

Cloud Sampling

In connection with LASL Test Group Project 11.2, eight F-84G aircraft performed cloud sampling, with one B-50 serving as sampler control. The F-84G aircraft collected samples at altitudes between 18,000 and 23,000 feet. The first sampler began cloud penetration two hours after the detonation, and the last two began about three hours after the detonation. Each F-84G had only a pilot, while the B-50 contained an estimated crew of nine, including one scientific adviser. The following listing displays information on the eight sampling missions (32; 33).

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)
F-84G #030	3	1:45	19.0
F-84G #033	5	2:15	22.0
F-84G #045	3	2:10	30.0
F-84G #051	3	2:10	15.0
F-84G #054	4	5:25	5.0
F-84G #037	1	0:30	0.7
F-84G #028		13:00	0.0
F-84G #055	1	13:00	4.0

Courier Service

Four aircraft departed from Indian Springs AFB within five hours of the detonation to deliver samples to the AEC nuclear weapons development laboratories and DOD laboratories. Two C-119s left for Kirtland Air Force Base to deliver samples for LASL. A C-47 departed for Bolling Air Force Base, Washington, D.C., with samples from Project 2.2. A second C-47 carried samples for project 40.6 from Indian Springs AFB to McClellan AFB (32; 33).

Cloud Tracking

After the detonation, a B-50 and a B-25, flying at 22,000 and 7,000 feet, respectively, tracked the nuclear cloud in a southeasterly direction north of U.S. Route 95 until they reached the shores of Lake Mead (32; 33).

Aerial Surveys of Terrain

The survey mission was performed by a C-47 aircraft flying 300 to 500 feet above ground. AN/PDR-27C and AN/PDR-39 **radiac** meters were used to determine terrain intensities. Takeoff time for the C-47 was about seven hours after the detonation. The C-47 aerial survey aircraft followed the same route toward Lake Mead, Nevada as the cloud tracking aircraft. In addition, two H-19 helicopters were used by radiological safety monitors to conduct aerial surveying activities (32; 33).

3.3 RADIATION PROTECTION AT SHOT MOTH

The purpose of the radiation protection procedures at Shot MOTH was to ensure that personnel exposure to ionizing radiation was as low as possible, while allowing participants to accomplish their tasks. Some of the procedures described in the Series volume resulted in records which enabled Exercise Desert Rock, the Joint Test Organization, and AFSWC to evaluate the effectiveness of their procedures. Such records for Shot MOTH have been located only for the Joint Test Organization. The JTO **Onsite** Radiological Safety Organization was staffed by Army personnel from the 1st Radiological Safety Support Unit, from Ft. McClellan, Alabama, and was managed by AFSWP. The information presented in this section includes film badge data, logistical data on radiological safety equipment, survey results, **iso-**intensity maps, and decontamination records for the Joint Test Organization. No description of Exercise Desert Rock VI or AFSWC safety activities has been located.

Dosimetry

During the period of 21 through 27 February 1955, which covers the 22 February MOTH event, 748 film badges and 416 pocket dosimeters were issued (19). Twelve personnel had accumulated gamma radiation exposures greater than 2.0 roentgens for Operation TEAPOT thus far, but less than the JTO-authorized limit of 3.9 roentgens. One individual from the Detroit Arsenal, participating in Project 3.1, had a total exposure of 5.75 roentgens by 23 February (11; 14; 19).

Eight pilots flew eight F-84G aircraft for cloud sampling during Shot MOTH. Film-badge readings for these individuals ranged from 0.34 to 0.66 roentgens of gamma radiation for the MOTH sampling mission (32).

Logistics

The General Supply Section issued 778 pieces of protective clothing and 1662 respirators during the period of Shot MOTH. In addition, the Instrument Repair Section issued 202 radiation survey meters during Shot MOTH (19).

Monitoring

During Shot MOTH, monitoring included both ground and aerial surveys. At 0547 hours, two minutes after detonation, the initial survey party, probably consisting of four two-man teams, and two two-man road patrol teams left the Control Point at Yucca Pass. They began their surveys at 0611 hours. A monitor outside the Radiological Safety Building checked for fallout, but detected none. The radiation was localized, and the entire survey was completed by 0730 hours and personnel returned to the Control Point at 0813 hours. A copy of the initial isointensity map is shown in figure 3-3. Two H-19 helicopters, each with a crew of five, began aerial surveys of terrain at 0553 hours,

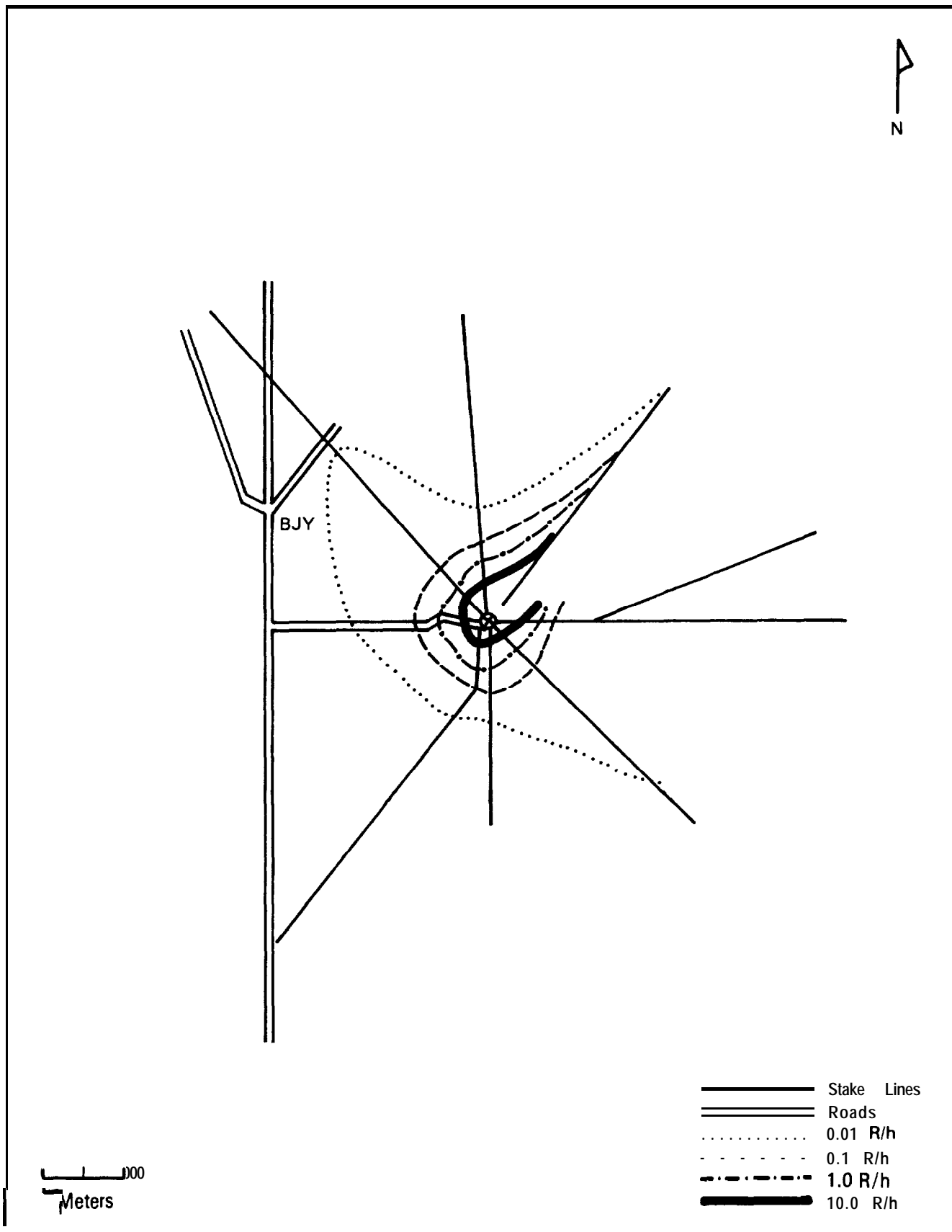


Figure 3-3: INITIAL SURVEY FOR SHOT MOTH, 22 FEBRUARY 1955,
0611 TO 0813 HOURS

eight minutes after detonation, ending the mission approximately 70 minutes later (19). The helicopter surveys were unsuccessful because of low fog and difficulties with communication equipment.

After the survey team had begun its work, the checkpoint teams and sign-posting detail departed from the Control Point at 0615 hours to establish **check-** and control-points and to post radiation warning signs.

Monitors resurveyed the shot area on 23, 24, and 28 February, and on 4 and 9 March. Copies of the isointensity maps of all the resurveys except 4 March are shown in figure 3-4. The average exposures for the initial survey team and first resurvey team were 0.34 and 0.25 roentgens, respectively.

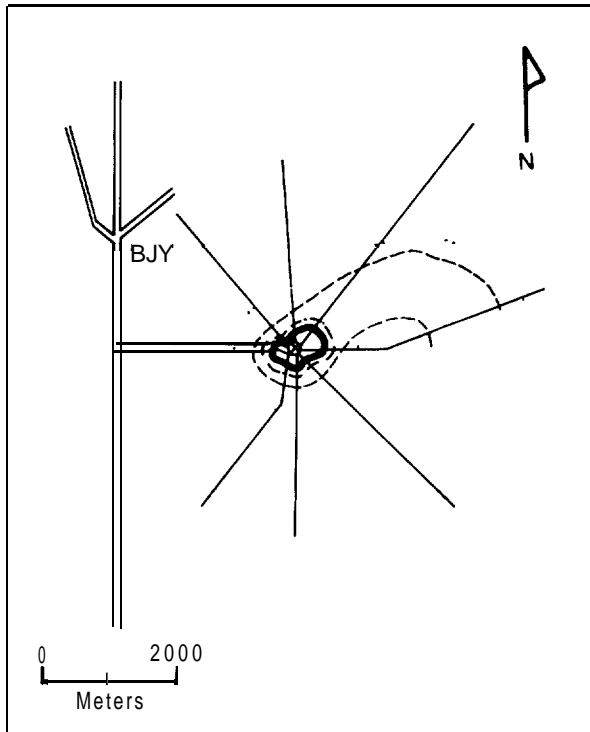
On shot-day, monitors were furnished the following projects (19):

<u>PROJECT</u>	<u>NUMBER OF MONITORS</u>
3.1	3
8.4	1
9.1	1
12.1	1
13.1	1
39.7	5

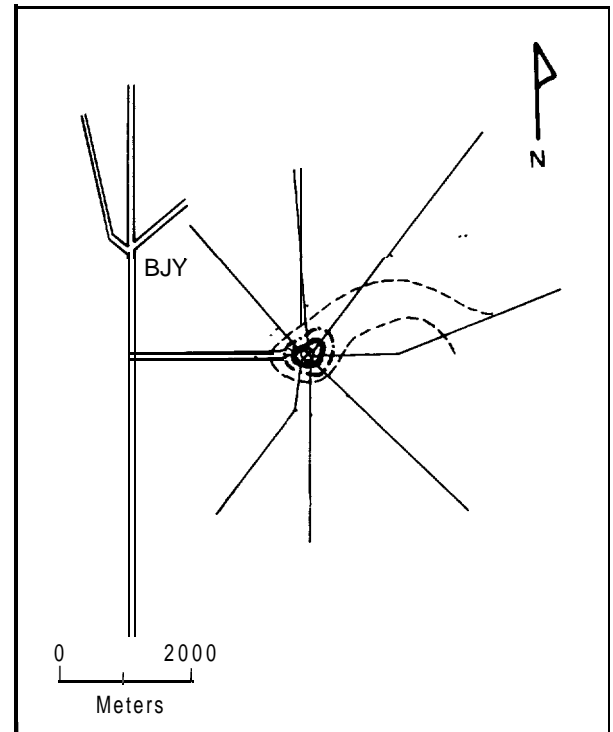
On the following day, the monitoring section provided an additional 12 monitors to projects, but the specific projects are not known (19).

Recovery and Re-entry Procedures

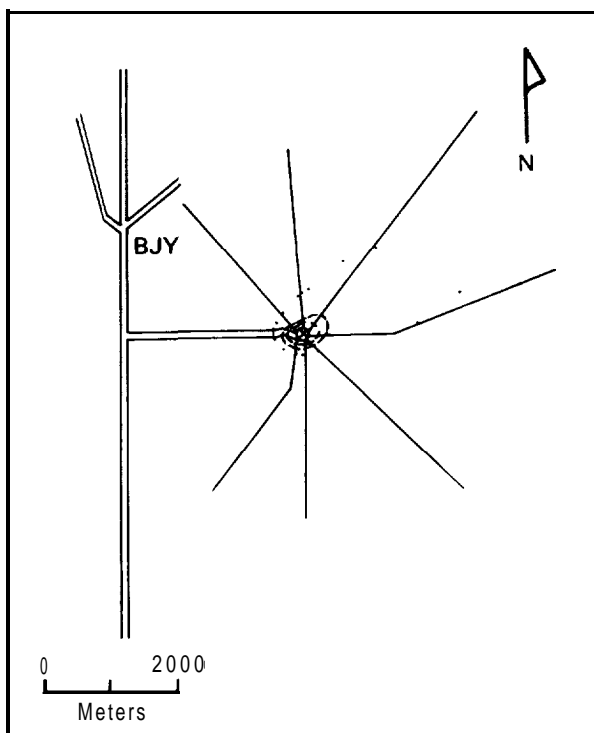
Although the helicopter survey was not completed, the Test Manager, on advice from the Radiological Safety Office, declared the area open for recovery operations at 0711 hours (19). On shot-day, five Project 39.7 and two Project 2.2 parties



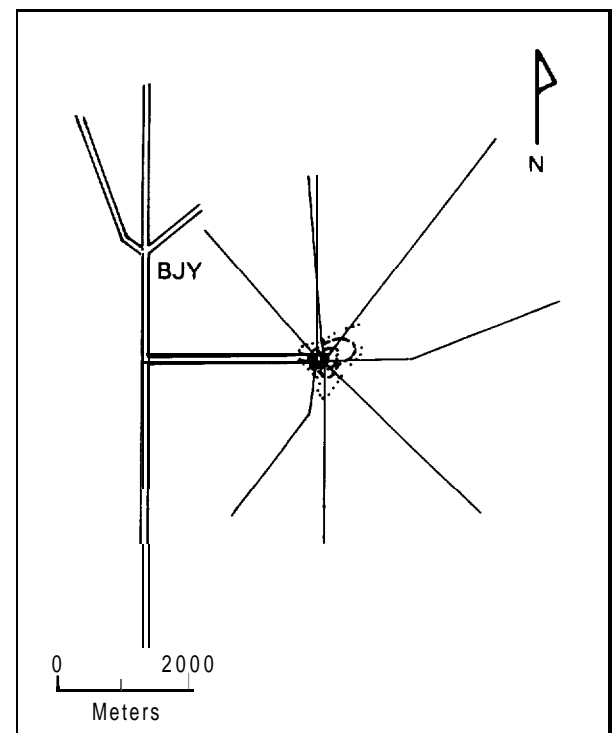
23 February 1955, 0745 to 0900 Hours



24 February 1955, 0701 to 0800 Hours



28 February 1955, 1100 to 1200 Hours



9 March 1955, 0850 to 1010 Hours



Figure 3-4: RESURVEYS FOR SHOT MOTH

received special permission from the Test Manager to enter radiation areas before recovery hour and to work past the 10 R/h area (19).

The following parties were cleared for entry into contaminated areas during Shot MOTH (19; 59):

<u>DATE</u>	<u>NUMBER</u>
22 February	26
23 February	12
24 February	8
25 February	1
28 February	28

Decontamination

During the period covering Shot MOTH, 22 through 28 February 1955, 19 vehicles and 137 other items of equipment required decontamination. In addition, 46 items of equipment were placed in the hot park until radiation intensities decayed to acceptable levels (19).

TESLA

SHOT SYNOPSIS

AEC TEST SERIES: TEAPOT
DOD EXERCISE: Desert Rock VI
DATE/TIME: 1 March 1955, 0530 hours
YIELD: 7 kilotons
HEIGHT OF BURST: 300 feet (tower shot)

Purpose of Test: To test a nuclear weapon for possible inclusion in the nuclear arsenal.

DOD Objectives: (1) To study the effects of a nuclear weapon on military equipment
(2) To allow DOD personnel to observe a nuclear detonation.

Weather: At shot-time, the temperature at shot height was -0.5°C ; pressure was 864 millibars; winds calm at surface, 10 knots from the southwest at 10,000 feet, 26 knots from the west at 20,000 feet, and 25 knots from the west at 30,000 feet.

Radiation Data: Onsite fallout, i.e., residual radiation greater than 0.01 R/h, extended from 2,000 to 3,000 meters southwest and south of ground zero. Fallout of 0.01 R/h, detected during the initial survey at 0555 to 0632 hours on shot-day, extended to within 200 meters of the trenches. Intensities exceeding 10.0 R/h were measured northeast of ground zero as far as the initial survey was performed.

Participants: Atomic Energy Commission, Exercise Desert Rock VI participants, Armed Forces Special Weapons Project, Air Force **Special** Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, University of California Radiation Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 4

SHOT TESLA

Shot TESLA, the third nuclear event of the TEAPOT Series, was originally scheduled for detonation on 25 February 1955, but was postponed several times because of weather conditions and technical difficulties. The TESLA device was detonated at 0530 hours on 1 March 1955. The device was on top of a 300-foot steel tower in Area 9 of the Nevada Test Site (NTS), at LJTM coordinates 844090. The device, designed by the University of California Radiation Laboratory (UCRL), yielded seven kilotons of explosive energy (29; 34). Original estimates of anticipated yield had been for only two kilotons.

At shot height, the temperature was minus 0.5 degrees Celsius, and the barometric pressure was 864 millibars. The weather was clear with winds calm at the surface, 10 knots from the southwest at 10,000 feet, of 26 knots from the west at 20,000 feet, and of 25 knots from the west at 30,000 feet. The cloud rose to an altitude of 30,000 feet MSL, and fallout from the cloud occurred to the east of ground zero (29; 34; 56).

Department of Defense (DOD) participants at Shot TESLA took part in Exercise Desert Rock VI activities, scientific and military effects experiments, and support missions, as described in this chapter. Figure 4-1 depicts the location of DOD personnel who are known to have been near the test area at shot time. An account of the radiological situation created by TESLA and the procedures used to minimize exposure of DOD participants to radiation, is summarized at the end of this chapter.

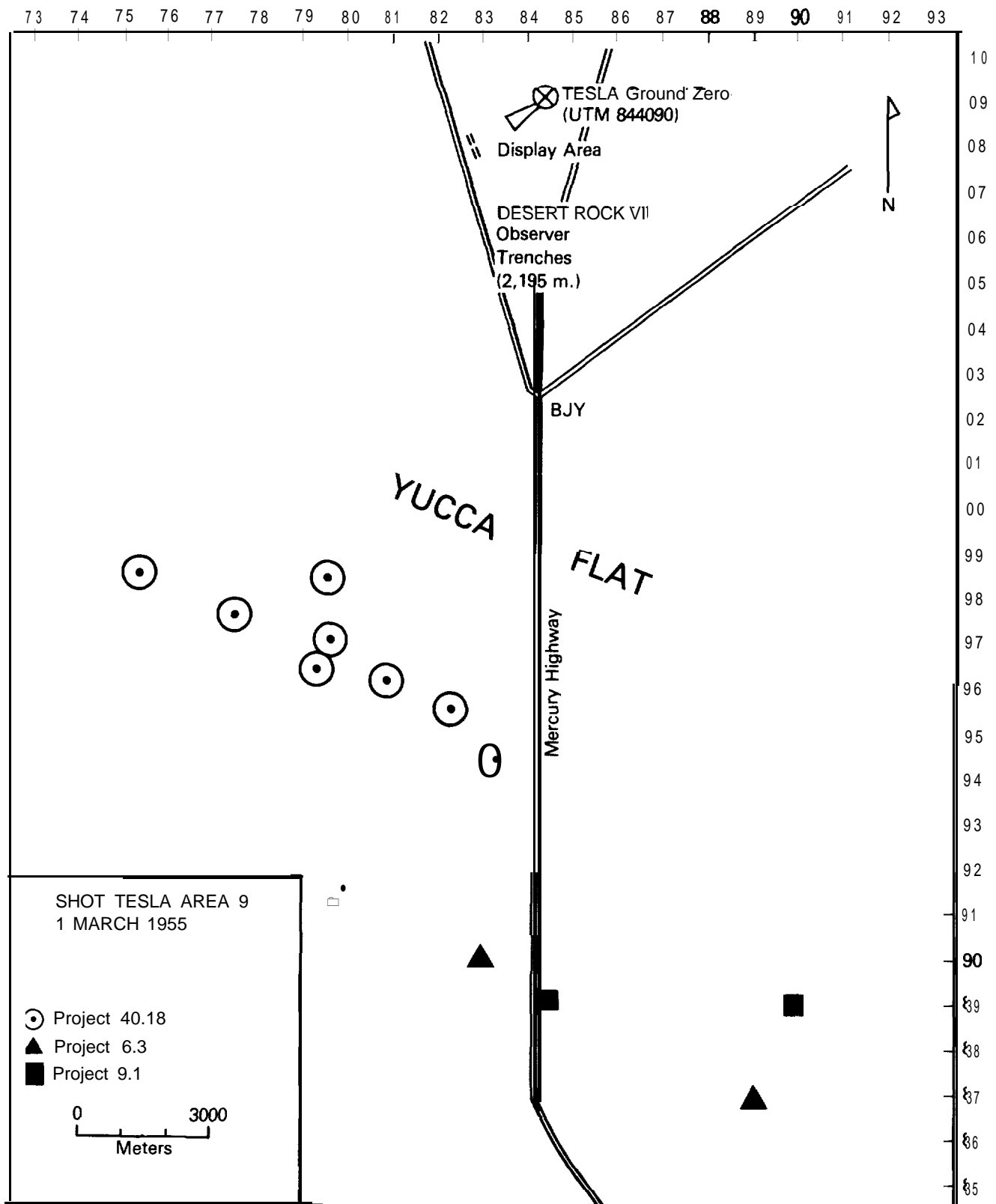


Figure 4-1: FORWARD POSITIONS OF DOD PERSONNEL AT SHOT-TIME FOR TESLA

4.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT TESLA

Desert Rock support personnel and exercise troops took part in four observer projects, one troop test, and two technical service projects conducted at Shot TESLA. Table 4-1 indicates Desert Rock VI operations at TESLA, including the number and title of each project, the name of the participating unit, the estimated number of DOD participants, and the service units involved in each project. Camp Desert Rock personnel also assessed the damage to items in the equipment display area. This damage effects evaluation was not part of a numbered project.

Table 4-1: EXERCISE DESERT ROCK VI PROJECTS, SHOT TESLA

Program Type	Project	Title	Estimated Personnel	Participants
Troop Orientation and Indoctrination	41 3	Army Observers	20	Army
	4011	Marine Observers	24	Marine Corps
	41 8	Air Force Observers	1	Air Force
	—	Camp Desert Rock Observers	478	Camp Desert Rock Support Troops
Troop Test	4018	Location of Atomic Bursts	45	Battery C (-), 532nd Field Artillery (Observation) Battalion
Technical Service	40 14	Chemical, Biological, and Radiological Defense Shelters Test	*	Chemical Warfare Laboratory
	40 19	Sixth Army CBR Defense Team Training Damage Effects Evaluation	24 *	Sixth Army Camp Desert Rock Support Troops

*

4.1.1 Troop Orientation and Indoctrination Projects

Exercise troops participated in three troop orientation and indoctrination projects at TESLA. A fourth observer group, composed of 478 Camp Desert Rock support units, also participated in the Troop Orientation and Indoctrination Program. These

personnel were not assigned to a numbered project. Desert Rock observers witnessed Shot TESLA from trenches southwest of ground zero. **Project** documentation indicates that these trenches were located 2,290 meters from the shot-tower, but recent analysis of aerial photographs showing the trenches and nearby roads suggests that the TESLA observer trenches were actually located about 2,200 meters from the point of detonation (35; 42; 44; 48).

The observers inspected the TESLA equipment display area, shown in figure 4-2, on 28 February 1955, the day before the device was detonated. The equipment display area included tanks, trucks, howitzers, and other military equipment. The display area was located from 330 to 910 meters from the shot-tower and approximately 1,200 meters in front of the observer trenches. According to planned procedures, the observers arrived in the shot area at 0400 hours, 90 minutes before the detonation, and moved to the trench area, which was located approximately 90 meters from the road. Safety, communications, and attendance checks were conducted at the trench area. The observers crouched in the trenches before the shot, remaining there until the blast wave had passed their position. They then stood in the trenches to observe the rising nuclear cloud for five to ten minutes. Within 20 minutes after the detonation, radiological personnel monitored the area for the walk to the equipment display area. Because the shot yield of seven kilotons was greater than had been expected, little of the planned tour could be accomplished. Observers were not allowed beyond the 5.0 R/h line, which was established and marked with white tape about 900 meters from the TESLA ground zero. They could only view the equipment at this outer limit of the display area.

The observers arrived at the radiological safety limit line of the display area about 0620 hours, 30 minutes after leaving the trench area. They remained at the edge of the equipment display for ten to 15 minutes, and then returned to the trench area.



Figure 4-2: DESERT ROCK OBSERVERS EXAMINE EQUIPMENT
DISPLAY PRIOR TO TESLA DETONATION

The observers probably arrived at the trench area at about 0700 hours, and met the vehicles to return to Camp Desert Rock. Available documentation does not indicate how many, if any, of these observers wore film badges (35; 42; 44; 48).

4.1.2 Troop Test

The one troop test conducted at Shot TESLA was Project 40.18, Location of Atomic Bursts. The project was performed by 45 participants from Battery C (-) of the 532nd Field Artillery (Observation) Battalion, as indicated in table 4-1. The test was designed to evaluate the suitability of conventional military equipment, procedures, and techniques developed by the Army Artillery School to locate nuclear bursts.

The project required the soldiers to establish nine observation stations located in various areas south of ground zero. The nine manned stations, shown in figure 4-1, were positioned at the following locations within the NTS (68):

<u>STATIONS</u>	<u>UTM COORDINATES</u>
Flash Control Point	794964
Flash Location 1	834944
Flash Location 2	823955
Flash Location 3	809961
Flash Location 4	796970
Flash Location 5	775976
Flash Location 6	754985
Sound control Point	796984
Radar	800915

These stations, which were located about 13 to 19 kilometers south to southwest of the TESLA ground zero, were positioned to simulate the standard deployment of an observation battery under tactical conditions.

The stations were occupied from about 1630 hours on the day before the event until just after the detonation. During the detonation, project personnel attempted to identify the location of the burst on a three-dimensional grid and to assess the yield of the burst. After the detonation, project personnel returned to Camp Desert Rock (42; 48; 68).

4.1.3 Technical Service Project

Project 40.14, Chemical, Biological, and Radiological Defense Shelters Test, was conducted by the Chemical Warfare Laboratories and the Engineer Research and Development Laboratories. The objective was to evaluate the effects of the blast wave on developmental chemical, biological, and radiological (CBR) defense techniques used with field bunkers and foxholes. The unmanned bunkers were located 420 meters from the shot-tower, while the foxholes, also unmanned, were situated head-on and side-on at distances from 450 to 1,800 meters from the shot tower. Project personnel were probably responsible for preparing and retrieving instruments and for inspecting the bunkers and foxholes (42).

Project 40.19, Sixth Army CBR Defense Team Training, was also conducted at Shot TESLA, as shown in table 4-1. Two Chemical, Biological, and Radiological (CBR) defense teams, totaling 24 personnel, monitored the shot area as part of their training in radiation protection activities. Specific activities for Project 40.19 at TESLA are unknown (49).

4.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT TESLA

In addition to the Exercise Desert Rock activities described in the previous section, DOD personnel performed a variety of

tests during Shot TESLA that required them to enter the forward area before, during, or after the shot.

DOD personnel performed the **projects** sponsored by the Field Command Military Effects Group and assisted in test group projects sponsored by the LASL test group, and the UCRL test group. DOD personnel did not assist in any of the Civil Effects Test Group (CETG) projects at TESLA. The Air Force also conducted three operational training **projects** during TESLA. In addition, support activities accounted for a number of DOD participants at Shot TESLA. The Air Force Special Weapons Center flew missions for the test groups and the Test Manager.

4.2.1 Department of Defense Participation in Military Effects Group Projects

The Military Effects Group of Armed Forces Special Weapons Project (AFSWP) Field Command conducted 17 **projects** at Shot TESLA, as shown in table 4-2. Table 4-2 lists the **projects**, including the participating agency and the estimated numbers of DOD personnel, when available. Because in most cases, many of the same individuals performed both **pre-** and **postshot** activities, estimates reflect the maximum number of DOD personnel who would have been involved in one aspect of the **project**. For example, if the project description states that 15 personnel performed **pre-**shot activities and five performed **postshot** recovery, the estimate listed in the table would be 15. The Test Manager allowed recovery operations to begin at 0700 hours, 90 minutes after the shot (19).

Project 1.2, Shock Wave Photography, was fielded to photograph the progression of the shock wave produced by TESLA. One unmanned station equipped with three cameras was established 3,770 meters from ground zero. Two project personnel probably spent two hours recovering the film from the camera station late on shot-day (63; 68; 76).

**Table 4-2: TEST GROUP PROJECTS WITH DEPARTMENT OF
DEFENSE PARTICIPATION, SHOT TESLA**

Project	Title	Participants	Estimated Personnel
Military Effects Group			
12	Shock Wave Photography	Naval Ordnance Laboratory	2
1 14b	Measurements of Air-blast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	6
21	Gamma Exposure versus Distance	Army Signal Corps Engineering Laboratories	*
22	Neutron Flux Measurements	Naval Research Laboratory	6
2 3a	Neutron-Induced Radioactive Isotopes in Soils	Naval Radiological Defense Laboratory	2
2 3b	Gamma Radiation Fields Above Fallout Contaminated Ground	Naval Radiological Defense Laboratory	*
24	Gamma Dose Rate versus Time and Distance	Evans Signal Laboratory	*
251	Fallout Studies	Chemical Warfare Laboratory, Army Chemical Center	*
27	Shielding Studies	Chemical Warfare Laboratory	3
2 8a	Contact Radiation Hazards Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
31	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	*
61 1b	Evaluation of a Radiological Defense Warning System	Army Signal Corps Engineering Laboratories	3
63	Missile Detonation Locator	Army Signal Corps Engineering Laboratories	5
64	Test of IBDA Equipment	Wright Air Development Center	16
84b	Thermal Measurements from Fixed Ground Installations	Naval Radiological Defense Laboratory	3
84d	Spectrometer Measurements	Naval Radiological Defense Laboratory	*
91	Technical Photography	Lookout Mountain Laboratory, AFSWC, Air Force Missile Test Center, EG and G	7
94	Atomic Cloud Growth Study	Air Force Cambridge Research Center, EG & G, U S Weather Bureau	*
Los Alamos Scientific Laboratory Test Group			
112	Radiochemistry Sampling	4926th Test Squadron (Sampling)	15
University of California Radiation Laboratory Test Group			
21 2	Sample Collecting	4926th Test Squadron (Sampling)	t
Civil Effects Test Group			
39 6	Measurement of Initial Residual Radiations by Chemical Methods	Army Signal Corps Engineering Laboratories	5

* Unknown

t These personnel also participated in Project 11 2

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was fielded by the Ballistic Research Laboratories, which furnished basic blast instrumentation for two projects of its own (this and Project 3.1) and for projects of other agencies. The objective of Project 1.14b was to measure variations in air pressure produced by the detonation. Self-recording pressure-time instruments were placed at distances ranging from 470 to 3,200 meters south of the shot-tower. Preparations for this experiment in the days and weeks preceding the detonation included preshot surveys, construction of instrumentation mounts, installation, and checks of gauges. Six project personnel spent an estimated two weeks preparing for this experiment.

Postshot recovery of data from the farthest section was accomplished on shot-day by two participants in about four hours. Data were collected from the stations closest to ground zero in two days by three personnel when radiation intensities in the area were declared acceptable for recovery operations (63; 68; 89).

Project 2.1, Gamma Exposure versus Distance, was designed to measure gamma-radiation intensities at various distances from the detonation. In fielding this project, personnel placed 12 film dosimeters on posts along a line on the east side of the main access road to Area 9, in the upwind sector of the TESLA test area. The dosimeters were located 460 meters to 1,600 meters from the shot-tower. At 0800, three individuals in one vehicle began recovering these dosimeters from the instrument station farthest from the tower and continued toward ground zero. One radiation-safety monitor accompanied this recovery team (37; 63; 68).

Project 2.2, Neutron Flux Measurements, evaluated the neutron radiation at 19 stations located various distances from

the nuclear detonation. Neutron-detection instruments were arranged on stakes along three axes running from the shot-tower. The first line of stakes was positioned between 270 and 910 meters north of ground zero, the second between 270 and 910 meters northeast of ground zero, and the third between 270 and 1,460 meters east of ground zero.

To obtain valid results from this project, the neutron detectors had to be analyzed promptly after exposure. Therefore, a five-man recovery team was allowed to follow the initial radiation-survey team into the shot area 45 minutes after the detonation to recover these neutron detectors. A radiological safety monitor accompanied this team, in addition to a few individuals from Project 2.7.

Several participants from Project 2.2 set out to recover the neutron detectors. According to a memorandum from the Project 2.2 officer to the Program 2 director, the recovery party encountered several difficulties while they were recovering the instruments:

- Unexpected large yield and fallout
- Rough terrain which reduced speed of recovery vehicle to a crawl
- Necessity of recovering many instruments with one recovery party
- A detour into a contaminated area as a result of a ditch which hindered recovery vehicles' progress.

As a result, several individuals accumulated radiation exposures greater than the allowable 3.9 roentgens. This is described in more detail in section 4.3 (12; 15; 18; 39; 60; 63; 66; 68; 81).

Project 2.3a, Neutron-induced Radioactive Isotopes in Soils, was designed to provide information on the gamma radiation induced in surrounding soil by neutrons from a nuclear

detonation. Because the soil samples were blasted away, no measurements were obtained. However, at an undetermined time after the detonation, a radiological safety team, probably consisting of two individuals, collected several pieces of metal debris from the vicinity of ground zero. These pieces were then transferred to sealed, radiologically safe containers and returned to the laboratory at Camp Mercury for analysis. This activity was in addition to the normal duties of the radiological safety team (55; 63; 68).

Project 2.3b, Gamma Radiation Fields above Fallout Contaminated Field, addressed gamma radiation resulting from fallout on the soil surface surrounding a nuclear detonation. Data were obtained by teams of project participants who measured preshot radiation levels near the point of detonation (91).

Project 2.4, Gamma Dose Rate versus Time and Distance, was performed to evaluate the neutron-induced gamma radiation hazard at various times after a detonation. Personnel placed ion-chamber and scintillation detector instruments at three stations around the shot-tower. One station was about 360 meters north-northeast, the second about 360 meters east-northeast, and the third about 270 meters east of the shot-tower. These packets were recovered by project personnel on the day of the detonation and on the day after the nuclear detonation (36; 63; 68).

Project 2.5.1, Fallout Studies, was conducted to evaluate the radiation hazard caused by fallout. The project was an extension of fallout studies performed at previous atmospheric nuclear weapons tests, and involved both ground and aerial surveys, and soil sampling. Typical Project 2.5.1 activities as they were performed throughout the TEAPOT Series are described in the TEAPOT Series volume (63; 68; 84).

Project 2.7, Shielding Studies, was designed to evaluate the protection afforded by various structures and equipment against gamma and neutron radiation and was performed in conjunction with Exercise Desert Rock troop test Project 40.18. Before shot-day, project personnel installed gamma-radiation film badges and neutron detectors in eight foxholes, four at 450 meters and four at 900 meters east-northeast of the shot-tower. Film badges were also placed on stakes 0.3 meters above ground along the same line 225, 450, 675, and 900 meters from ground zero. At 0702 hours, a two-man team recovered the film badges and neutron detectors 450 and 900 meters from ground zero. One radiological safety monitor, furnished by the project, accompanied the recovery team.

A second recovery party entered the area to gather detectors two and one-half hours after recovery hour was declared. This was the latest that recovery of samples could be delayed and still meet the schedule of the courier aircraft, leaving eight hours after the TESLA burst (18; 28; 60; 63; 66; 68; 82; 90).

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was performed by at least five AFSWC personnel at Indian Springs AFB, to assess the exposure potential presented by personal contact with aircraft that had flown through a nuclear cloud. Standard gamma survey meters were held near the contaminated components of the aircraft to determine their radiation intensities. Several types of meters were used and their readings were compared. The general procedures for the project at TEAPOT shots are described in the TEAPOT Series volume (26; 63; 68).

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 of the blast front created by a nuclear detonation. Unlike some of the projects in Program 2, the vehicle targets were not

used in this shot. Instead, **project** personnel installed four or five gauges in the ground prior to the detonation to measure pressure versus time phenomena as a result of the TESLA detonation. The gauges were recovered by **project** personnel about two days after the detonation (6; 63; 68).

Project 6.1.1b, Evaluation of a Radiological Defense Warning System, was designed to evaluate the components of a new radiological defense warning system. The stations for this **project** were located 1.25 kilometers west, and 3.2, 12.9, and 22.5 kilometers south of the shot-tower. Before the detonation, three personnel spent about two days selecting site locations, mounting the detectors, and checking equipment. One hour before **shot-time**, one participant manned a detector station 305 meters northwest of the Control Point. He remained through shot-time, returning to the Control Point within 15 minutes after the detonation. At 0900, approximately two hours after the area was declared open for recovery operations, two participants traveled in a vehicle to the three other stations to remove records (63; 68; 78).

Project 6.3, Missile Detonation Locator, was designed to test the feasibility of a tactical range detonation-locator system for use in determining the location of nuclear detonations. The detonation locator consisted of broad-band receivers set up on baselines in California approximately 110 and 320 kilometers from the NTS. Radio links between the stations provided the time-comparisons necessary to determine relative times of arrival of the electromagnetic pulse at each station.

In support of this project, five hours before the shot, five personnel divided into two teams traveled to stations **6.3a** and **6.3b**, located at UTM coordinates 830901 and 892868, as shown in figure 4-1. One hour after the detonation, they returned to the Control Point (63; 68; 74).

Project 6.4, Test of IBDA Equipment, was to gather engineering evaluation data for an IBDA system installed in a B-50D aircraft. The secondary objective was to determine the maximum operating range of the yield-measuring component of the system. The B-50D IBDA system consisted of the standard radar set, AN/APQ-24; an experimental radar set, AN/APA-106 (XA-1); a recording set, light and time, AN/ASH-4 (XA-1); and K-17 aerial camera. To accomplish the secondary objective, two F-94 aircraft, each manned by two crewmen, were instrumented with a recording set and a bomb-spotting camera.

The B-50D, which staged out of Kirtland Air Force Base, had a crew of ten. Since engineering evaluation tests were being conducted, one additional engineer and one technician accompanied the crew to monitor and ensure the operation of the system (27; 32; 63; 68).

Project 8.4b, Thermal Measurements from Fixed Ground Installations, was conducted to measure total thermal radiation from TEAPOT nuclear detonations at ranges where damage to military targets results. Thermal-radiation measurements were made with MK6F calorimeters and radiometers from ground installations situated 1,390 and 1,650 meters from the shot-tower. Preshot selection of sites and placement of instruments probably took two project personnel four hours. Postshot recovery of data was probably accomplished in one hour on shot-day by two project personnel and a radiological safety monitor. Recovery personnel would have worn protective clothing and used respiratory protection (50; 63; 68).

Project 8.4d, Spectrometer Measurements, was designed to measure the thermal radiation produced by a nuclear detonation as a function of time. The recording instruments were located in Building 410, near the Control Point at Yucca Pass (63; 68; 80).

Project 9.1, Technical Photography, provided documentary photographs of the nuclear event. The project, which included personnel from the Lookout Mountain Laboratory of the 1352nd Motion Picture Squadron, involved both a ground-photography mission and an air-photography mission.

The TESLA Operations Order 1-55 indicates that, three hours prior to detonation, four participants in two vehicles entered the Yucca Lake area to take documentary photographs and to operate camera stations at UTM coordinates 900890 and at News Nob. These individuals left the area within an hour after shot-time. At 0702 hours, when the test area was declared open for recovery operations, seven personnel in three vehicles entered the shot area to take damage photographs. One monitor from the 1st Radiological Safety Support Unit accompanied the party.

Another three photographers photographed the detonation and cloud growth from an RC-47 aircraft positioned about 10 to 16 kilometers southeast of ground zero at an altitude of 10,000 to 16,000 feet. The aircraft, which probably had a crew of three and an estimated three photographers, returned to Indian Springs AFB, its staging base, within an hour after the detonation (30; 32; 63; 68).

Project 9.4, Atomic Cloud Growth Study, was designed to photograph the development of the nuclear cloud for scientific purposes. Three camera stations were used at this shot, including one on Charleston Peak and one in the Amargosa Desert. A theodolite reading on cloud height was obtained from the Control Point (32; 38; 63; 68).

4.2.2 Department of Defense Participation in LASL and UCRL Test Group Projects

The Los Alamos Scientific Laboratory (LASL) Test Group and the University of California Radiation Laboratory (UCRL) Test Group each conducted eight diagnostic projects designed to measure the characteristics of the TESLA detonation. Of the eight projects conducted by the LASL Test Group, only Project 11.2, Radiochemistry Sampling, included DOD participation. Project 11.2 was supported by sampling pilots from AFSWC 4926th Test Squadron (Sampling) and is discussed in section 4.2.5 of this chapter.

UCRL designed the TESLA device and therefore sponsored the event. Of the eight projects conducted by the UCRL Test Group, only Project 21.2, Sample Collecting, involved personnel. This project was performed by the same sampler pilots from AFSWC 4926th Test Squadron (Sampling) who performed the Los Alamos Scientific Laboratory Test Group Project 11.2, Radiochemistry Sampling. This project is also discussed in section 4.2.5 of this chapter.

4.2.3 Department of Defense Participation in CETG Projects

The Civil Effects Test Group conducted eight projects at Shot TESLA. No DOD personnel are known to have participated in any of these projects (23; 63).

4.2.4 Department of Defense Operational Training Projects

The Air Force conducted three operational training projects at Shot TESLA.

Project 40.3, Crew Indoctrination, was established to train Tactical Air Command aircrews in the effects of a nuclear detonation. Six F-84 aircraft, each operated by one pilot, participated in this project. Three aircraft simulated a B-T9 maneuver,

and three simulated a dive-bombing exercise. At shot-time, the aircraft participating in the B-T9 maneuver were located about nine kilometers east of the detonation at an altitude of 15,000 to 17,500 feet. Available information has indicated that the six F-84 aircraft were positioned by two MSQ-1 radars located 50 kilometers south of ground zero. These MSQ-1 radar sites were operated by two teams, one consisting of about ten personnel, the other consisting of about five. These ground personnel were from the Air Force and remained in the area until after shot-time. After the detonation, the six F-84 aircraft left the test area within ten minutes and returned to George AFB, California (1; 3; 32; 85).

Project 40.6, Calibration of Electromagnetic Effects, was performed by Air Force personnel who measured the characteristics of the electromagnetic pulse created by the detonation. Personnel occupied several permanent stations located significant distances from ground zero during the detonation. At 0900 hours on the day before the shot, three personnel left station 40.6b on Yucca Lake, 17 kilometers south of the TESLA ground zero, in a helicopter to service eight sets of unmanned recording equipment located at distances between 10 to 20 kilometers from the shot-tower. These project personnel were in the shot area about four hours. At 0330 hours on shot-day, about two hours before the detonation, two men arrived at station 40.6c, ten kilometers west of ground zero, to operate equipment until one hour after the detonation. In addition, three men arrived at station 40.6b on Yucca Lake to operate equipment until two hours after the detonation. When the Test Manager declared that recovery operations could begin, project personnel recovered data from within their stations and left for Camp Mercury to evaluate project results (3; 68; 77).

Project 40.8, Calibration of Bomb Debris, was also performed by Air Force personnel. This project analyzed airborne fission

products and gasses from the radioactive nuclear cloud. Collection of these samples was performed by AFSWC 4926th Test Squadron (Sampling) aircraft at the same time that the aircraft collected cloud samples for LASL Project 11.2 and UCRL Project 21.2. This activity is discussed under AFSWC operations, in the next section of this chapter (32).

4.2.5 Air Force Special Weapons Center Activities

Air Force Special Weapons Center support consisted of nuclear cloud-sampling missions, sample-courier missions, cloud-tracking missions, and aerial surveys of terrain. Cloud sampling was conducted for LASL Project 11.2, UCRL Project 21.2, and for Air Force Project 40.8. The following listing displays AFSWC support missions at Shot TESLA (32).

PROJECT	MISSION	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	DOD PERSONNEL
11.2/21.2/40.8	Cloud Sampling			
	Sampler Control	B-50	1	9
	Sampler	F-84G	6	6
	Courier Service	c-47	2	6
		B-25	1	5
		c-119	1	4
		Unknown	1	-
	Cloud Tracking	B-29	1	12
		B-25	1	5
	Aerial Surveys of Terrain	c-47	1	3
		H-19	3	15

Cloud Sampling

At TESLA, six F-84G aircraft, each with a pilot, are known to have collected samples of the nuclear cloud for LASL Project 11.2, Radiochemistry Sampling; UCRL Project 21.2, Sample Collecting; and Air Force Project 40.8, Calibration of Bomb

Debris. A B-50 aircraft, with a crew of nine, including a scientific advisor from UCRL, acted as the sampler-control airplane. The sampling aircraft altitudes ranged between 19,500 and 26,000 feet. The first sampler began cloud penetration one hour and five minutes after the detonation, and the sixth aircraft began three hours after shot-time. The following listing presents information concerning each aircraft mission (32; 33).

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)
F-84G #030	2	3:00	100
F-84G #051	6	2:10	50
F-84G #054	3	3:00	60
F-84G #028	3	1:15	7
F-84G #043	4	2:10	5
F-84G #037	2	1:10	3

These aircraft staged from Indian Springs AFB and returned after completing their sample-collecting missions, where the filter samples were removed from the aircraft and packaged for shipment to laboratories for analysis.

Courier Service

Five aircraft carried samples obtained from the TESLA sampler aircraft to laboratories throughout the country for analysis.

One C-47 left Indian Springs AFB at 1015 hours for Kirtland AFB with one sample destined for LASL. One B-25 left at 1025 hours enroute to Bolling AFB, Washington, D.C., with one sample for the Naval Research Laboratory from Project 2.2. One C-47 left at 1022 hours for Oakland Municipal Airport, California, with two containers aboard for UCRL. One C-119 left at 1030 hours for Oakland Municipal Airport, California, with two containers destined for UCRL. The type and departure time of the fifth courier aircraft, which probably carried cloud samples for Air Force Project 40.8, is not documented (32; 33).

Cloud Tracking

The TESLA nuclear cloud was tracked by one B-29 and one B-25, flying at altitudes of 27,000 feet and 10,000 to 15,000 feet, respectively. The aircraft tracked the cloud in an easterly direction to Glendale, Nevada. After completing its tracking mission, the B-29, under the direction of the sampler control B-50, penetrated the cloud to simulate a commercial airliner inadvertently entering a nuclear cloud. The Technical Air Operations Report states that the exterior contamination of the airplane did not exceed 0.042 R/h. Besides a five-man crew, the B-25 carried several civilian newsmen who participated in and reported on the cloud-tracking mission. Following the mission, the two aircraft returned to Indian Springs AFB and Kirtland AFB (32; 33).

Aerial Surveys of Terrain

As directed by the Test Manager and the Test Director, a C-47 aircraft performed a low-level, 300- to 500-foot terrain survey. This aircraft measured radiation intensities east into Utah. The H-19 helicopters also carried radiological safety monitors who were conducting terrain surveying activities from the air (32; 33).

4.3 RADIATION PROTECTION AT SHOT TESLA

The purpose of the radiation protection procedures developed by Exercise Desert Rock VI, JTO, and AFSWC for the TEAPOT Series was to ensure that individual exposure to ionizing radiation was as low as possible, while allowing participants to accomplish the operational requirements of each **activity** or mission. **Some** of the procedures described in the Series volume resulted in records which enabled Exercise Desert Rock, the Joint Test Organization, and AFSWC to evaluate the effectiveness of their procedures. Such records for TESLA have been located only for the Joint Test Organization. The JTO **Onsite** Radiological Safety Organization was staffed by Army personnel from the 1st Radiological **Safety** Support Unit from Ft. McClellan, Alabama, and was managed **by** AFSWP.

The information presented in this section includes film badge data, logistical data on radiological **safety** equipment, survey results, isointensity maps, and decontamination records. Other than the Final Dosage Report, no description of Exercise Desert Rock VI or AFSWC **safety** activities was located.

Dosimetry

From 28 February through 5 March 1955, which covers the 1 March detonation of TESLA, the Dosimetr~~y~~g and Records Section of the JTO issued 614 film badges and 570 pocket dosimeters.

Available film-badge readings indicate that six AFSWC pilots flying cloud-sampling missions during the TESLA event received exposures ranging from 0.4 to 1.3 roentgens of gamma radiation. Film-badge readings also show that 11 JTO **project** personnel had accumulated exposures greater than 2.0 roentgens but less than 3.9 roentgens. During this **time**, nine other DOD participants accumulated exposures greater than 3.9 roentgens (8; 12; 14; 19; 32).

On 1 March, two 1st Radiological Safety Support Unit personnel received exposures of 16.0 and 19.3 roentgens of radiation. Their activities have been described as follows (2):

At 0738 the above named men entered the 1 R/h contaminated area of Shot TESLA, approximately 1,270 yards from GZ . . . to recover some glazed material for an alpha inspection. Approximately 350 yards from GZ . . . the AN/PDR-39 survey instrument carried in the cab of the half-ton pickup and set on the 50K scale, went off scale. However, as there was no glassed [sic] material apparent at this point, the party proceeded to within 50 yards east of GZ before it was apparent there was no heavily glazed area. [One man] dismounted the vehicle . . . and quickly collected some surface material. The driver of the vehicle . . . did not get out of the cab.... The total elapsed time within the 1 R/h area was approximately three minutes. The total time [the man] was out of the cab . . . was about 30 seconds.

The two men were denied further access to radiation areas.

The other seven participants at Shot TESLA who exceeded the 3.9 roentgen limit by 1 March were four Naval Research Laboratory personnel and three Chemical and Radiology Laboratory personnel. Their cumulative exposures were 10.78, 11.49, 12.05, 12.30, 3.98, 5.86, and 8.42 roentgens, respectively (11; 19; 92). According to a memorandum from the Test Director, these men were from Projects 2.2 and 2.7. His memo, dated 3 March 1955, states:

The field decision by Projects 2.2 and 2.7.1 to continue recovery operations on 1 March after it was apparent that the . . . limit would be exceeded is considered to be not justified.... It is suggested that you examine very carefully the recovery plans of those of your projects which may be affected to ensure that there will be no more cases of unjustified overexposure (14).

Logistics

The General Supply Division of the Logistics Section issued 969 pieces of protective clothing and 167 respirators during Shot TESLA. In addition, the Instrument Repair Section issued 200 radiation-survey meters (19).

Monitoring

During Shot TESLA, monitoring included both aerial and ground surveys. At 0532, two minutes after detonation, the initial survey party of five two-man teams left the Radiation Safety Building at the Control Point and assembled near the BUSTER-JANGLE "Y" intersection. Twenty minutes later, at 0552 hours, the onsite Radiological Safety Officer directed the team to begin its survey. The survey was completed at 0632 hours. A copy of the initial isointensity map is shown in figure 4-3. Two two-man road patrols left with the initial survey team and found Mercury Highway clear of contamination. The initial helicopter survey began at 0552 and ended at 0642 hours. This survey was performed by three H-19 helicopters, each with a survey team of five. By 0605, the area and main checkpoints were established, and the sign detail had begun posting warning signs. By the time the initial survey was completed, all signs were posted. Resurveys of the shot area were made on 1, 2, 4, and 8 March. Copies of the isointensity maps generated from these resurveys are shown in figure 4-4. The average exposures for the initial and first resurvey teams were 0.60 and 0.55 roentgens, respectively (19).

On shot-day, monitors were provided to the following projects (19):

<u>PROJECTS</u>	<u>NUMBER OF MONITORS</u>
8.4	2
9.1	1
22.1	1
24.1	1
Unspecified	5

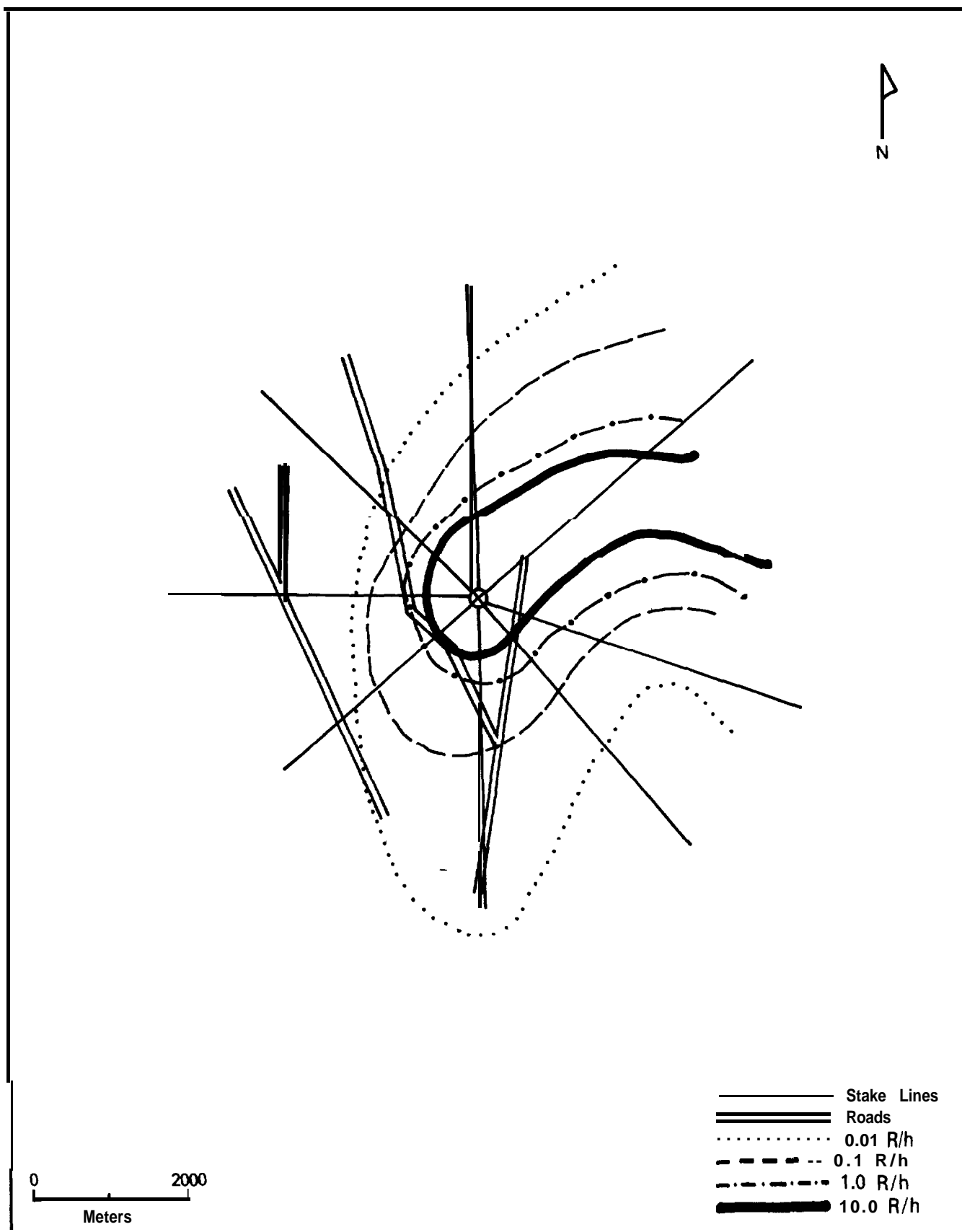
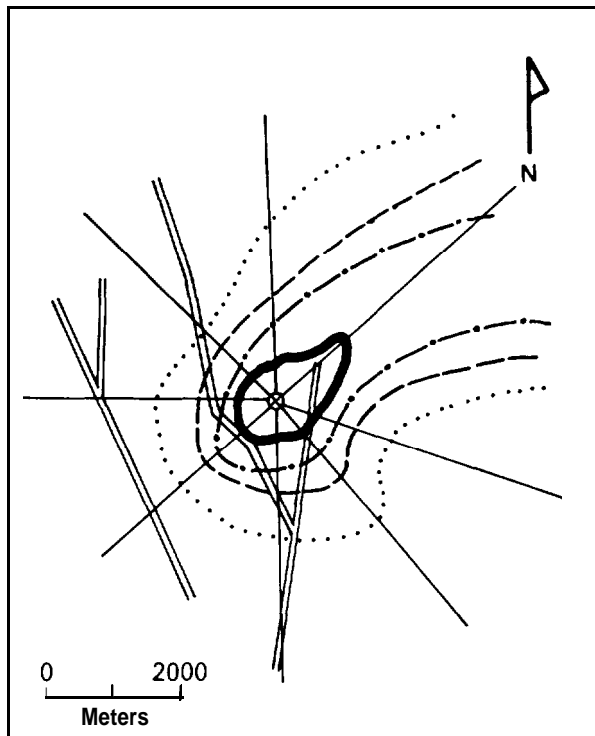
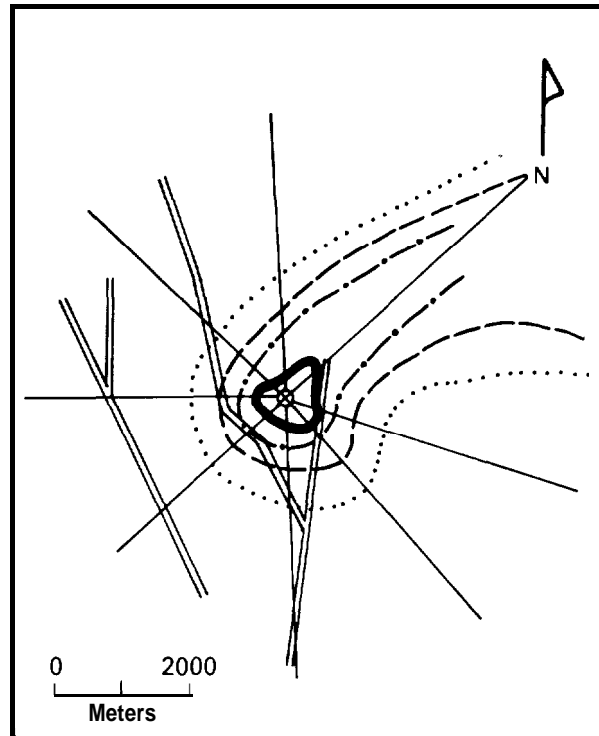


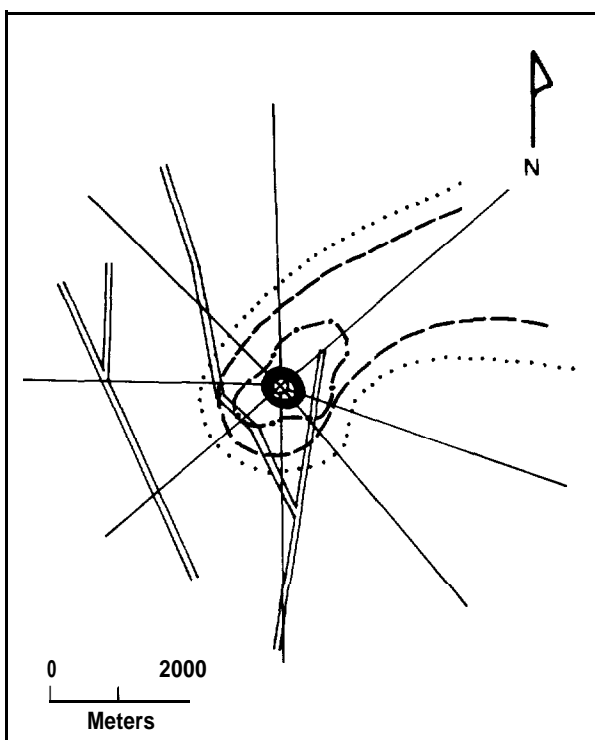
Figure 4-3: INITIAL SURVEY FOR SHOT TESLA, 1 MARCH 1955,
0555 TO 0635 HOURS



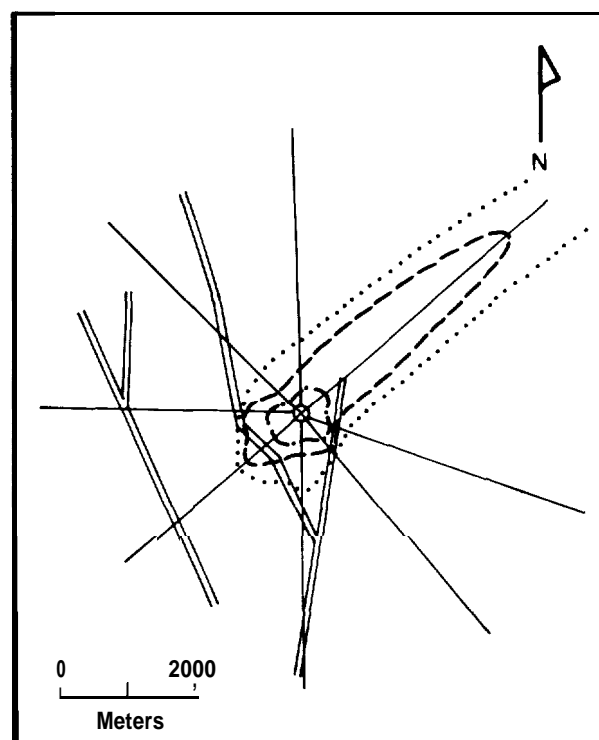
1 March 1955, 1442 to 1535 Hours



2 March 1955, 1345 to 1600 Hours



4 March 1955, 0615 to 0700 Hours



8 March 1955, 0700 to 0800 Hours

————— Stake Lines
 ————— Roads
 0.01 R/h
 - - - - - 0.1 R/h
 - . - . - 1.0 R/h
 - 1 0 . 0 R/h

Figure 4-4: RESURVEYS FOR SHOT TESLA

Recovery and Re-entry Procedures

The Test Manager authorized one Project 2.2 party to enter areas of radiation intensities greater than 10 R/h. A radio-logical safety monitor accompanied the Project 2.2 party and reported readings of 25 R/h at a location 915 meters from ground zero, at a bearing of 65 degrees, and greater than 50 R/h on this same bearing about 150 meters from ground zero. Members of this recovery party received exposures that exceeded the allowable limit, as discussed in chapter 6 of the TEAPOT Series volume (19; 59).

The Plotting and Briefing Section cleared the following numbers of parties for entry into the test area (19; 59):

<u>DATE</u>	<u>NUMBER</u>
1 March	9
2 March	4
3 March	7
4 March	7

Decontamination

During the period covering Shot TESLA, 1 March through 6 March 1955, members of the Vehicle and Equipment Decontamination Section decontaminated two buses, 32 other vehicles, and 30 additional items of equipment. One truck and 47 more pieces of equipment were placed in the hot park (19).

TURK

SHOT SYNOPSIS

AEC TEST SERIES: TEAPOT
DOD EXERCISE: Desert Rock VI
DATE/TIME: 7 March 1955, 0520 hours
YIELD: 43 kilotons
HEIGHT OF BURST: 500 feet (tower shot)

Purpose of Test To test nuclear weapons for possible inclusion in the nuclear arsenal.

DOD **Objectives:** (1) To study the effects of a nuclear weapon on military equipment
 (2) To allow DOD personnel to observe a nuclear detonation.

Weather: At shot-time, temperature was 5.6°C; pressure was 855 millibars; surface winds were 10 knots from the northwest, fairly light and variable aloft, but becoming westerly up to 47 knots from the west by 45,000 feet.

Radiation Data: **Onsite** fallout greater than 0.01 R/h, detected during the initial survey from 0630 to 0915 hours, extended up to about 2,100 meters southeast of ground zero, but was greater than 10.0 R/h at similar distances to the southwest of ground zero.

Participants: Atomic Energy Commission, Exercise Desert Rock VI participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, University of California Radiation Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 5

SHOT TURK

Shot TURK, the fourth shot of the TEAPOT Series, had the largest yield of the 14 TEAPOT nuclear events. Originally scheduled for detonation on 15 February 1955, TURK was delayed for nearly three weeks by weather conditions, and was detonated on 7 March at 0520 hours. Positioned on top of a 500-foot tower in Area 2 of the Nevada Test Site (NTS), at UTM coordinates 784104, TURK had a yield of 43 kilotons of explosive energy (29; 34). The nuclear device detonated at Shot TURK was developed by the University of California Radiation Laboratory.

The temperature at shot-time was 5.6 degrees Celsius and the air pressure was 855 millibars. The surface wind speed was 10 knots from the northwest, from the north at 2 knots at 10,000 feet, the northeast at 14 knots at 20,000 feet, from the **south-southeast** at seven knots at 30,000 feet, and from the west at 47 knots at 45,000 feet. The TURK nuclear cloud top reached an altitude of 44,700 feet MSL. The main portion of the TURK cloud and subsequent fallout drifted west and north (34; 58).

Department of Defense (DOD) participants took part in Exercise Desert Rock activities, diagnostic and effects experiments, and support missions, as described in this chapter. Figure 5-1 depicts the location of DOD project personnel in the test area at shot-time. An account of the radiological situation created by Shot TURK, and the procedures used to determine the situation are summarized at the end of this chapter.

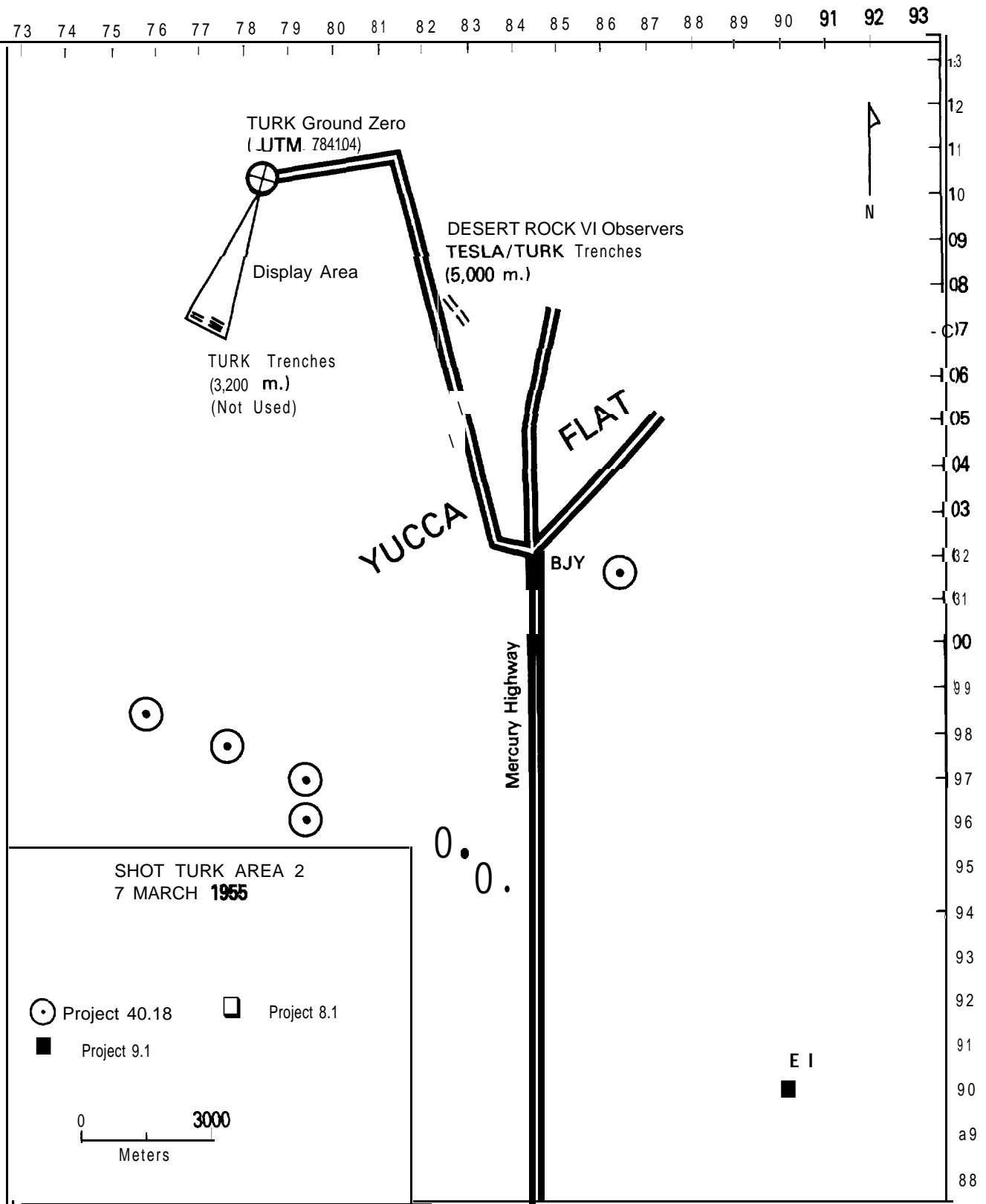


Figure 5-1: FORWARD POSITIONS OF DOD PERSONNEL AT SHOT-TIME FOR TURK

5.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT TURK

Table 5-1 lists Desert Rock VI programs at Shot TURK, in addition to the numbers and titles of projects, **project** sponsors, numbers of DOD participants, and their unit affiliations.

5.1.1 Troop Orientation and Indoctrination Projects

Five troop orientation and indoctrination **projects** took place at Shot TURK, including 445 Camp Desert Rock support troops who participated in one unnumbered troop orientation and indoctrination project.

As Table 5-1 shows, 464 observers witnessed Shot TURK. Although trenches had been constructed for TURK observers 3,200 meters south of ground zero, they were within the expected path of fallout, and therefore were not used. The trenches occupied by TURK observers were the same trenches used on 1 March by the troop observers at Shot TESLA. These trenches were located 5,000 meters southeast of the TURK shot-tower (35; 42).

Table 5-1: EXERCISE DESERT ROCK VI PROJECTS, SHOT TURK

Program Type	Project	Title	Estimated Personnel	Participants
Troop Orientation and Indoctrination	41.3	Army Observers	14	Army
	41.4	Navy Observers	2	Navy
	40.11	Marine Observers	1	Marine Corps
	41.8	Air Force Observers	2	Air Force
	-	Camp Desert Rock Observers	445	Camp Desert Rock Support Troops
Troop Test	40.18	Location of Atomic Bursts	45	Battery C (-), 532nd Field Artillery (Observation) Battalion
Technical Service	40.19	Sixth Army CBR Defense Team Training	24	Sixth Army
	40.21	Ordnance Vehicular Equipment Test	*	Ballistic Research Laboratories; 573rd Ordnance Company; Detroit Arsenal; Chemical Warfare Laboratory

* Unknown

The observers arrived at the trenches between 0410 and 0420 hours. During the one-hour wait for the detonation, security and communications checks were completed, and the observers went through a preshot orientation program.

Since fallout was predicted to be heavy in the forward area, transport vehicles were parked approximately eight kilometers south of the trench area, to provide a quick evacuation. A post-shot tour of the Project 40.21 equipment display area, shown in figure 5-2, was conducted on the following day because of radiation levels in the display area on shot-day (35).

5.1.2 Troop Test

Only one troop test, Project 40.18, Location of Atomic Bursts, was conducted at Shot TURK. This project was conducted by 45 participants from Battery C (-), 532nd Field Artillery (Observation) Battalion. The objective was to test equipment capable of locating the position of a nuclear detonation on a three-dimensional grid and determining its yield. Surveys were conducted with radar sets, microphones, and cameras installed in eight stations shown in figure 5-1. These stations approximated the positions of an observation battery deployed under tactical conditions. Participants reached their stations at 1720 on 6 March, 12 hours before the detonation (42; 45; 67). The eight manned stations were positioned at the following locations within the NTS (67):

<u>STATIONS</u>	<u>UTM COORDINATES</u>
Flash Control Point	794964
Station Location 1	834945
Station Location 2	824953
Station Location 3	810961
Station Location 4	794969
Station Location 5	775976
Station Location 6	758985
Sound Control Point	862019



**Figure 5-2: DESERT ROCK OBSERVERS EXAMINE EQUIPMENT
DISPLAY ONE DAY AFTER THE TURK DETONATION**

5.1.3 Technical Service Projects

Exercise Desert Rock VI personnel performed two technical service projects at Shot TURK. Project 40.19, Sixth Army CBR Defense Team Training, was designed to train and field-test Chemical, Biological, and Radiological defense teams and their monitoring equipment. Two defense teams, totaling 24 participants, witnessed the TURK detonation from the observer trenches on 7 March. At 0900 on the following day, one team entered the forward area, established its command post two kilometers east of ground zero, and sent four survey parties out to determine the 1.0, 2.0, and 4.0 R/h isointensity areas using the radial method explained in section 3.3.8 of the TEAPOT Series volume. In the afternoon of 8 March, the team continued its surveys by locating the 8.0 and 16.0 R/h isointensity areas. During their surveys, project personnel approached to within 130 meters of ground zero. As the ground surveys were being conducted, one team member performed an aerial survey, probably in an L-20 aircraft. The entire survey activity was completed by 1500 hours.

The second team performed essentially the same activities on 9 March. However, this team was recalled while resurveying the test area because of a strong wind blowing dust into their area (49).

Project 40.21, Ordnance Vehicular Equipment Test, was sponsored by the Ballistic Research Laboratories. Its objectives were to determine the minimizing effect or damages of roll-over safety bars placed on wheeled vehicles, to obtain data for the future design of ordnance equipment, and to investigate the shielding effect of armor against gamma radiation. To achieve the desired objectives, the following equipment was placed in various positions in the display area:

- Three M48 tanks
- One M59 armored infantry vehicle

- One T97 self-propelled gun
- Six jeeps
- Six 2.5-ton cargo trucks
- Four 5-ton trucks.

The main participant in the project was a detachment from the 573rd Ordnance Company, which placed the test equipment. Ballistic Research Laboratories personnel from the Field Command Military Effects Group Project 3.1 recorded blast pressures from gauges located near the test equipment, while Army Chemical Warfare Laboratories personnel from AFSWP Project 2.7 took radiation measurements. Detroit Arsenal personnel helped place the test vehicles (6; 42; 75; 90).

5.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT TURK

In addition to the Exercise Desert Rock activities described in the previous section, DOD personnel took part in a variety of tests during Shot TURK that required them to enter the forward area before, during, and after the shot. DOD personnel performed the 19 projects sponsored by the Field Command Military Effects Group. DOD personnel assisted in another six test group projects, three sponsored by the LASL test group, one by the UCRL test group, and two by the Civil Effects Test Group (CETG). The Air Force, Navy, and Marine Corps conducted eight operational training projects. In addition, support activities accounted for a number of DOD participants at Shot TURK. The Air Force Special Weapons Center (AFSWC) flew missions for the test groups and the Test Manager.

5.2.1 Department of Defense Participation in Military Effects Group Projects

The 19 projects conducted by the Military Effects Group at Shot TURK are shown in table 5-2. Table 5-2 lists the test group

**Table 5-2: TEST GROUP PROJECTS WITH DEPARTMENT OF
DEFENSE PARTICIPATION, SHOT TURK**

Project	Title	Participants	Estimated Personnel
Military Effects Group			
1 1	Measurement of Free Air Atomic Blast Pressures	Air Force Cambridge Research Center	12
12	Shock Wave Photography	Naval Ordnance Laboratory	7
111	Spectral Measurements of Dynamic Pressure versus Time and Distance	Sandra Laboratory	8
1 14b	Measurements of As-blast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	6
21	Gamma Exposure versus Distance	Army Signal Corps Engineering Laboratories	*
26	Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field	Naval Medical Research Institute	8
28a	Contact Radiation Hazards Associated with Contaminated Aircraft	Air Force Special Weapons Center	*
31	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	4
52	Effects on Fighter Type Aircraft in Flight	Wright Air Development Center	2
61 Ia	Evaluation of Military Radar Equipment	Army Signal Corps Engineering Laboratories	3
61 Ib	Evaluation of a Radiological Defense Warning System	Army Signal Corps Engineering Laboratories	3
63	Missile Detonation Locator	Army Signal Corps Engineering Laboratories	4
64	Test of IBDA Equipment	Wright Air Development Center	16
65	Test of Airborne Naval Radars for IBDA	Bureau of Aeronautics	3
81	Measurement of Direct and Ground-reflected Thermal Radiation at Altitude	Bureau of Aeronautics	8
8.4e	Air Temperature Measurements	Naval Radiological Defense Laboratory	6
8 4f	Bolometer Measurements	Naval Radiological Defense Laboratory	*
91	Technical Photography	Lookout Mountain Laboratory, AFSWC; Air Force Missile Test Center, EG and G	7
94	Atomic Cloud Growth Study	Air Force Cambridge Research Center, Strategic Air Command, U S Weather Bureau	*

* Unknown

Table 5-2: TEST GROUP PROJECTS, SHOT TURK (Continued)

Project	Title	Participants	Estimated Personnel
Los Alamos Scientific Laboratory Test Group			
11 2	Radiochemistry Sampling	4826th Test Squadron (Sampling)	*
18 3	Time Interval Measurements	Naval Research Laboratory	*
18.4	Spectroscopy	Naval Research Laboratory	*
University of California Radiation Laboratory Test Group			
21 2	Sample Collecting	4926th Test Squadron (Sampling)	*
Civil Effects Test Group			
37 1	Factors Influencing the Biological Fate and Persistence of Radioactive Fallout	AFSWC	*
37 2	Phenomenology of Fallout at Near Distance	AFSWC	*

* Unknown

projects with DOD participation, including the participating agencies and the estimated numbers of DOD personnel involved. Because in most cases, many of the same individuals performed both pre-and postshot activities, estimates reflect the maximum number of DOD personnel who would have been involved in one aspect of the project. For example, if the project description states that 15 individuals performed preshot activities and five performed postshot recovery, the estimate listed in the table would be 15. The Test Manager allowed recovery operations to begin at 0825 hours, 2 hours after the shot (19).

Project 1.1, Measurement of Free Air Atomic Blast Pressures, used parachute-borne instruments to obtain data on the blast wave produced in the atmosphere. A few minutes before the detonation, instruments were dropped from two B-29 aircraft passing high above the TURK shot-tower. Following the detonation, at 1125 hours, three recovery teams, consisting of three project personnel and one radiological safety monitor each, proceeded in a weapons carrier to Area 2 to recover the air-dropped instruments.

These teams accomplished the recovery and returned from the shot area within four hours (41; 64; 67).

Project 1.2, Shock Wave Photography, was fielded to photograph the effects of the TURK shock wave. Four unmanned cameras were placed approximately 5,700 meters from the shot-tower. A series of smoke lines was created in the air beyond the shot-tower to facilitate detection of the shock waves by the cameras. To create the smoke, 16 smoke rockets were positioned in a lattice pattern 900 meters beyond the shot-tower seconds before the detonation. The movement of the shock wave through the air was detected by the displacement of this smoke grid.

On the day before the shot, at 1200 hours, six personnel in two vehicles proceeded to the rocket line located 900 meters northeast of the shot-tower to check equipment. Six hours later, after arming the rockets, these personnel left the area.

Recovery of the film from the four cameras was probably accomplished by six participants within one day of the shot. A radiological safety monitor accompanied Project 1.2 personnel during the recovery operations (64; 67; 76).

Project 1.11, Special Measurements of Dynamic Pressure versus Time and Distance, was conducted to measure variations in air-pressure caused by the detonation. Project 1.11 was intended for implementation at Shot MET. However, since most of the instruments to be used were new, they were given a preliminary field-test at TURK. It is estimated that four personnel spent three days surveying sites and installing gauges at six locations in the Yucca Flat area before the shot.

After the Test Manager announced at 0825 hours that recovery operations could begin, two **teams** of three individuals each entered Areas 4 and 9 to recover data and project equipment. The

location of equipment in Area 4 was about 830 meters north of the planned APPLE 1 ground zero, and nine kilometers from the TURK ground zero. The location in Area 9 was the 1.2a trailer revetment, which was approximately 15 kilometers from the TURK ground zero. One radiological safety monitor accompanied each work party (5; 64; 67).

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was conducted to measure the variations in air-pressure produced by a nuclear detonation. The instruments for Project 1.14b were placed along a line south-southwest of the TURK shot-tower at distances ranging from 540 meters to 3,220 meters. Preshot surveys, construction of instrumentation mounts, installation, and checks of gauges probably took six participants one week. Postshot recovery of data was accomplished in the days following the detonation, when radiation had decayed significantly (64; 67; 89).

Project 2.1, Gamma Exposure versus Distance, was designed to measure initial gamma radiation intensities at various distances from the nuclear detonation. Fourteen film dosimeter stations were arranged along a line extending 1,370 to 2,220 meters from the TURK shot-tower. Recovery operations took place on shot-day, after the Test Manager permitted re-entry into the test area (37; 64; 67).

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

Two teams of four men in two vehicles drove toward ground zero to a 0.5 R/h intensity area of the fallout field, located 2,700 meters from ground zero, and placed two mannequin stations on the day after the shot. The gamma radiation intensity reading

at the mannequin stations was actually 0.6 R/h. The project teams also placed two other dosimetry mannequins 2,250 meters from ground zero, at locations of 3.0 and 3.5 R/h intensities. The length of time personnel were in the field has not been documented, but positioning the four mannequins is likely to have required no more than 15 to 20 minutes (52; 64; 67).

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was conducted by at least five AFSWC personnel at Indian Springs AFB, to assess the exposure potential presented to ground-crew personnel by contact with F-84 aircraft that had flown through a nuclear cloud. Standard gamma survey meters were held near the contaminated components of the aircraft 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. By resurveying aircraft periodically over the next two days, and by attaching film to contaminated areas of the aircraft with masking tape, the accumulation of radiation exposure over time was assessed. The film was removed for analysis within 24 hours after the detonation.

During Project 2.8a some participants also placed film over the hands and fingers of their gloves while they performed the radiation surveys. The film was then removed, developed, and evaluated to assess accumulated dose to ground-crews working on contaminated aircraft. In another approach, project personnel rubbed the base of their hands over the surface of an aircraft with known contamination to make a radioautograph of the hand with large film packs. In this way, changes in the contamination patterns of aircraft and relative amounts of contamination which transferred to the hand could be measured. While conducting these studies, no members of the survey team exceeded the JTO authorized limit of 3.9 roentgens of whole body exposure (26; 64; 67).

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-enhanced blast wave created by a nuclear detonation. Prior to shot-day, three 1/4-ton trucks, six 2 1/2-ton trucks, two 5-ton trucks, two M48 tanks, one T97 self-propelled gun, and one M59 armored personnel carrier were placed on a line running south-southwest from the shot-tower from 716 meters to 1,130 meters. Project personnel also placed film badges on the M59 personnel carrier, on the self-propelled 155mm gun, and on one M48 tank. Recovery was not performed on shot day, however.

Three men in one vehicle, accompanied by a radiological safety monitor and personnel from Project 2.7, were scheduled to recover film badges from the armored vehicles in the shot area. It is estimated that this took one hour, and probably occurred on the day following the shot.

In the days following TURK, the vehicles that could be used again to yield worthwhile data were transported to the Shot MET and Shot HORNET shot areas. The two M48 tanks, the T97, and the M59 were moved to the APPLE 1 area to continue the tests on armored vehicles (6; 64; 67).

The purpose of Project 5.2, Effects on Fighter Type Aircraft in Flight, was to investigate the response of a F-84F <jet-fighter aircraft to the blast forces produced by a nuclear detonation. Two F-84F aircraft, each with a pilot, were oriented in a level-flight attitude to receive symmetrical tail-on inputs from the blast. At detonation, the first aircraft was at a slant range of about 4,320 meters from ground zero and at a height above the burst of 11,560 feet. The second F-84F was at a slant range of about 7,980 meters from ground zero and at a height above burst of 25,130 feet (64; 67; 83).

Project 6.1.1 was divided into two projects. Project 6.1.1a, Evaluation of Military Radiac Equipment, was to evaluate new radiation detecting instruments. Radiac instruments were placed in 15 locations between 900 and 2,700 meters from the shot-tower. The instruments were retrieved by three project personnel, including one radiological safety monitor, approximately two hours after recovery operations were permitted (10; 64; 67).

Project 6.1.1b, Evaluation of a Radiological Defense Warning System, was to assess the components of an experimental warning system. The system was located 3.2 and 6.4 kilometers east, and 18 to 28 kilometers south of the shot-tower. It is estimated that preshot activities, consisting of site selections, maintenance of detectors, and checks of equipment, probably took three DOD participants two days.

Five hours after the detonation, a team of two men in one vehicle traveled to three stations south and east of ground zero to remove equipment. One radiological safety monitor accompanied this party. A third project member drove to the farthest station, 27 kilometers south of ground zero, to recover equipment (64; 67; 78).

Project 6.3, Missile Detonation Locator, was to evaluate a tactical-range radar system for use in determining the location of a nuclear detonation. Two teams, each with two men in two vehicles, traveled to two stations 19 and 21 kilometers south of the shot-tower, arriving at these stations to operate test equipment by 2200 on 6 March, the day before the detonation. The teams remained at the stations through shot-time, and left for the Control Point within one hour, at 0620 on 7 March (64; 67; 74).

Project 6.4, Test of IBDA Equipment, was conducted to gather engineering evaluation data for an IBDA system installed in a B-50D aircraft. A secondary objective of the project was to determine the maximum operating range of the yield-measuring component of the system. Typically, the B-50D staged out of Kirtland Air Force Base and was positioned by radar between seven and thirteen kilometers from ground zero, to simulate a weapons delivery aircraft. The B-50 had a crew of ten, plus one engineer and technician to ensure the operation of the IBDA system. Two F-94s from Indian Springs AFB, each with two-man crews, were positioned 128 and 160 kilometers from ground zero at the time of detonation (27; 32; 64; 67).

Project 6.5, Test of Airborne Naval Radars for IBDA, was to evaluate the suitability of standard Navy radar to determine the location, height of burst, and yield of a nuclear detonation. An AJ-2 aircraft, with a crew of three, and an R4D aircraft, flew at an altitude of 30,000 feet on a 90-degree true heading inbound and was located at a point 11 kilometers west of ground zero at the time of detonation. The aircraft maintained the inbound heading until arrival of the blast front, continuing on this course for about 30 seconds, and then returned to its staging base in San Diego via Las Vegas (64; 67; 87).

Project 8.1, Measurement of Direct and Ground-reflected Thermal Radiation at Altitude, was performed to determine the ability of Navy aircraft to withstand the thermal radiation produced by a nuclear detonation. At detonation, an AD-6 aircraft was at a slant range of about 5,730 meters from ground zero and an altitude of 8,510 feet. An AD-4B was at a slant range of about 5,900 meters from ground zero and an altitude of 15,010 feet. A third Navy AD aircraft was used as standby. Each aircraft carried only one pilot.

At 0130 on shot-day, a team of five project personnel in two vehicles traveled to a radar station, at UTM coordinates 902906 on the NTS, to track and position Project 8.1 aircraft. The radar-team remained on location until one hour after shot-time (64; 67; 72).

Project 8.4e, Air Temperature Measurements, was conducted to measure the changes in air temperature following a nuclear detonation. A three-meter tower was positioned 457 meters south of ground zero. The tower was located just at the base and due west of a six-meter-high mound that enclosed a shelter for a Heiland Oscillographic Recorder. Ten instruments were mounted on the tower: three each at about 0.2 meter and 0.5 meter elevations from grade, two at about 1.0 meters, one at about 2.0 meters, and one at about 3.0 meters.

Preshot activities, included surveying locations, constructing the recording shelter and tower, and installing and checking out the instrumentation. They are likely to have taken five AEC contractor personnel and four project personnel one week to perform. Records indicate that two radiological safety monitors were assigned to Project 8.4e on shot-day. They accompanied two project teams consisting of two men each to collect essential data from the instrument site after recovery operations were permitted by the Test Manager. This initial recovery activity would have required about four hours. Recovery of the remaining data and equipment, and site cleanup, was probably accomplished in the days following the shot, after the radiation intensities at the project site had decayed to negligible levels (53; 64; 67).

The objective of Project 8.4f, Bolometer Measurements, was to determine the distribution of irradiance as a function of time during a nuclear detonation. All data were taken from Building 410, situated near the Control Point area in Yucca Pass (54; 64; 67; 79).

Project 9.1, Technical Photography, provided photographic documentation of the detonation and involved both ground and air activities. As part of the ground operations, three men began operating a photography station, located at the Control Point in Yucca Pass, at 0245 hours on shot-day. These three men remained at the station through shot-hour. Two of the three participants were probably employees of Edgerton, Germeshausen, and Grier, the contractor that accomplished most of the field work for Project 9.1. Operation Order 1-55 for TURK lists a major as commander of the party. He probably belonged to Lookout Mountain Laboratory, 1352nd Motion Picture Squadron.

The air operations were for nuclear cloud photography, using one RC-47 aircraft. The aircraft, each with a crew of three personnel and an estimated three photographers from Lookout Mountain Laboratory flew a holding pattern oriented from 10 to 16 kilometers southeast of ground zero at an altitude of 8,000 to 10,000 feet. Operations were supervised by the Lookout Mountain Laboratory, which did the photographic work, while the aircraft was manned by personnel from AFSWC and the Air Force Missile Test Center (30; 32; 64; 67).

Project 9.4, Atomic Cloud Growth Study, was conducted to evaluate the development of the cloud produced by the nuclear detonation. Project 9.4 included DOD personnel in both field and air activities. Field participation consisted of a *joint* effort by the Air Force Cambridge Research Center and the U.S. Weather Bureau in obtaining theodolite measurements on the rate of cloud rise and maximum cloud height. The project instruments were located at the north fence of the Control Point, Building T, at Yucca Pass.

Air participation in Project 9.4 was performed by the Strategic Air Command, which conducted an aerial photography mission involving two B-47s. Since this involvement in Project 9.4 was

part of Operational Training Project 40.5, details of the aerial photography mission are addressed in section 5.2.5 of this chapter (32; 38; 64; 67).

5.2.2 Department of Defense Participation in LASL and UCRL Test Group Projects

The LASL Test Group sponsored ten projects, only three of which included DOD participants: Projects 11.2, 18.3, and 18.4. Project 11.2 was performed by personnel of AFSWC 4926th Test Squadron (Sampling). The activities of this project are discussed with AFSWC activities in section 5.2.5 of this chapter. The two other projects that included DOD personnel: Project 18.3, Time Interval Measurements, and 18.4, Spectroscopy, were conducted by the Naval Research Laboratory. Documentation for these two projects is very limited (9).

The UCRL Test Group also sponsored ten projects at Shot TURK. Of these, only one, 21.2, Sample Collecting, involved DOD personnel. This mission was performed by personnel of AFSWC 4926th Test Squadron (Sampling). The activities of personnel in this project are discussed in section 5.2.5 of this chapter.

5.2.3 Department of Defense Participation in CETG Projects

The Civil Effects Test Group (CETG) conducted ten projects at Shot TURK. AFSWC flew radio-relay missions for Projects 37.1 and 37.2 as part of its terrain survey mission. These missions are discussed in section 5.2.5, and represent the only CETG projects involving DOD personnel during Shot TURK (24; 64).

5.2.4 Department of Defense Operational Training Projects

Eight DOD operational training projects were conducted at Shot TURK and are discussed below.

Project 40.1, Evaluation of IBDA Equipment and Techniques, which was conducted by the Strategic Air Command, included four RB-47s staging from George AFB, California. Its objective was to train Strategic Air Command crews to evaluate bomb damage assessment equipment during bomb-drop and aerial nuclear detonation exercises. Three of the aircraft made passes tangential to ground zero at altitudes ranging from 34,500 feet to 39,000 feet. The fourth RB-47 flew directly over ground zero at 40,000 feet (3; 32).

Project 40.3, Crew Indoctrination, was conducted by the Tactical Air Command. Six F-84 aircraft based at George AFB performed a controlled flyby maneuver. The objective was to train Tactical Air Command crews in the effects of a nuclear detonation while flying simulated tactical delivery and flyby maneuvers. According to planned documents, the F-84s, each with a pilot, established their position by orbiting 110 to 130 kilometers northeast of ground zero. They then flew at altitudes of 28,000 to 29,000 feet on a west-bound vector towards the NTS. Two minutes before detonation, the aircraft descended to altitudes ranging from 26,000 to 19,000 feet. Within eight kilometers of ground zero, the planes swung to the north before the blast wave arrived. After blast arrival, the planes returned to their base of operation (3; 32; 85).

According to TURK's Operation Order 1-55, ground activities for Project 40.3 were conducted by ten DOD personnel. At 0300 hours on shot-day, they occupied an MSQ radar station at UTM coordinates 928626, which was on the south side of Frenchman Flat. The personnel, who were probably from Tactical Air Command, operated the station until 0720 hours, almost two hours after detonation (67).

Project 40.4, Gust Effects on B-36 Aircraft, was conducted by the Strategic Air Command, and used one B-36 aircraft operating from Carswell AFB, Texas. The objective was to test the

weapons delivery capability of a B-36 aircraft, and to assess the delivery aircraft's escape distance from bombs of varying yields under different delivery systems. The plane carried 12 crewmen, including a radiological safety monitor. Flying between 23,000 and 27,000 feet, the B-36 established a 12 to 15 minute east-west race-track orbit over the shot-tower. The orbit was timed so that the airplane was directly above ground zero when the blast wave arrived. Once the blast wave had passed, the aircraft returned to its home base (1; 3; 32).

Project 40.5, Reconnaissance Crew Indoctrination, was also conducted by the Strategic Air Command. Project personnel performed photographic support for Project 9.4. Two RB-47 aircraft, each carrying a pilot, a co-pilot, and a radiological safety monitor, flew directly over ground zero at 47,000 and 43,000 feet, respectively. Their mission was to photograph the nuclear cloud. One RB-47 operated from Lockbourne AFB, and the other was based at Forbes AFB (1; 3; 32).

Project 40.6, Calibration of Electromagnetic Effects, was conducted by the Air Force to analyze the electromagnetic pulse emitted by the detonation of a nuclear device. At 0930 hours on the day before the TURK detonation, a team of four men in a helicopter left station 40.6b, located on Yucca Lake, 23 kilometers southeast of the shot-tower, to place four sets of unmanned recording equipment north, east, south, and west of ground zero at distances from 10 to 20 kilometers. This team was to leave the shot area before 1800 hours. According to planning documents, five men in two vehicles were to travel to station 40.6b to operate equipment two hours before the shot until one hour after the detonation (3; 32; 67; 77).

Project 40.8, Calibration of Bomb Debris, was also sponsored by the Air Force to determine the relative yields of all pertinent nuclear products and residues for use in categorizing

nuclear weapons. Nuclear cloud sampling for the project was integrated with the AFSWC sampling missions sponsored by LASL Project 11.2, and is discussed in section 5.2.5 of this chapter.

Project 40.10, Delivery Crew Indoctrination, was conducted by the **Navy**. Four AD aircraft, six AJ aircraft, three F-2H aircraft, and one TV2 aircraft performed simulated weapons delivery maneuvers at altitudes ranging from 24,000 to 34,000 feet. The objective was to familiarize Navy personnel with the effects of a nuclear detonation. The flight pattern established a race-track orbit over Indian Springs AFB, and then passed ground zero 30 seconds before the detonation. The airplanes then turned sharply to the right to be tail-on at the arrival of the blast wave, whereupon they returned to their base at San Diego, California (1; 3; 32).

Project 40.13, Tactical Indoctrination for a Marine Aircrew, was conducted by the Air Fleet Marine Force Pacific, and involved six AD aircraft, and one R4D aircraft operating out of El Toro Marine Air Base, Santa Ana, California. Its objective was to familiarize Marine personnel with the effects of a nuclear detonation. According to planned documents, the ADs and the R4D orbited at 17,000 feet and 15,000 feet, respectively, between Lathrop Wells, Nevada, and Camp Desert Rock, about 70 kilometers from the TURK shot-tower. The aircraft probably left El Toro 40 minutes before detonation, arrived over the NTS at H-hour, and then orbited for one hour after detonation (1; 3; 32).

5.2.5 Air Force **Special** Weapons Center Activities

The AFSWC Air Operations Center at Yucca Pass coordinated all military air traffic over the NTS. The support missions discussed in this section were carried out by AFSWC personnel and were divided into four categories: cloud sampling, courier service, cloud tracking, and aerial surveys of terrain.

Cloud sampling, which was conducted by AFSWC for LASL Project 11.2; LJCRL Project 21.2; and Air Force Project 40.8, enabled AEC and Air Force scientists to obtain samples of the nuclear cloud. Courier service, which involved no contact with the TURK nuclear cloud, was the delivery of test samples to weapons laboratories and DOD laboratories for prompt analysis. Cloud tracking not only allowed the AEC to plot the course of the nuclear cloud, but also helped the Civil Aeronautics Administration prevent commercial aircraft from crossing the cloud's path. Surveying allowed the Test Manager to monitor the land areas exposed to the nuclear cloud.

Listed by activity below are the number of aircrew members, and the number and type of aircraft involved. With the exceptions of the B-50 and B-29 cloud-tracking aircraft, which originated at Kirtland AFB, AFSWC aircraft staged out of Indian Springs AFB (32).

PROJECT	TITLE	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	ESTIMATED NUMBER OF PERSONNEL
11.2, 21.2, and 40.8	Sampling			
	Sampler Control	B-50	1	9
	Samplers	F-84G	9	9
	Courier Service	c-47	1	3
		c-119	2	8
		B-25	1	5
	Cloud Tracking	B-50	1	12
		B-29	1	12
		B-25	1	5
	Aerial Surveys of Terrain	c-47	3	9
		H-19	3	15

Cloud Sampling

At Shot TURK, nine F-84G aircraft carrying one AFSWC pilot each, performed the cloud-sampling mission. In addition, a B-50 with an estimated crew of nine and one scientific adviser on

board acted as sampler control. Particulate cloud-sampling was carried out for Projects 11.2 and 21.2. Compressed air samples were also taken by sampling pilots for Air Force Project 40.8. The operation had some minor difficulties, including the loss of cabin pressure within one aircraft due to a film badge lodged in a canopy seal. The sampling altitudes ranged from 23,000 to 43,000 feet. The first aircraft began cloud penetration one hour and 20 minutes following the detonation, and the ninth sampler began four hours after the detonation. The following listing provides information for each aircraft mission (32; 33):

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)
F-84G #028	4	6:00	40
F-84G #033	6	2:00	5
F-84G #043	4	3:16	58
F-84G #046	5	6:00	10
F-84G #049	2	0:40	.6
F-84G #051	2	2:00	5
F-84G #054	4	14:45	5
F-84G #038	2	26:00	5
F-84G #030	3	1:35	3

Upon completion of their sampling sorties, each aircraft returned to Indian Springs AFB.

Courier Service

In order to transport scientific samples to the AEC nuclear weapons development laboratories and DOD laboratories, four AFSWC aircraft left Indian Springs AFB within six hours of the detonation for McClellan AFB, UCRL, and Kirtland AFB. A C-47, a B-25, a C-119 left with samples at five-minute intervals, beginning at 1100. A second C-119 left at 1112 (32; 33).

Cloud Tracking

Cloud-tracking at Shot TURK was more complicated than at previous shots. Upon detonation at 0520 hours on 7 March 1955, the TURK nuclear cloud separated into an uneven mass, forcing the three cloud-trackers to fly different courses. A B-50 from Kirtland AFB, flying at 28,000 to 31,000 feet MSL, traveled due east tracking the cloud to Glendale, Nevada. A B-29 from Kirtland AFB followed another portion of the cloud northwest at an altitude of 20,000 to 23,000 feet MSL until it reached Tonopah, Nevada. A third aircraft, a B-25 from Indian Springs AFB, tracked the cloud northward at an altitude of 11,000 to 14,000 feet MSL (32; 33).

Aerial Surveys of Terrain

For TURK, three C-47s performed aerial surveys of the terrain around the NTS. Two of the aircraft flew 300 to 500 feet above ground, while the third flew at 12,000 and 13,000 feet. The third C-47 also acted as radio-relay aircraft for CETG Projects 37.1 and 37.2 and their ground vehicles. The area monitored by the C-47s stretched north of the NTS to Tonopah and Round Mountain, Nevada. Although the mission was routine, it was complicated by an unusual wind-shear which resulted in an unusually wide cloud dispersion and a large area of fallout. Three H-19

helicopters also transported radiological safety monitors during the surveying activities (32; 33).

5.3 RADIATION PROTECTION AT SHOT TURK

The purpose of the radiation protection procedures developed by Exercise Desert Rock VI, JTO, and AFSWC was to ensure that participants' exposure to ionizing radiation was as low as possible while completing their tasks. Some of the procedures described in the Series volume resulted in records which enabled Exercise Desert Rock, the Joint Test Organization, and AFSWC to evaluate the effectiveness of their procedures. Such records for TURK have been located only for the Joint Test Organization. The JTO Onsite Radiological Safety Organization was staffed by soldiers of the Army's 1st Radiological Safety Support Unit, from Ft. McClellan, Alabama, and was managed by AFSWP.

The information presented in this section includes film badge data, logistical data on radiological safety equipment, survey results, isointensity maps, and decontamination records. Other than the Final Dosage Report, no description of Exercise Desert Rock VI or AFSWC safety activities have been located. The Final Dosage Report summarizes exposure for the entire series and is therefore discussed in the TEAPOT Series volume.

Dosimetry

From 6 March through 10 March 1955, the period including Shot TURK on 7 March, 14 persons accumulated exposures between 2.0 and 3.9 roentgens for Operation TEAPOT thus far. In addition, four participants accumulated exposures greater than 3.9 roentgens (92). One was a member of the 1st Radiological Safety Support Unit; one was a lieutenant from the 479th Supply Squadron; one was with the 3082nd Aviation Depot Group; and the other was with Headquarters, Chemical Corps Training Command. The first two individuals had cumulative exposures of 4.61 and

4.69 roentgens, respectively, by 10 March. The third had a cumulative exposure of 4.41 roentgens by 11 March. The fourth person had a total exposure of 3.94 roentgens by 8 March (11; 12; 19). An additional person, a civilian from Bendix Aviation, received a total exposure of 4.07 roentgens by 8 March (11).

Nine AFSWC pilots flew cloud-sampling missions in F-84G aircraft for Shot TURK. Their film-badge readings ranged from 0.8 to 1.5 roentgens of gamma-radiation exposure.

During the five-day period from 6 through 10 March, the Dosimetry and Records Section issued 1,515 film badges and 496 pocket dosimeters (14; 19; 32).

Logistics

During Shot TURK, the General Supply Section issued 512 pieces of protective clothing and 105 respirators. In addition, the Instrument Repair Section issued 244 radiation survey meters during the test event (19).

Monitoring

Because wind conditions predicted for shot-time would have carried fallout south over the Control Point, the **Onsite** Security Division devised an evacuation plan for that area. This plan scheduled the initial survey and area access checkpoint teams to survey areas around the Control Point in the event of fallout (19).

At 0630, 70 minutes after detonation, the Radiological Safety Officer determined that fallout would not reach the Control Point area. The initial survey team had left the Control Point at 0530 hours, reorganized at the BKY intersection, and began its survey at 0630 hours. The initial survey team consisted of five two-man teams. An aerial survey party consisting of five three-man teams conducted surveys of the shot area from three H-19 helicopters as well (19).

Additional two-man teams, who had been added to assist in the potential evacuation, took further readings. Fallout intensities across the Area 2 access road exceeded 10 R/h. The initial survey was completed at 0915 hours. A copy of the initial isointensity map is shown in figure 5-3. The onsite fallout pattern could not be entirely mapped because of mountainous terrain to the southwest (19).

Monitors resurveyed the shot area on 8, 9, 17, and 25 March. Copies of the isointensity maps generated from resurveys are shown in figure 5-4. The average exposures for participants in the initial and first resurvey teams were 1.2 and 0.6 roentgens, respectively (19).

On shot-day, monitors were provided to the following projects (19):

<u>PROJECT</u>	<u>NUMBER OF MONITORS</u>
1.1	3
1.2	1
1.12	2
1.14	4
3.1	4
6.1.1	1
8.4	2
23.2	1
23.5	1
30.3	2
33.1	1
38.1	4

In addition, the Monitoring Section furnished 15 monitors for projects on the days following Shot TURK (19).

Recovery and Re-entry Procedures

Following the cancellation of the evacuation plan for the Control Point area, the initial survey began at 0630 and was completed by 0915 hours. The Test Manager declared recovery-hour at 0825 (19).

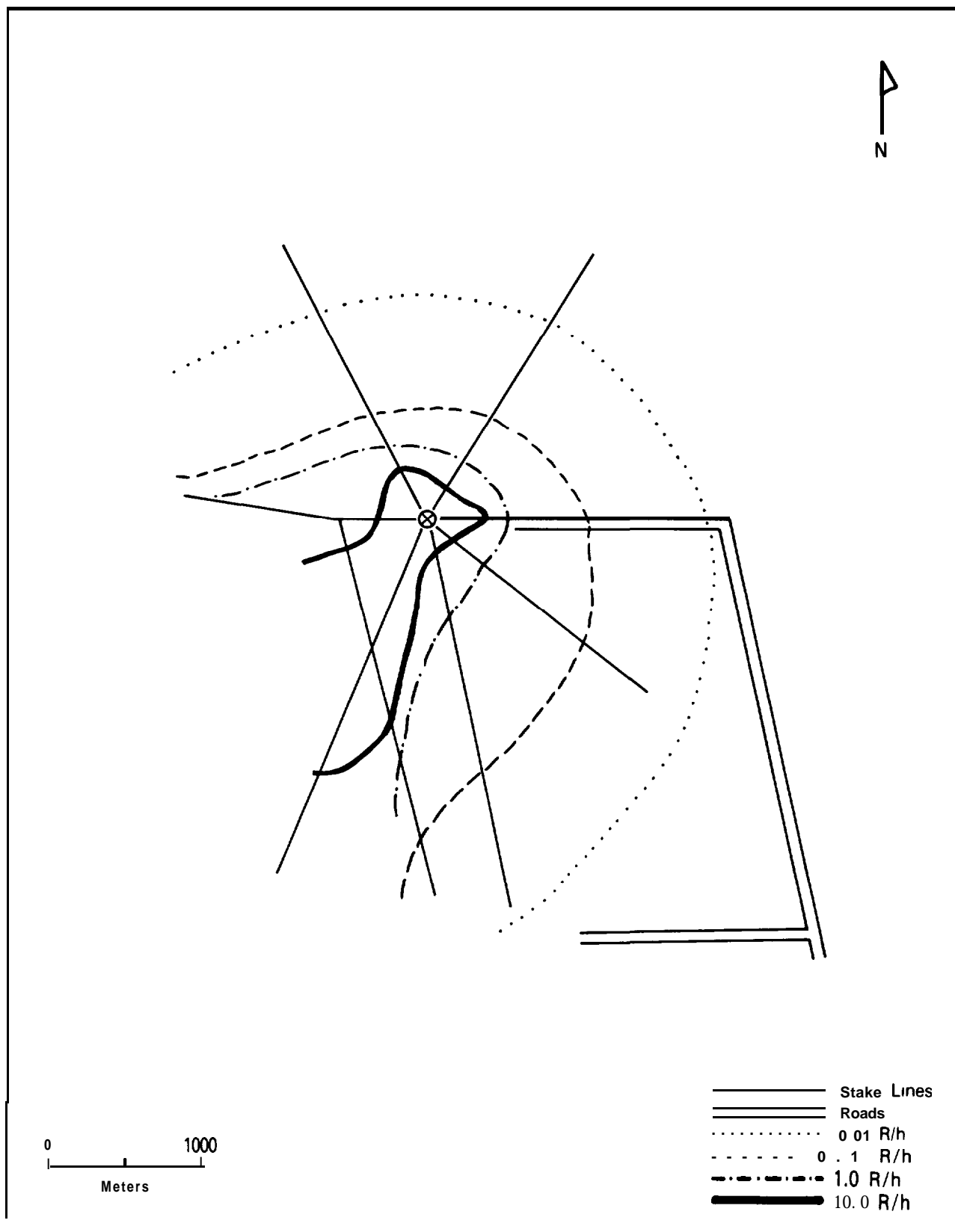
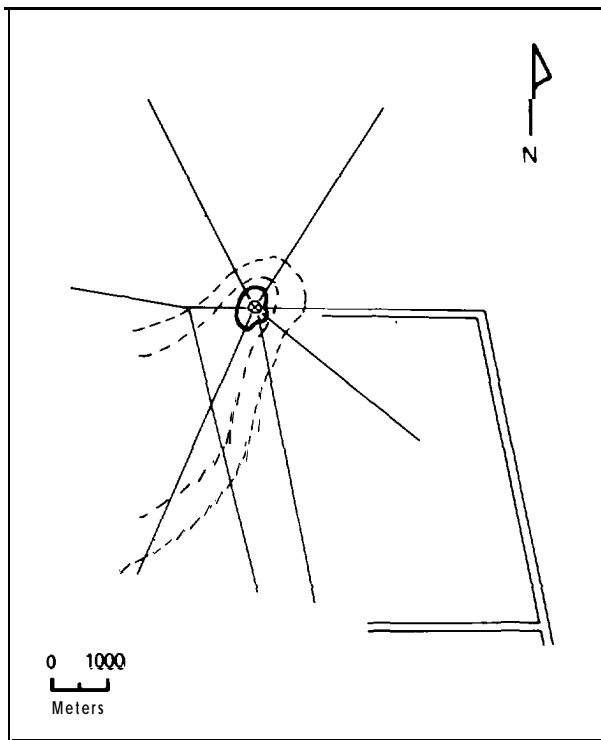
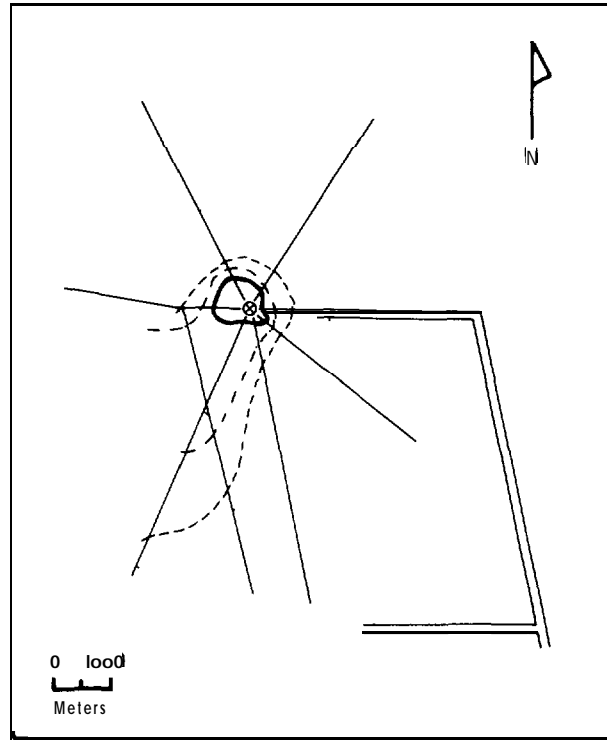


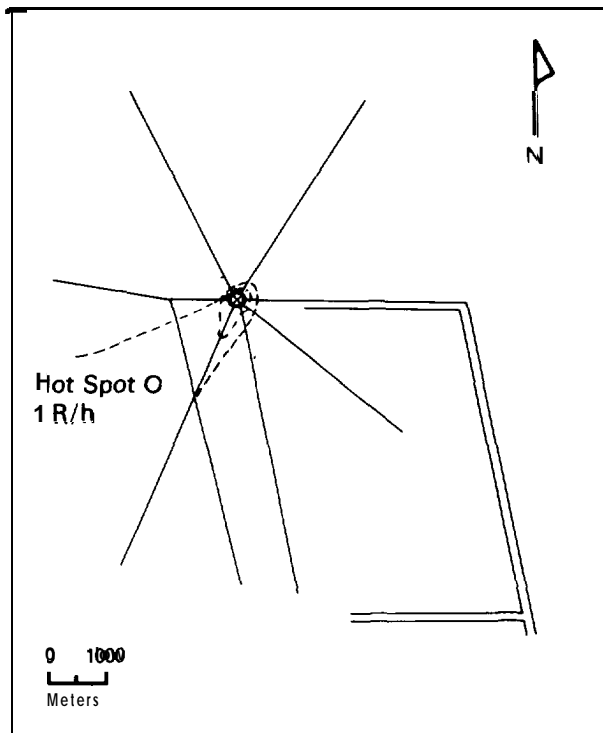
Figure 5-3: INITIAL SURVEY FOR SHOT TURK, 7 MARCH 1955,
0630 TO 0915 HOURS



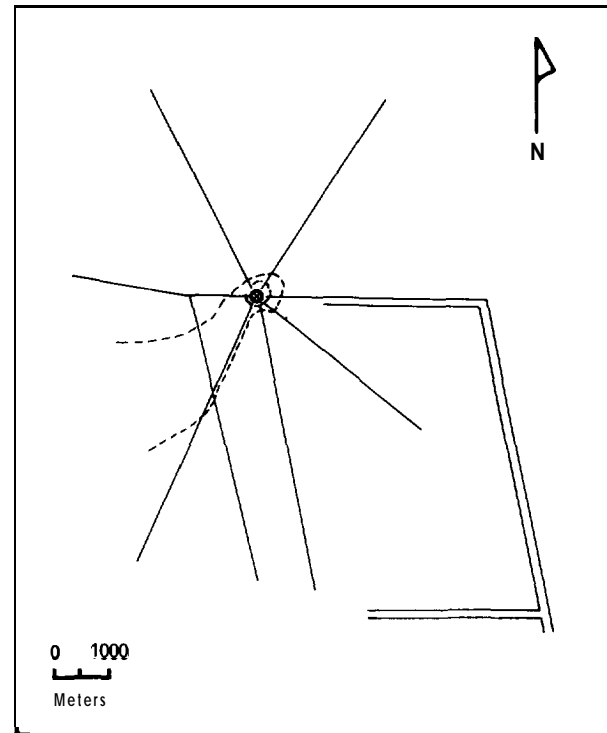
8 March 1955, 0630 to 0800 Hours



9 March 1955, 0900 to 1120 Hours



17 March 1955, 1200 to 1500 Hours



1107 to 1200 Hours

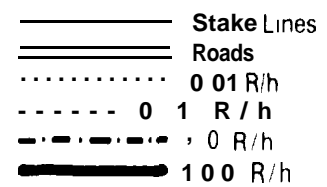


Figure 5-4: RESURVEYS FOR SHOT TURK

The following numbers of parties were cleared briefed for entry into the test area (19; 59):

<u>DATE</u>	<u>NUMBER</u>
7 March	23
8 March	11
9 March	16
10 March	8
11 March	3
12 March	2
13 March	1

Decontamination

During Shot TURK, 7 through 10 March, 36 vehicles and ten pieces of equipment required decontamination. An additional six items were placed in the hot park to permit their radiation intensities to decay to acceptable limits (19).

HORNET

SHOT SYNOPSIS

AEC TEST SERIES: TEAPOT
DOD EXERCISE: Desert Rock VI
DATE/TIME: 12 March 1955, 0520 hours
YIELD: 4 kilotons
HEIGHT OF BURST: 300 feet (tower shot)

Purpose of Test: To test nuclear weapons for possible inclusion in the nuclear arsenal.

DOD Objective: To study the effects of a nuclear weapon on military materiel.

Weather: At shot-time, the temperature at shot height was at 2°C; relative humidity at 29 percent; pressure at 874 millibars; then surface wind blew at one knot from the southwest, reaching 53 knots from the west at 40,000 feet.

Radiation Data: Onsite fallout was greater than 10.0 R/h to the east of ground zero as far as the initial survey (0553 to 0735 hours) was conducted.

Participants: Exercise Desert Rock VI participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 6

SHOT HORNET

The fifth shot of the TEAPOT Series was Shot HORNET. Originally planned for 8 March 1955, HORNET was detonated four days later, on 12 March, at 0520 hours. The nuclear device was positioned on top of a 300-foot tower in Area 3 of the Nevada Test Site (NTS), at UTM coordinates 867996, and yielded four kilotons of energy (29; 34). The Los Alamos Scientific Laboratory (LASL) developed the HORNET device and sponsored the event. The nuclear cloud reached an altitude of 37,000 feet MSL. The HORNET cloud and subsequent fallout drifted eastward and then spread to the northeast and southeast as it approached the Utah/Arizona state line (29; 34; 57).

Department of Defense (DOD) participants took part in one Exercise Desert Rock activity, as well as in diagnostic and effects experiments, and support missions, all described in this chapter. An account of the radiological situation created by Shot HORNET, along with the procedures used to determine the situation and subsequently minimize exposure of participants to radiation, is summarized at the end of the chapter.

6.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT HORNET

The Troop Orientation and Indoctrination Program, which accounted for the largest number of DOD personnel at all other TEAPOT events, was not implemented at Shot HORNET. The Technical Service Program, which often involved complex field activities, also was not conducted at HORNET. The only Desert Rock activity instituted at HORNET was one troop test, Project 40.18, Location

of Atomic Bursts. Project 40.18, was conducted by 45 participants from Battery C (-), 532nd Field Artillery (Observation) Battalion. The objectives of Project 40.18 were to test equipment and procedures for locating a nuclear detonation on a three-dimensional grid and determining its yield. Surveys were carried out at stations equipped with cameras, bhangmeters, radar sets, and sound microphones=. About 45 personnel were involved. Personnel manned seven survey stations approximating the deployment of an observation battery under tactical conditions, and located at the following locations (71):

<u>STATIONS</u>	<u>UTM COORDINATES</u>
Station Location 6	740958
Station Location 5	791938
Station Location 4	805922
Station Location 3	822906
Sound Control Point	858874
Station Location 2	843886
Station Location 1	867868
Flash Control Point	822906

All the stations were manned at 1630 hours on 11 March, almost 13 hours before the HORNET detonation. Although documentation does not indicate when personnel departed from the stations, it is probable that Project 40.18 personnel remained at the stations only a short time after the detonation, returning to Camp Desert Rock as soon as their data were recorded (9; 42; 71).

6.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT HORNET

In addition to the Exercise Desert Rock activities described in the previous section, Department of Defense personnel performed a variety of tasks during Shot HORNET that required them to enter the forward area before, during, or after the shot.

DOD personnel conducted 20 projects sponsored by the Field Command Military Effects Group and assisted in another three test

group projects; two sponsored by the LASL test group and one by the Civil Effects Test Group. The Air Force, Navy, and Marine Corps conducted five operational training projects. In addition, the Air Force Special Weapons Center (AFSWC) flew missions for the test groups and the Test Manager. These support activities accounted for a number of DOD participants at Shot HORNET.

6.2.1 Department of Defense Participation in Military Effects Group Projects

The 20 projects performed by the Military Effects Group at Shot HORNET, are shown in table 6-1. Table 6-1 lists the test group **projects** with DOD participation, includes the fielding agency and, when available, the estimated numbers of DOD participants. **Because in most cases**, many of the same personnel performed both **pre-** and **postshot** activities, estimates reflect the maximum number of DOD participants who would have been involved in one aspect of the **project**. For example, if the **project** description states that 15 participants performed preshot activities and five performed **postshot** recovery, the **estimate** listed in the table would be 15. The Test Manager allowed recovery operations to begin at 0755 hours (19).

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was conducted to measure air-pressure variations produced by a nuclear detonation. Instruments were placed on two lines extending from ground zero: one extended east, with instruments at distances ranging from 230 to 730 meters from the shot-tower, while the second line extended southwest with instruments between 192 to 604 meters. Surveys, construction of instrumentation mounts, installation, and checks of gauges prior to shot-day probably took six personnel two weeks to accomplish. Recovery of the data from the stations was probably accomplished by three project personnel in the two days following the nuclear test, when radiation had decayed substantially (61; 71; 89).

**Table 6-1: TEST GROUP PROJECTS WITH DEPARTMENT OF
DEFENSE PARTICIPATION, SHOT HORNET**

Project	Title	Participants	Estimated Personnel
Military Effects Group			
1 14b	Measurements of Air-blast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	6
21	Gamma Exposure versus Distance	Army Signal Corps Engineering Laboratories	*
22	Neutron Flux Measurements	Naval Research Laboratory	4
23a	Neutron-Induced Radioactive Isotopes in Soils	Naval Radiological Defense Laboratory	4
23b	Gamma Radatron Fields Above Fallout Contaminated Ground	Naval Radiological Defense Laboratory	*
251	Fallout Studies	Chemical Warfare Laboratory, Army Chemical Center	*
28a	Contact Radatron Hazards Associated with Contaminated Aircraft	Air Force Special Weapons Center	*
31	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	4
52	Effects on Fighter Type Aircraft in Flight	Wright Air Development Center	2
61 1a	Evaluation of Military Radac Equipment	Army Signal Corps Engineering Laboratories	3
61 1b	Evaluation of a Radiological Defense Warning System	Army Signal Corps Engineering Laboratories	3
63	Missile Detonation Locator	Army Signal Corps Engineering Laboratories	4
64	Test of IBDA Equipment	Wright Air Development Center	16
65	Test of Airborne Naval Radars for IBDA	Bureau of Aeronautics	3
03	Protection Afforded by Operational Smoke Screens	Army Chemical Center	11
64b	Thermal Measurements from Fixed Ground Installations	Naval Radiological Defense Laboratory	9
84d	Spectrometer Measurements	Naval Radiological Defense Laboratory	*
84f	Bolometer Measurements	Naval Radiological Defense Laboratory	*
91	Technical Photography	Lookout Mountain Laboratory, AFSWC, Air Force Missile Test Center, EG and G	7
94	Atomic Cloud Growth Study	Air Force Cambridge Research Center, U S Weather Bureau, EG and G	*
Los Alamos Scientific Laboratory Test Group			
11 2	Radiochemistry Sampling	4926th Test Squadron (Sampling), AFSWC	10
184	Spectroscopy	Naval Research Laboratory	*
397	Physical Measurement of Neutron and Gamma Radatron Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects	School of Aviation Medicine	1

* Unknown

Project 2.1, Gamma Exposure versus Distance, was fielded to evaluate the gamma radiation exposure potential at various distances from a nuclear detonation. Twenty-one dosimeter stations were arranged along a line extending from the shot-tower into the expected upwind sector of the shot area. The dosimeter stations were between 250 and 1,900 meters from the shot-tower. About one hour after recovery operations began, three project personnel and a radiological safety monitor in a weapons carrier started to collect the dosimeters, working toward ground zero as far as the radiation intensities permitted. All stations were recovered. It is estimated that this recovery task took about 15 minutes (37; 61; 71).

Project 2.2, Neutron Flux Measurements, was conducted to evaluate the neutron-radiation exposure potential at various distances from a nuclear detonation. Neutron-detection instruments were located between 90 and 910 meters southwest of the shot-tower. The stations within 400 meters of ground zero were attached to a cable laid from the surface point of a detonation, while the remaining stations were set on stakes.

To obtain valid results from this project, the neutron-detection instruments had to be analyzed as soon after exposure as possible. Therefore, the Test Manager allowed a recovery team of Project 2.2 personnel to follow the initial radiological survey team into the shot area 20 minutes after the detonation. These personnel pulled the instrument cable to the 450-meter station area for recovery of the attached instruments. At 0655 hours, three project participants in one vehicle set out to recover the remaining neutron detectors at the staked stations beyond 450 meters. This party was accompanied by one monitor from the Radiological Safety Support Unit. It is estimated that project personnel spent about 30 minutes in this area disconnecting and recovering instruments (39; 61; 71).

In **Project 2.3a**, Neutron-induced Radioactive Isotopes in Soils, nine soils were obtained from various locations within the continental U.S., Hawaii, and Puerto Rico and were considered by the U.S. Department of Agriculture to represent typical sands, loams, and clays. In addition, a tenth soil was obtained from the test site prior to detonation. Four samples were made of each of the ten soil types. Project personnel then placed the 40 soil samples in separate 1.5-inch iron pipes which were capped at both ends. A member of Sandia Laboratory attached the iron pipes to a cable, which reached from the shot-tower to an anchor point outside the expected radiation field. The soil containers attached to the cable were about 50, 140, 230, and 320 meters from the shot-tower.

About three hours after the detonation, three participants from **Project 2.7**, accompanied by an unknown number of participants from **LASL's Program 12** and one radiological safety monitor from Sandia, retrieved the 40 samples. They drove to the end of the cable farthest from ground zero, attached the cable to the back of the vehicle, and pulled it, with the soil containers attached, to an area of minimal radioactivity. The samples were immediately removed from the cable and taken to Camp Mercury for analysis (55; 61; 71; 90).

Although JTO planning documents indicate that **Project 2.3b**, Gamma Radiation Fields above Fallout Contaminated Ground, and **Project 2.7**, Shielding Studies, were scheduled to be conducted at HORNET, research has yielded no descriptions of project activities at this test event. General descriptions of activities for **Projects 2.3b**, and **2.7** are contained in the TEAPOT Series volume (61; 71).

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 an aerial survey of the HORNET shot area following the detonation. The aerial survey was conducted within 24 hours after the HORNET burst (61; 71; 84).

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was conducted by AFSWC personnel at Indian Springs AFB. The objective of this project was to evaluate the radiological exposure potential to ground personnel working on aircraft that had flown through a nuclear cloud. This was accomplished by correlating the radiation dose rates indicated by standard gamma radiation survey meters held near the contaminated components of the aircraft. Available documentation indicates that this project was similarly conducted at 11 TEAPOT events. At most shots, two aircraft flew through the cloud. After the aircraft landed, as many as five individuals took part in the radiation survey, which took about two hours. Decay studies were conducted up to 24 hours after the detonation. A general description of project procedures appears in the TEAPOT Series volume (26; 61; 71).

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, was conducted to determine the ability of heavy equipment to withstand the blast effects of a nuclear detonation. For HORNET, one of the shot-specific objectives of Project 3.1 was to obtain radiation-attenuation data on tank armor. Since Shot TURK was delayed from its original firing date, an M48 tank was removed from the TURK display and placed 410 meters southwest of the HORNET shot-tower. After the shot, this tank was moved out of the HORNET shot area to the APPLE 1 shot area where only background radiation was present. There radiation decay of the tank was analyzed. Other tanks were located about 460 meters east of the shot-tower.

At 2200 hours on the day before the HORNET test, two project personnel entered Area 3 in two vehicles to activate gauges on or

near pieces of heavy equipment located 180 to 750 meters east and southwest of the shot-tower. This activity took approximately two hours.

The Postshot Report for HORNET states that recovery of instruments was to take place at a later date to reduce the radiation exposure to personnel (6; 61; 71).

Project 5.2, Effects on Fighter Type Aircraft in Flight, was conducted to determine the ability of an F-84 aircraft to withstand blast forces produced by a nuclear detonation. One F-84F, with a pilot, was positioned in a level-flight attitude to receive symmetrical and asymmetrical side-on gust loads. At detonation, the F-84 was at a slant range of about 4,540 meters from the point of detonation and at a height of 10,500 feet MSL at the time of shock arrival (61; 71; 83).

Project 6.1.1a, Evaluation of Military Radiac Equipment, was designed to evaluate new radiation detection instruments. Film badges and dosimeters of various types were placed at 11 locations between 900 and 2,700 meters from the shot-tower. The dosimeters were retrieved by three personnel, including a radiological safety monitor, at approximately 0855 (10; 61; 71).

Project 6.1.1b, Evaluation of a Radiological Defense Warning System, was designed to evaluate components of a new radiological warning system. The system stations were positioned 12.8 and 14.4 kilometers south of the shot-tower. It is estimated that preshot activities, consisting of site selection, maintenance of detectors, and checks of equipment, probably took three individuals one day. At 0855 hours on shot-day, a team of nine participants entered residual radiation fields to place additional experimental radiac meters intended for evaluation for use in the warning system. Two monitors from the Radiation Safety Organization accompanied these project personnel (61; 71; 78).

Project 6.3, Missile Detonation Location, was conducted to test the feasibility of a tactical-range radar system for use in determining the location of nuclear detonations. The detonation locator consisted of broad-band receivers, which were set up on baselines in California approximately 110 and 320 kilometers southwest of the NTS.

Onsite participation in Project 6.3 was limited to two teams of project personnel. About five hours before shot-time, the two teams traveled to two test stations situated ten and 13 kilometers south-southwest of the shot-tower. They remained at these locations to operate equipment through shot-time, and returned to the Control Point by 0755, two and a half hours after the detonation (61; 71; 74).

Project 6.4, Test of IBDA Equipment, was designed to gather engineering evaluation data for an Indirect Bomb Damage Assessment (IBDA) system, installed in a B-50D aircraft. The system consisted of the standard radar set, AN/APQ-24; an experimental radar set, AN/APA-106 (XA-1); a light and time recording set, AN/ASH-4 (XA-1); and a K-17 aerial camera. A secondary objective was to determine the maximum operating range of the AN/ASH-4 recording set, the yield-measuring component of the system. This was accomplished by placing a recording set and a bomb-spotting camera in each of two F-94 aircraft to obtain comparison data. The B-50D usually carried a crew of ten, but because technical evaluation data was sought, an additional engineer and technician were added to the crew to monitor the system. Each F-94 had a two-man crew.

Typically, the B-50D which staged out of Kirtland AFB, was positioned by radar between seven and 13 kilometers from the point of detonation, to simulate a weapons delivery mission. The F-94s, from Indian Springs AFB, were positioned about 64 and 252 kilometers from ground zero at shot-time. However, at HORNET one

F-94 aborted at take-off. The second F-94 performed the mission, but experienced radar positioning trouble (27; 32; 61; 71).

As Project 6.5, Test of Naval Airborne 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. Supervised by the Bureau of Aeronautics, an AJ aircraft, with a crew of three, flew at an altitude of 30,000 feet on a 90-degree true heading inbound and was about 11 kilometers west of ground zero at the time of detonation. The aircraft maintained the inbound heading until arrival of the blast front, continuing on this course for about 30 seconds and then returned to its staging base in San Diego via Las Vegas (32; 61; 71; 87).

Project 8.3, Protection Afforded by Operational Smoke Screens Against Thermal Radiation, was fielded to evaluate the effectiveness of a smoke screen as a shield against the heat produced by a nuclear detonation. A smoke screen instrument line was established running due east from the shot-tower. Three primary instrument stations were located on this line at locations about 310, 430, and 580 meters from the shot-tower. Secondary stations were located at 230 and 730 meters. To produce the smoke screen, 120 smoke generators were placed around the instrument line. If adverse wind conditions had prevented some or all of the smoke generators from firing, a grid array of an additional 75 smoke pots was set up to cover the instrument line. Firing of smoke pots and smoke generators was controlled from the Control Point with a selective firing system to permit a choice of smoke-generating methods under existing wind conditions. Two remote-reading wind direction and velocity gauges were installed at locations 240 meters east and 790 meters west of the shot-tower on the smoke instrumentation line. These

meteorological instruments were connected to recorders in the Control Point. The readings from these gauges guided the Project Director in deciding whether smoke generators or smoke pots would be fired.

One aircraft at a slant range of 12,875 meters from ground zero and at an altitude of 8,000 feet took aerial photographs of the instrument array during the detonation. Both motion-picture and still cameras were positioned at stations 3,020, 4,580, 5,410, and 6,000 meters from ground zero to assist in locating the smoke screen position and to determine the cloud height.

According to the Test Director's Operational Order for HORNET, at 0720 hours, three participants were to proceed in one vehicle to the Project 8.3 primary instrument stations located 310, 430, and 580 meters from ground zero to determine the status of the project. At the same time, six participants in two vehicles were to be at the secondary instrument stations 230 and 730 meters from ground zero. The personnel, accompanied by two radiological safety monitors, spent two hours in the field (4; 31; 32; 61; 71).

The objective of Project **8.4b**, Thermal Measurements from Fixed Ground Installations, was to measure the thermal radiation from TEAPOT nuclear detonations at ranges where thermal radiation caused damage to military targets. Thermal-radiation measurements were made with **MK6F** calorimeters and radiometers from ground installations relatively close to ground zero.

At 0715 hours, about two hours after the detonation, six project personnel traveled in three vehicles to recover film and inspect instruments at locations 1,500 meters west of ground zero and approximately 300, 400, and 600 meters east of ground zero. Three radiological safety monitors, furnished by the 1st Radiological Safety Support Unit, accompanied these personnel.

Recovery personnel wore protective clothing and respirators (50; 61; 71).

Project 8.4d, Spectrometer Measurements, was designed to measure the thermal energy released by the detonation as a function of time. The recording spectrometer was located in Building 410, near the Control Point in Yucca Pass. Personnel worked in Building 410, both before and after the shot (61; 71; 80).

Project 8.4f, Bolometer Measurements was conducted to determine changes in the amount of thermal radiation as a function of time during a nuclear detonation. As with Project 8.4d, data were taken from Building 410 (54; 61; 71; 79).

Project 9.1, Technical Photography, documented project activities and results. Although this project had no DOD ground participation, an RC-47 aircraft photographed the nuclear cloud. The plane flew a holding pattern from 10 to 16 kilometers northeast of ground zero at an altitude of 8,000 to 10,000 feet. The RC-47, manned by personnel from AFSWC and the Air Force Missile Test Center, was supervised by the Lookout Mountain Laboratory, which performed the photographic work. Project 9.1 personnel also arranged to have aerial photographs taken from two B-50s, possibly provided by Project 6.4 (30; 32; 61; 71).

Project 9.4, Atomic Cloud Growth Study, was designed to obtain theodolite measurements on the rate of cloud rise and maximum cloud height. The theodolite was located at the north fence of the Control Point. The number of DOD personnel involved in this project is not known, and it is likely that personnel activities consisted only of positioning the theodolite and retrieving data from it (21; 30; 32; 38; 61; 71).

6.2.2 Department of Defense Participation in LASL and UCRL Test Group Projects

Both AEC nuclear weapons development laboratories conducted scientific and diagnostic experiments to determine the effects of the HORNET detonation.

The LASL Test Group performed 15 projects at HORNET. Of these 15 projects, only two have been identified as involving DOD participants: Project 11.2, Radiochemistry Sampling, and Project 18.4, Spectroscopy. Because Project 11.2, was performed by AFSWC aircraft of the 4926th Test Squadron (Sampling), the activities of this project are discussed in section 6.2.5.

Project 18.4, Spectroscopy, was conducted by the Naval Research Laboratory. Little documentation for Project 18.4 has been found. Research has not yielded a weapons test report with sufficient information to prepare a detailed analysis of the project (9).

The University of California Radiation Laboratory Test Group performed two projects at Shot HORNET: Project 21.1, Fission and Fusion Yields, and Project 22.2, Diagnostic Measurements. Neither of these projects, however, involved field participation by DOD personnel.

6.2.3 Department of Defense Participation in CETG Projects

The Civil Effects Test Group (CETG) conducted seven projects at Shot HORNET. Of these, only Project 39.7, Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects, involved DOD personnel (20; 21).

Project 39.7, Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of

Dose with Biological Effects, was designed to correlate by physical and biological means neutron and gamma-radiation dose and effect from nuclear devices expected to produce high ratios of neutron to gamma-radiation yields. DOD participation was limited to one person from the Air Force School of Aviation. The nature of his involvement is not documented, but it is probable that he served as a consultant to CETG project personnel. Available data do not indicate whether the DOD participant was involved in fielding operations. He may have been part of a fielding team (20; 40; 61).

6.2.4 Department of Defense Operational Training Projects

Five operational training projects were conducted at Shot HORNET. Thirty aircraft and approximately 45 DOD personnel participated in these projects.

Project 40.3, Crew Indoctrination, included 12 F-84 aircraft operating from George AFB, California, which performed a controlled flyby maneuver. The objective was to train crews in the effects of a nuclear detonation while flying simulated weapon-delivery techniques and flyby maneuvers. The aircraft, each with a pilot, established their positions by orbiting 110 to 130 kilometers northeast of the shot-tower. They then flew due west at 28,000 feet to 29,000 feet towards the NTS. Two minutes before detonation, the aircraft descended to altitudes ranging from 26,000 feet to 19,000 feet. Within eight kilometers of ground zero, the planes swung to the north to be tail-on the blast wave. After blast arrival, the planes returned to their home base (1; 3; 32; 85).

Project 40.6, Calibration of Electromagnetic Effects, was conducted by the Air Force. Its objective was to examine the electromagnetic pulse emitted by a nuclear detonation. The HORNET Operation Plan 1-55 relates that four separate teams

performed the following activities before the detonation. At 1300 hours the day before the detonation, two personnel in one vehicle were to go to station **40.6c**, located 13.6 kilometers northwest of ground zero, to set up test equipment. This party was to leave the area before 1800 hours that day. At 1300 hours on the day before the detonation, another party of three men in a helicopter was to leave station **40.6b** on Yucca Lake, ten kilometers south of ground zero, to service eight sets of unmanned recording equipment circling ground zero at distances between 10 and 20 kilometers. This activity took about four hours. Two hours before the shot, four personnel were to arrive at station **40.6b** on Yucca Lake to operate equipment until two hours after the detonation. At the same time, two personnel were to arrive at station **40.6c** to operate test equipment until one hour after the shot (3; 77).

The purpose of Project 40.8, Calibration of Bomb Debris, was to determine the relative yields of nuclear products and residues for use in characterizing nuclear weapons. Project activities were integrated with AFSWC sampling missions for LASL Project 11.2 and are discussed in section 6.2.5 of this chapter.

Project 40.10, Delivery Crew Indoctrination, was conducted by the Navy. Three AD aircraft and 11 F-2H aircraft performed simulated weapons delivery maneuvers at altitudes ranging from 24,000 to 34,000 feet. The project objective was to familiarize Navy **aircrews** with the effects of nuclear detonations. The aircraft established a race-track orbit over Indian Springs AFB, and then passed abeam of ground zero 30 seconds before the detonation. The aircraft then flew sharply to the right to receive the blast wave in a tail-on position, and returned to their base at San Diego, California. Total Navy personnel participation in Project 40.10 was probably 20 individuals. The three AD aircraft carried a total of nine participants, and each F-2H aircraft carried one pilot (1; 3; 32).

Project 40.12, Delivery Crew Indoctrination-Dive Bombing, was conducted by the Marine Corps. The project was designed to train Marine Corps **aircrews** on the effects of a nuclear detonation while flying at medium altitudes in the near vicinity of a test event. Three **F-9F** aircraft, based at the Marine Corps Auxiliary Air Station, Mojave, California, simulated a dive-bomb weapons delivery before the detonation. The **F9Fs** began orbiting approximately 40 kilometers south of the shot-tower at 25,000 feet to establish their timing. Thereafter, the aircraft established a northerly course, flying east of ground zero. After passing abeam of a designated target, both aircraft turned left in a 180-degree maneuver, diving south on the target at a 70-degree angle of approach. The aircraft pulled out at 15,000 feet to 13,000 feet, passing over ground zero 25 seconds before detonation. The **F-9Fs** carried one pilot each (1; 3; 32).

6.2.5 Air Force Special Weapons Center Activities

AFSWC supervised air activities at HORNET, including those of the DOD operational training projects discussed in the previous section. The AFSWC Air Operations Center coordinated military air traffic over the NTS. The support missions, which were carried out by AFSWC personnel, were divided into four categories: cloud-sampling, courier service, cloud-tracking, and aerial surveys of terrain.

Cloud sampling, which was conducted for LASL Project 11.2 and Air Force Project 40.8, enabled AEC and DOD scientists to obtain samples of the nuclear cloud. Courier service was provided to deliver AEC test group samples to the nuclear weapons design laboratories and military research and development laboratories for prompt analysis. Cloud tracking enabled the AEC to plot the course of the nuclear cloud, and helped the Civil Aviation Administration prevent commercial aircraft from crossing the cloud path. Terrain surveying allowed the AEC to monitor the

land areas exposed to the nuclear cloud. Altogether, 19 aircraft and about 600 AFSWC personnel, including 73 aircrew members, participated in these support missions, as the following listing shows.

PROJECT	TITLE	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	ESTIMATED NUMBER OF PERSONNEL	DOD
11.2 and 40.8	Sampling Sampler Control Samplers	B-50	1	9	
		F-84G	7	7	
	Courier Service	c-47	1	3	
		B-25	3	15	
		c-119	1	4	
	Cloud Tracking	B-50	1	12	
		B-25	1	5	
	Aerial Surveys of Terrain	c-47	1	3	
		H-19	3	15	

Cloud Sampling

Shot HORNET involved seven F-84G sampler aircraft with one pilot each, and one B-50 sampler control with an estimated crew of nine and one scientific adviser **onboard**. All aircraft operated from Indian Springs AFB. During this mission, personnel gathered particulate cloud samples for LASL Project 11.2 and compressed-air samples for Air Force Project 40.8. Several difficulties were encountered in the sampling activities, including a malfunction in the B-50 sampler control aircraft and an inoperative dose-rate meter in one of the sampler aircraft. The altitudes of the sampler aircraft ranged between 16,000 and 37,000 feet. The first aircraft began sampling the cloud one hour and 30 minutes after detonation, and the final sampler began three hours and 30 minutes after detonation. Information about each aircraft mission is displayed on the following listing (32; 33).

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)
F-84G #034	3	9: 00	35.0
F-84G #032	5	13:00	7.0
F-84G #055	1	2:00	.5
F-84G #030	3	1: 00	7.0
F-84G #028	3	5:30	3.0
F-84G #037	2	1:10	1.0
F-84G #043	5	10:35	Not Documented

Courier Service

Five AFSWC aircraft and one aircraft from CARCO, a commercial carrier, provided courier service after Shot HORNET. The courier aircraft began departing from Indian Springs AFB within four and one-half hours after the detonation. The first three aircraft took samples to LASL via Kirtland AFB. The first airplane to leave was the twin civilian Bonanza from CARCO, the second was a C-47, and the third was a B-25. A C-119 was the fourth aircraft to depart, flying to McClellan AFB, California, to deliver material for a DOD laboratory. The fifth aircraft, a B-25, left for Bolling AFB, Washington, D.C., with samples for the Naval Research Laboratory. The last aircraft was a B-25, which carried samples to the University of California Radiation Laboratory (32; 33).

Cloud Tracking

Cloud-tracking at Shot HORNET was accomplished by a B-50 flying at 23,000 to 26,000 feet MSL and a B-25 flying at 15,000 feet MSL. The B-50 was based at Kirtland AFB and the B-25 at Indian Springs AFB. The B-50 replaced the regular B-29 aircraft, which aborted due to engine trouble. The aircraft tracked the cloud in a southeasterly direction north of U.S. Route 95 as far as the shores of Lake Mead. On completing the mission, aircraft returned to Indian Springs and Kirtland AFB (32; 33).

Aerial Surveys of Terrain

At Shot HORNET, the low-level survey of the NTS was performed by a C-47 aircraft operating from Indian Springs AFB. A second C-47, which usually served as a relay aircraft for ground to air communications, did not participate in this event. The C-47 aircraft conducted aerial surveys of terrain along the same route followed by the cloud tracking aircraft. Three H-19 helicopters also transported radiological safety monitors during surveying activities (32; 33).

6.3 RADIATION PROTECTION AT SHOT HORNET

The purpose of the radiation protection procedures developed by Exercise Desert Rock VI, JTO, and AFSWC was to ensure that the participants' exposure to ionizing radiation was as low as possible while completing their tasks. Some of the procedures described in the Series volume resulted in records which enabled Exercise Desert Rock, the Joint Test Organization, and AFSWC to evaluate the effectiveness of their procedures. Such records have been located only for JTO participants. The JTO Onsite Radiological Safety Organization was staffed by soldiers from the Army's 1st Radiological Safety Support Unit, from Ft. McClellan, Alabama, and was managed by AFSWP.

The information presented in this section includes film badge data, logistical data on radiological safety equipment, survey results, isointensity maps, and decontamination records. Other than the Final Dosage Report, no description of Exercise Desert Rock VI or AFSWC safety activities have been located. The Final Dosage Report summarizes exposure for the entire series and is therefore discussed in the TEAPOT Series volume.

Dosimetry

The period 11 through 20 March 1955, which included Shot HORNET on 12 March, resulted in 24 participants accumulating exposures between 2.0 roentgens and 3.9 roentgens. Three additional participants accumulated exposures in excess of the 3.9-roentgen authorized limit (92). Documentation on the circumstances surrounding these overexposures has not been found. Seven AFSWC pilots flew cloud-sampling missions for Shot HORNET. Their film-badge readings ranged from 0.4 to 0.98 roentgens (19; 32).

During this ten-day period, the Dosimetry and Records Sections issued 1,794 film badges and 496 pocket dosimeters (19).

Logistics

The General Supply Section issued 609 pieces of protective clothing and 161 respirators. In addition, the Instrument Repair Section issued 247 radiation survey meters (19).

Monitoring

Two minutes after detonation, at 0522, the initial survey party of four two-man teams left the Control Point. At 0553 hours, the teams began their survey. The teams completed their survey by 0735; A copy of the initial survey isointensity map is shown in figure 6-1. Two two-man access road checkpoint teams

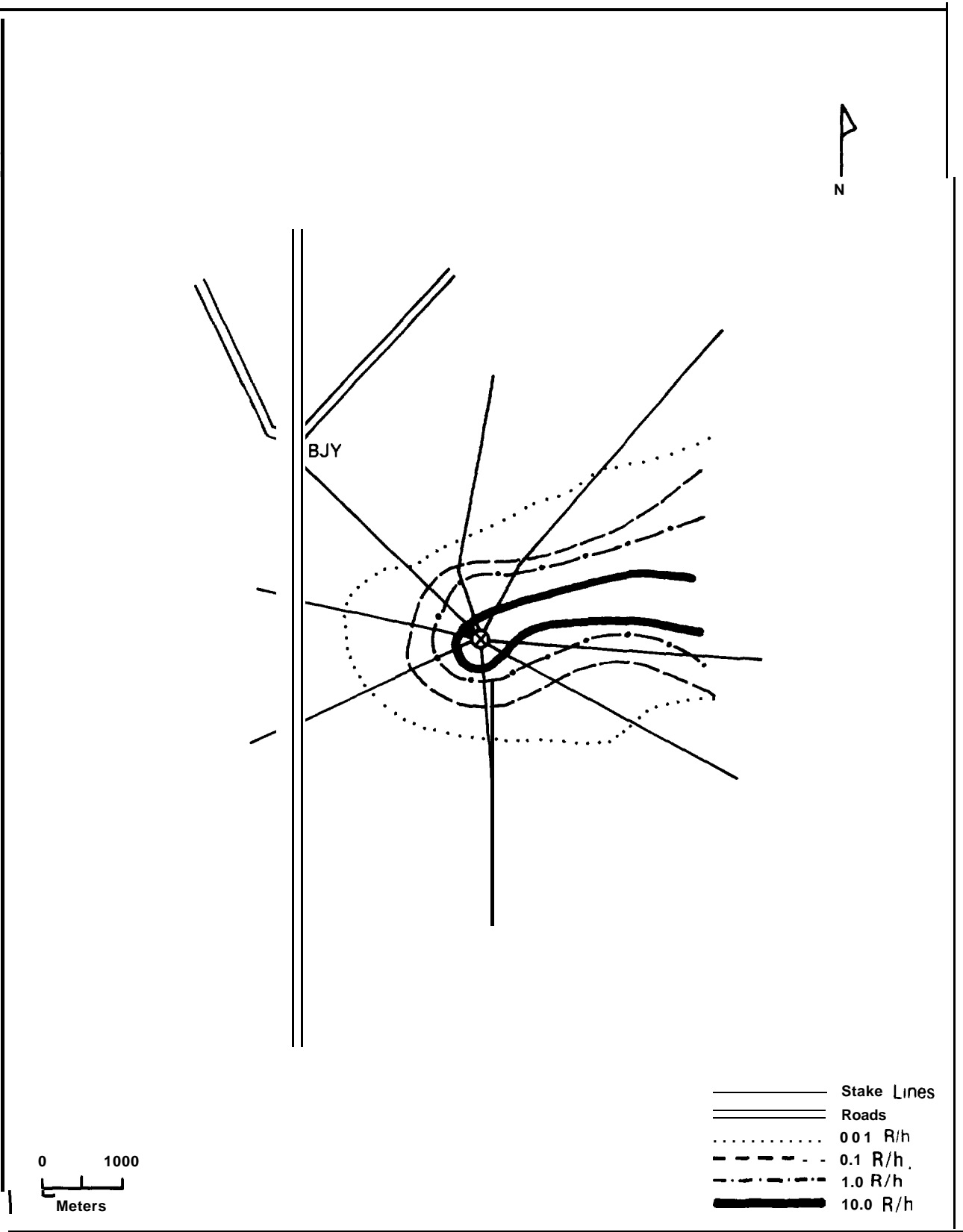


Figure 6-I: INITIAL SURVEY FOR SHOT HORNET, 12 MARCH 1955, 0553 TO 0735 HOURS

and the two-man patrol left the Control Point at the same time as the initial survey party. By 0545 hours, the access road checkpoint teams had established checkpoints outside the 0.01 R/h area. At 0550 hours, the main checkpoint was established at the intersection of Mercury Highway and the south access road to Area 3. The test area was resurveyed on 13, 16, and 25 March, on 12 and 20 April, and on 4 May. Copies of the isointensity maps generated from the resurveys of 13, 16, and 25 March and 12 April are shown in figure 6-2. The average total exposures for the initial survey team and the first resurvey team were 0.86 and 0.26 roentgens, respectively (19).

On shot-day, the Monitoring Section furnished monitors to the following projects for Shot HORNET (19):

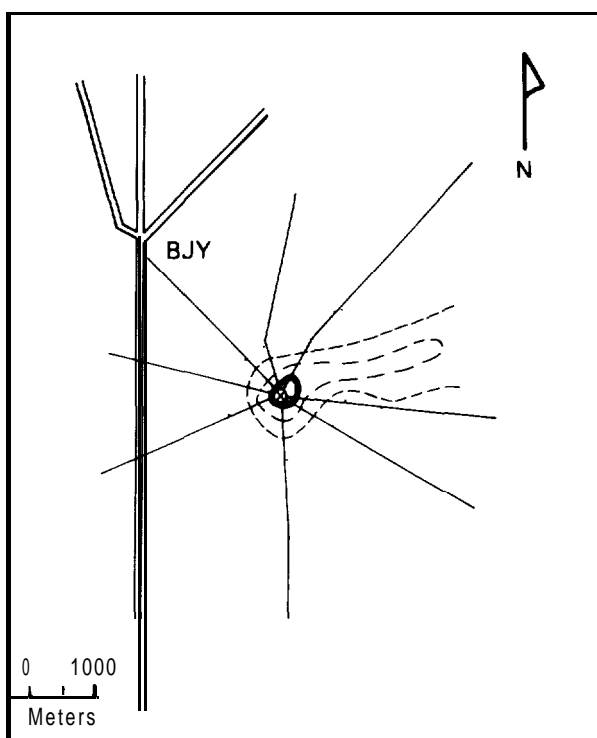
<u>PROJECT</u>	<u>NUMBER</u>
2.2	1
3.1	3
8.3	1
8.4	1
12	1
39.6	1
39.7	4
Miscellaneous	5

On days following the shot, an additional 15 monitors were provided to various groups (19).

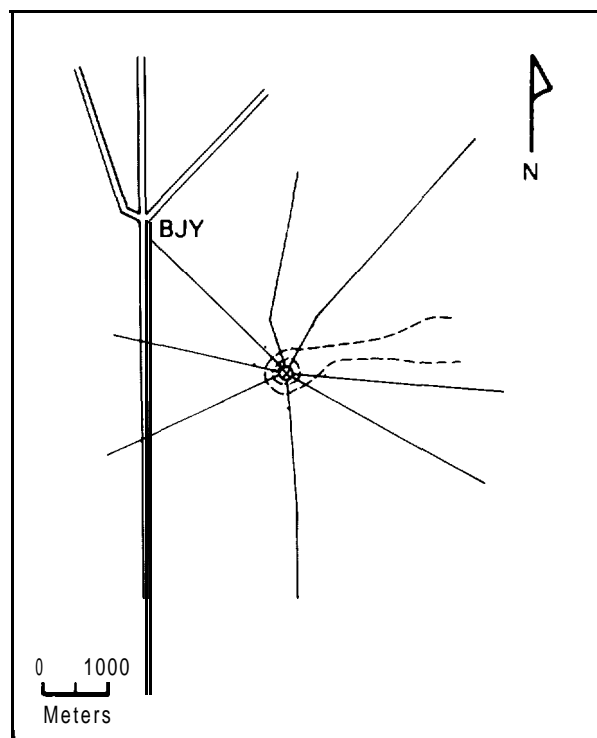
Recovery and Re-entry Procedures

Initial survey parties, road patrols, and checkpoint personnel received their final briefings at 0445 hours on shot-day. The ground survey took place between 0553 and 0735 hours, and the aerial survey, using three H-19 helicopters, occurred between 0556 and 0633 hours. The Test Manager declared recovery hour at 0655 hours (19).

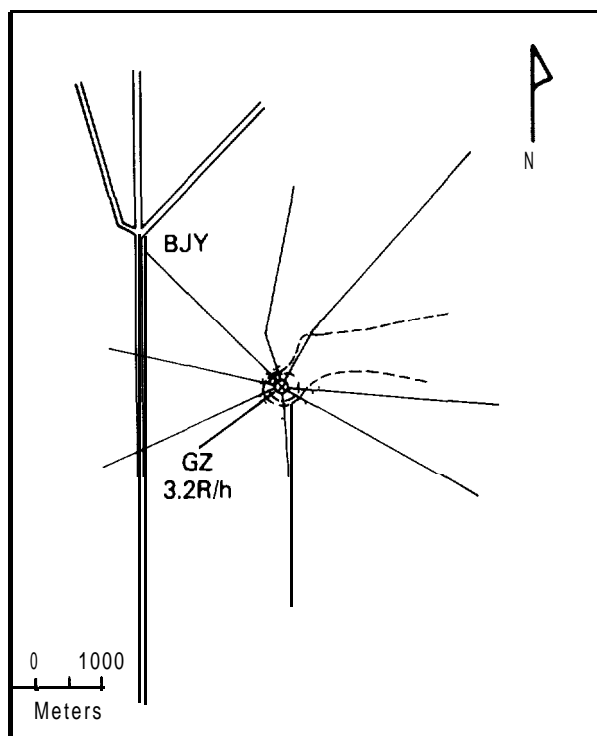
The Test Manager authorized four Project 39.7 teams, one Reynolds Electrical and Engineering Company work party and one



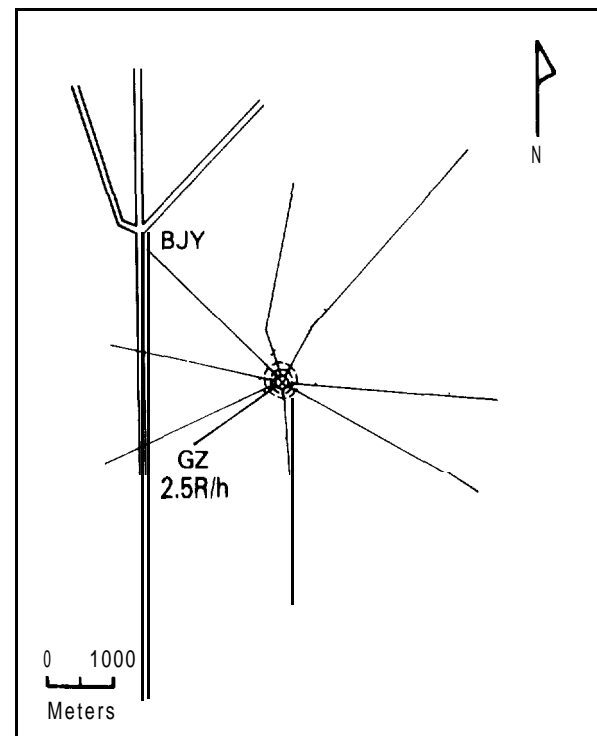
Resurvey: 13 March 1955,
0650 to 0755 Hours



Resurvey 16 March 1955,
0630 to 0658 Hours



Resurvey: 25 March 1955,
1300 to 1430 Hours



Resurvey. 12 April 1955



Figure 6-2: RESURVEYS FOR SHOT HORNET

team each from Project 2.7a, Program 12, Project 14.1, and Project 18.5 to enter the test area before recovery hour. In addition, personnel from Project 39.7 received permission to enter areas with radiation intensities greater than 10 R/h (19).

The Plotting and Briefing Section cleared the following numbers of parties for entry into the shot area on the following dates (19; 59):

<u>DATE</u>	<u>NUMBER</u>
12 March	34
15 March	4
16 March	1
17 March	2
18 March	1
19 March	1
20 March	1

Decontamination

During Shot HORNET, 36 vehicles and 65 pieces of equipment required decontamination. An additional 86 items were placed in the hot park to permit their radiation intensities to decay to acceptable levels (19).

SHOTS WASP THROUGH HORNET
REFERENCE LIST

The following list of references represents only those documents cited in the WASP through HORNET volume. When a DASA-WT document is followed by an EX, the latest version has been cited. A complete list of documents reviewed during the preparation of the TEAPOT Series volumes is contained in the Operation TEAPOT volume.

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.

Source documents bearing an availability statement of CIC may be reviewed at the following address:

Department of Energy
Coordination and Information Center
(Operated by Reynolds Electrical & Engineering Co., Inc.)
ATTN: Mr. Richard V. Nutley
2753 S. Highland
P.O. Box 14100
Las Vegas, Nevada 89114

Phone: (702) 734-3194
FTS: 598-3194

Source documents bearing an availability statement of NTIS may be purchased from the National Technical Information Service. When ordering by mail or phone, please include both the price code and the NTIS number. The price code appears in parentheses before the NTIS order number.

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Springfield, Virginia 22161

Phone: (703) 487-4650
(Sales Office)

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

SHOTS WASP THROUGH HORNET REFERENCE LIST

1. Air Force Special Weapons Center, Field Test Group #5
(Prov). "Operation Plan 1-54 for Operation TEAPOT."
Kirtland AFB, NM.: AFSWC. 12/20/54. 200 Pages.***
2. Armed Forces Special Weapons Project, Field Command; Los
Alamos Scientific Laboratory. [Memoranda for AEC
Test Director, Subject: Circumstances Surrounding
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Veterans Administration-RO
Honolulu, HI
ATTN: Director

Veterans Administration-RO
Chicago, IL
ATTN: Director

Veterans Administration-RO
Seattle, WA
ATTN: Director

Veterans Administration-RO
Indianapolis, IN
ATTN: Director

Veterans Administration-RO
Des Moines, IA
ATTN: Director

Veterans Administration-RO
Wichita, KS
ATTN: Director

Veterans Administration-RO
Louisville, KY
ATTN: Director

Veterans Administration-RO
New Orleans, LA
ATTN: Director

Veterans Administration-RO
Togus, ME
ATTN: Director

Veterans Administration-RO
Baltimore, MD
ATTN: Director

Veterans Administration-RO
Boston, MA
ATTN: Director

Veterans Administration-RO
St. Paul, MN
ATTN: Director

Veterans Administration-RO
Jackson, MS
ATTN: Director

Veterans Administration-RO
Huntington, WV
ATTN: Director

Veterans Administration-RO
St. Louis, MO
ATTN: Director

Veterans Administration-RO
Ft. Harrison, MI
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Lincoln, NE
ATTN: Director

Veterans Administration-RO
Reno, NV
ATTN: Director

Veterans Administration-RO
Manchester, NH
ATTN: Director

Veterans Administration-RO
Newark, NJ
ATTN: Director

Veterans Administration-RO
Milwaukee, WI
ATTN: Director

Veterans Administration-RO
Albuquerque, NM
ATTN: Director

Veterans Administration-RO
Buffalo, NY
ATTN: Director

Veterans Administration-RO
New York, NY
ATTN: Director

Veterans Administration-RO
Winston-Salem, NC
ATTN: Director

Veterans Administration-RO
Fargo, ND
ATTN: Director

Veterans Administration-RO
Cleveland, OH
ATTN: Director

Veterans Administration-RO
Muskogee, OK
ATTN: Director

Veterans Administration-RO
Portland, OR
ATTN: Director

Veterans Administration-RO
Pittsburgh, PA
ATTN: Director

Veterans Administration-RO
Philadelphia, PA
ATTN: Director

Veterans Administration-RO
San Francisco, CA
ATTN: Director

Veterans Administration-RO
San Juan, Puerto Rico
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Columbia, SC
ATTN: Director

Veterans Administration-RO
Sioux Falls, SO
ATTN: Director

Veterans Administration-RO
Houston, TX
ATTN: Director

Veterans Administration-RO
Waco, TX
ATTN: Director

Veterans Administration-RO
Salt Lake City, UT
ATTN: Director

Veterans Administration-RO
White River Junction, VT
ATTN: Director

Veterans Administration-RO
Roanoke, VA
ATTN: Director

Veterans Administration-RO
Cheyenne, WY
ATTN: Director

Veterans Administration-RO
San Diego, CA
ATTN: Director

Veterans Administration-RO
Boise, ID
ATTN: Director

Veterans Administration-RO
Detroit, MI
ATTN: Director

Veterans Administration-RO
Nashville, TN
ATTN: Director

The White House
ATTN: Domestic Policy Staff

DEPARTMENT OF ENERGY CONTRACTORS

Lawrence Livermore National Lab
ATTN: Tech Info Dept Library

Los Alamos National Scientific Lab
ATTN: Library
ATTN: ADPA MSS 195

Sandia National Lab
ATTN: W. Hereford
ATTN: Central Library

Reynolds Electrical & Engr Co., Inc
ATTN: CIC
ATTN: W. Brady

OTHER

Adams State College
ATTN: Librn

Akron Public Library
ATTN: Librn

Alabama State Dept of Archives & History
ATTN: Military Records Div

University of Alabama
ATTN: Reference Dept, Dralier 3
ATTN: Director of Libraries (Reg)

University of Alaska Library at Anchorage
ATTN: Librn

University of Alaska
ATTN: Dir of Libraries

Albany Public Library
ATTN: Librn

Alexander City State Jr College
ATTN: Librn

Allegheny College
ATTN: Librn

Allen County Public Library
ATTN: Librn

Altoona Area Public Library
ATTN: Librn

American Statistics Index
Congressional Info Service, Inc
ATTN: Cathy Jarvey

Anaheim Public Library
ATTN: Librn

College of Wooster
ATTN: Gov Docs

Angelo State University Library
ATTN: Librn

Angelo Iacoboni Public Library
ATTN: Librn

Anoka County Library
ATTN: Librn

Appalachian State University
ATTN: Library Docs

Arizona State University Library
ATTN: Librn

University of Arizona
ATTN: Gov Doc Dept/C. Bower

Arkansas College Library
ATTN: Library

Brooklyn College
ATTN: Doc Div

OTHER (Continued)

Arkansas Library Comm
ATTN: Library

Arkansas State University
ATTN: Library

University of Arkansas
ATTN: Gov Docs Div

Austin College
ATTN: Librn

Atlanta Public Library
ATTN: Ivan Allen Dept

Atlanta University
ATTN: Librn

Auburn University Library & Montgomery (Reg)
ATTN: Librn

C. W. Post Ctr Long Island University
ATTN: Librn

Bangor Public Library
ATTN: Librn

Bates College Library
ATTN: Librn

Baylor University Library
ATTN: Docs Dept

Beloit College Libraries
ATTN: Serials Docs Dept

Bemidji State College
ATTN: Library

State University College
ATTN: Gov Docs

Akron University
ATTN: Gov Docs

Boston Public Library (Reg)
ATTN: Docs Dept

Bowdoin College
ATTN: Librn

Bowling Green State University
ATTN: Lib Gov Docs Services

Bradley University
ATTN: Librn

Brandeis University Library
ATTN: Docs Section

Brigham Young University
ATTN: Librn

Brigham Young University
ATTN: Docs Collection

Brookhaven National Laboratory
ATTN: Tech Library

OTHER (Continued)

Broward County Library Sys
ATTN: Librn

Brown University
ATTN: Librn

Bucknell University
ATTN: Reference Dept

Buffalo & Erie Co Public Library
ATTN: Librn

State University Library of California at Fresno
ATTN: Library

University Library of California at Los Angeles
ATTN: Pub Affairs Serv U.S. Docs

Unlverslty of California at San Diego
ATTN: Docs Dept

State College Library of California at Stanislaus
ATTN: Library

California State Polytechnic University Library
ATTN: Librn

California State Unlverslty at Northridge
ATTN: Gov Doc

California State Library (Reg)
ATTN: Librn

California State University at Long Beach Library
ATTN: Librn

California State University
ATTN: Librn

California State University
ATTN: Librn

California University Library
ATTN: Gov Pub Dept

California Unlverslty Library
ATTN: Librn

California Unlverslty Library
ATTN: Gov DOCS Dept

California Unlverslty Library
ATTN: Docs Sec

University of California
ATTN: Gov DOCS Dept

Calvin College Library
ATTN: Librn

Kearney State College
ATTN: Gov Docs Dept

Cambria County Library Sys
ATTN: Librn

Carleton College Library
ATTN: Librn

OTHER (Continued)

Carnegie Library of Pittsburgh
ATTN: Librn

Carnegie Mellon University
ATTN: Dir of Libraries

Carson Regional Library
ATTN: Gov Pubs Unit

Case Western Reserve Unlverslty
ATTN: Librn

Casper College
ATTN: Librn

University of Central Florida
ATTN: Library Docs Dept

Central Michigan Unlverslty
ATTN: Library Docs Sec

Central Missouri State Univ
ATTN: Gov Docs

Central State University
ATTN: Lib Docs Dept

Central Washington Unlverslty
ATTN: Lib Docs Sec

Central Wyoming College Library
ATTN: Librn

Charleston County Library
ATTN: Librn

Charlotte & Mecklenburg County Public Library
ATTN: E. Correll

Chattanooga Hamilton County, Bi centennial Library
ATTN: Librn

Chesapeake Public Library System
ATTN: Librn

Chicago Public Library
ATTN: Gov Pubs Dept

State Unlverslty of Chicago
ATTN: Librn

Chicago University Library
ATTN: Dir of Libraries
ATTN: Docs Processing

Cincinnati University Library
ATTN: Librn

Citadel, Daniel Library
ATTN: Librn

Claremont Colleges Libraries
ATTN: DOC Collection

Clemson University
ATTN: Dir of Libraries

OTHER (Continued)

Cleveland Public Library
ATTN: Docs Collection

Cleveland State University Library
ATTN: Librn

Coe Library
ATTN: Docs Div

Colgate University Library
ATTN: Ref Lib

Colorado State University Libraries
ATTN: Librn

University of Colorado Libraries
ATTN: Dir of Libraries

Columbia University Library
ATTN: Docs Svc Ctr

Columbus & Franklin Cty Public Library
ATTN: Gen Rec Div

Compton Library
ATTN: Librn

Connecticut State Library (Reg)
ATTN: Librn

University of Connecticut
ATTN: Gov't of Connecticut

University of Connecticut
ATTN: Dir of Libraries

Cornell University Library
ATTN: Librn

Corpus Christi State University Library
ATTN: Librn

Culver City Library
ATTN: Librn

Curry College Library
ATTN: Librn

University of North Carolina at Asheville
ATTN: Librn

Dallas County Public Library
ATTN: Librn

Dallas Public Library
ATTN: Librn

Dalton Junior College Library
ATTN: Librn

Dartmouth College
ATTN: Librn

Davenport Public Library
ATTN: Librn

Davidson College
ATTN: Librn

OTHER (Continued)

Dayton & Montgomery City Public Library
ATTN: Librn

University of Dayton
ATTN: Librn

Decatur Public Library
ATTN: Librn

Dekalb Community College So Cpus
ATTN: Librn

Delaware Paw University
ATTN: Librn

University of Delaware
ATTN: Librn

Delta College Library
ATTN: Librn

Delta State University
ATTN: Librn

Denison University Library
ATTN: Librn

Denver Public Library (Reg)
ATTN: Docs Div

Dept of Library & Archives (Reg)
ATTN: Librn

Detroit Public Library
ATTN: Librn

Dickinson College Library
ATTN: Librn

Dickinson State College
ATTN: Librn

Alabama Agricultural Mechanical University & Coll
ATTN: Librn

Drake University
ATTN: Cowles Library

Drew University
ATTN: Librn

Duke University
ATTN: Pub Docs Dept

Duluth Public Library
ATTN: Docs Sec

East Carolina University
ATTN: Lib Docs Dept

East Central University
ATTN: Librn

East Islip Public Library
ATTN: Librn

OTHER (Continued)

East Orange Public Library
ATTN: U. S. Gov't Depository

East Tennessee State University Sherrod Library
ATTN: Docs Dept

East Texas State University
ATTN: Library

Monmouth County Library Eastern Branch
ATTN: Librn

Eastern Illinois University
ATTN: Librn

Eastern Kentucky University
ATTN: Librn

Eastern Michigan University Library
ATTN: Library

Eastern Montana College Library
ATTN: Docs Dept

Eastern New Mexico University
ATTN: Librn

Eastern Oregon College Library
ATTN: Librn

Eastern Washington University
ATTN: Librn

El Paso Public Library
ATTN: Docs & Genealogy Dept

Elko County Library
ATTN: Librn

Elmira College
ATTN: Librn

Elon College Library
ATTN: Librn

Enoch Pratt Free Library
ATTN: Docs Ofc

Emory University
ATTN: Librn

Evansville & Vanderburgh Cty Public Library
ATTN: Librn

Everett Public Library
ATTN: Librn

Fairleigh Dickinson University
ATTN: Depository Dept

Florida A & M University
ATTN: Librn

Florida Atlantic University Library
ATTN: Civ of Pub Docs

OTHER (Continued)

Florida Institute of Technology
ATTN: Library

Florida International University Library
ATTN: Docs Sec

Florida State Library
ATTN: Docs Sec

Florida State University
ATTN: Librn

University of Florida
ATTN: Dir of Library (Reg)
ATTN: Docs Dept

Fond Du Lac Public Library
ATTN: Librn

Ft Hays State University
Ft Hays Kansas State College
ATTN: Librn

Ft Worth Public Library
ATTN: Librn

Free Public Library of Elizabeth
ATTN: Librn

Free Public Library
ATTN: Librn

Freeport Public Library
ATTN: Librn

Fresno Cty Free Library
ATTN: Librn

Gadsden Public Library
ATTN: Librn

Garden Public Library
ATTN: Librn

Gardner Webb College
ATTN: Docs Library

Gary Public Library
ATTN: Librn

Geauga Cty Public Library
ATTN: Librn

Georgetown University Library
ATTN: Gov Docs Room

Georgia Institute of Technology
ATTN: Librn

Georgia Southern College
ATTN: Librn

Georgia Southwestern College
ATTN: Dir of Libraries

Georgia State University Library
ATTN: Librn

OTHER (Continued)

University of Georgia
ATTN: Dir of Libraries (Reg)

Glassboro Stde College
ATTN: Librn

Gleeson Library
ATTN: Librn

Graceland College
ATTN: Librn

Grand Forks Public City-County Library
ATTN: Librn

Grand Rapids Public Library
ATTN: Dir of Lib

Greenville County Library
ATTN: Librn

Grinnell College Library
ATTN: Librn

Guam RFK Memorial University Library
ATTN: Fed Depository Coll

University of Guam
ATTN: Librn

Gustavus Adolphus College
ATTN: Librn

South Dakota University
ATTN: Librn

Hardin-Simmons University Library
ATTN: Librn

Hartford Public Library
ATTN: Librn

Harvard College Library
ATTN: Dir of Lib

Harvard College Library
ATTN: Serials Rec Div

University of Hawaii Library
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
ATTN: Librn

Haydon Burns Library
ATTN: Librn

Hennepin County Library
ATTN: Gov Docs

Henry Ford Community College Library
ATTN: Librn

OTHER (Continued)

Herbert H. Lehman College
ATTN: Lib Docs Div

Hofstra University Library
ATTN: Docs Dept

Hollins College
ATTN: Librn

Hopkinsville Community College
ATTN: Librn

Wagner College
ATTN: Librn

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
ATTN: Docs Dept

Huntington Park Library
ATTN: Librn

Hutchinson Public Library
ATTN: Librn

Idaho Public Library & Information Center
ATTN: Librn

Idaho State Library
ATTN: Librn

Idaho State University Library
ATTN: Docs Dept

University of Idaho
ATTN: Dir of Libraries (Reg)
ATTN: Docs Sec

University of Illinois Library
ATTN: Docs Sec

Illinois State Library (Reg)
ATTN: Gov Docs Br

Illinois University at Urbana-Champaign
ATTN: P. Watson Docs Lib

Illinois Valley Community College
ATTN: Library

Illinois State University
ATTN: Librn

Indiana State Library (Reg)
ATTN: Serial Sec

Indiana State University
ATTN: Docs Library

OTHER (Continued)

Indiana University Library
ATTN: Docs Dept

Indianapolis Marion County Public Library
ATTN. Social Science Div

Iowa State University Library
ATTN. Gov Docs Dept

Iowa University Library
ATTN. Gov Docs Dept

Butler University
ATTN: Librn

Isaac Delchdo College
ATTN: Librn

James Madison University
ATTN: Librn

Jefferson County Public Library
Lakewood Regional Library
ATTN: Librn

Jersey City State College
ATTN F. A. Irwin Library Periodicals
Doc Sec

Johns Hopkins University
ATTN: Docs Library

La Roche College
ATTN: Librn

Johnson Free Public Library
ATTN: Librn

Kalamazoo Public Library
ATTN. Librn

Kansas City Public Library
ATTN: Docs Div

Kansas State Library
ATTN Librn

Kansas State University Library
ATTN: Docs Dept

University of Kansas
ATTN: Dir of Library (Reg)

University of Texas
ATTN: Lyndon B. Johnson School of Public
Affairs Library

Maine Maritime Academy
ATTN. Librn

University of Maine
ATTN Librn

OTHER (Continued)

Kent State University Library
ATTN: Docs Div

Kentucky Dept of Library & Archives
ATTN: Docs Sec

University of Kentucky
ATTN: Gov Pub Dept
ATTN: Dir of Lib (Reg)

Kenyon College Library
ATTN: Librn

Lake Forest College
ATTN: Librn

Lake Sumter Community College Library
ATTN: Librn

Lakeland Public Library
ATTN: Librn

Lancaster Regional Library
ATTN: Librn

Lawrence University
ATTN: Docs Dept

Brigham Young University
ATTN: Docs & Map Sec

Lewis University Library
ATTN: Librn

Library and Statutory Dist & Svc
2 cy ATTN. Librn

Earlham College
ATTN Librn

Little Rock Public Library
ATTN: Librn

Long Beach Public Library
ATTN: Librn

Los Angeles Public Library
ATTN: Serials Div U. S. Docs

Louisiana State University
ATTN Gov Doc Dept
ATTN. Dir of Libraries (Reg)

Louisville Free Public Library
ATTN. Librn

Louisville University Library
ATTN. Librn

Hoover Institution
ATTN. J. Blngham

OTHER (Continued)

Manchester City Library
ATTN: Librn

Mankato State College
ATTN: Gov Pubs

University of Maine at Farmington
ATTN: Dir of Libraries

Marathon County Public Library
ATTN: Librn

Principia College
ATTN: Librn

University of Maryland
ATTN: McKeldin Library Docs Div

University of Maryland
ATTN: Librn

University of Massachusetts
ATTN: Gov Docs Coll

Maui Public Library
Kahului Branch
ATTN: Librn

McNeese State University
ATTN: Librn

Memphis & Shelby County Public Library &
Information Center
ATTN: Librn

Memphis State University
ATTN: Librn

Mercer University
ATTN: Librn

Mesa County Public Library
ATTN: Librn

Miami Dade Community College
ATTN: Librn

University of Miami Library
ATTN: Gov Pubs

Miami Public Library
ATTN: Docs Div

Miami University Library
ATTN: Docs Dept

University of Santa Clara
ATTN: Docs Div

Michigan State Library
ATTN: Librn

Michigan State University Library
ATTN: Librn

Murray State University Library
ATTN: Lib

OTHER (Continued)

Michigan Tech University
ATTN: Lib Docs Dept

University of Michigan
ATTN: Acq Sec Docs Unit

Middlebury College Library
ATTN: Librn

Millersville State College
ATTN: Librn

State University of New York
ATTN: Docs Librn

Milwaukee Public Library
ATTN: Librn

Minneapolis Public Library
ATTN: Librn

University of Minnesota
ATTN: Dir of Libraries (Reg)

Minot State College
ATTN: Librn

Mississippi State University
ATTN: Librn

University of Mississippi
ATTN: Dir of Libraries

Missouri University at Kansas City General
ATTN: Librn

University of Missouri Library
ATTN: Gov Docs

M.I.T. Libraries
ATTN: Librn

Mobile Public Library
ATTN: Gov Info Div

Midwestern University
ATTN: Librn

Montana State Library
ATTN: Librn

Montana State University Library
ATTN: Librn

University of Montana
ATTN: Dir of Libraries (Reg)

Montebello Library
ATTN: Librn

Moorhead State College
ATTN: Library

Mt Prospect Public Library
ATTN: Gov't Info Ctr

OTHER (Continued)

Nassau Library System
ATTN Librn

Natrona County Public Library
ATTN Librn

Nebraska Library Community
Nebraska Public Clearinghouse
ATTN Librn

University of Nebraska at Omaha
ATTN Univ Lib Docs

Nebraska Western College Library
ATTN Librn

University of Nebraska
ATTN Dir of Libraries (Reg)

University of Nebraska Library
ATTN: Acquisitions Dept

University of Nevada Library
ATTN Gov Pubs Dept

University of Nevada at Las Vegas
ATTN: Dir of Libraries

New Hampshire University Library
ATTN: Librn

New Hanover County Public Library
ATTN: Librn

New Mexico State Library
ATTN: Librn

New Mexico State University
ATTN Lib Docs Div

University of New Mexico
ATTN: Dir of Libraries (Reg)

University of New Orleans Library
ATTN Gov Docs Div

New Orleans Public Library
ATTN Librn

New York Public Library
ATTN: Librn

New York State Library
ATTN Docs Control Cultural Ed Ctr

State University of New York at Stony Brook
ATTN: Main Lib Docs Sec

State University of New York Col Memorial Lib
at Cortland
ATTN Librn

State University of New York
ATTN Lib Docs Sec

North Texas State University Library
ATTN Librn

OTHER (Continued)

State University of New York
ATTN: Librn

New York State University
ATTN: Docs Ctr

State University of New York
ATTN Docs Dept

New York University Library
ATTN: Docs Dept

Newark Free Library
ATTN Librn

Newark Public Library
ATTN Librn

Niagara Falls Public Library
ATTN: Librn

Nicholls State University Library
ATTN: Docs Div

Nieves M Flores Memorial Library
ATTN: Librn

Norfolk Public Library
ATTN: R. Parker

North Carolina Agricultural & Tech State
University
ATTN Librn

University of North Carolina at Charlotte
ATTN Atkins Lib Doc Dept

University Library of North Carolina at Greensboro
ATTN Librn

University of North Carolina at Wilmington
ATTN: Librn

North Carolina Central University
ATTN: Librn

North Carolina State University
ATTN Librn

University of North Carolina
ATTN: BA SS Div Docs

North Dakota State University Library
ATTN Docs Librn

University of North Dakota
ATTN: Librn

North Georgia College
ATTN: Librn

Minnesota Div of Emergency Svcs
ATTN Librn

OTHER (Continued)

Northeast Missouri State University
ATTN: Li brn

Northeastern Oklahoma State University
ATTN: Li brn

Northeastern University
ATTN: Dodge Library

Northern Arizona University Library
ATTN: Gov Docs Dept

Northern Illinois University
ATTN: Li brn

Northern Michigan University
ATTN: Docs

Northern Montana College Library
ATTN: Li brn

Northwestern Michigan College
ATTN: Li brn

Northwestern State University
ATTN: Li brn

Northwestern State University Library
ATTN: Li brn

Northwestern University Library
ATTN: Gov Pubs Dept

Norwalk Public Library
ATTN: Li brn

Northeastern Illinois University
ATTN: Library

University of Notre Dame
ATTN: Doc Ctr

Oakland Community College
ATTN: Li brn

Oakland Public Library
ATTN: Li brn

Oberlin College Library
ATTN: Li brn

Ocean County College
ATTN: Li brn

Ohio State Library
ATTN: Li brn

Ohio State University
ATTN: Lib Docs Div

Ohio University Library
ATTN: Docs Dept

Oklahoma City University Library
ATTN: Li brn

Oklahoma City University Library
ATTN: Li brn

OTHER (Continued)

Oklahoma Department of Libraries
ATTN: U. S. Gov Docs

University of Oklahoma
ATTN: Docs Div

Old Dominion University
ATTN: Doc Dept Univ Lib

Olivet College Library
ATTN: Li brn

Omaha Public Library Clark Branch
ATTN: Li brn

Onondaga County Public Library
ATTN: Gov Docs Sec

Oregon State Library
ATTN: Li brn

University of Oregon
ATTN: Docs Sec

Ouachita Baptist University
ATTN: Li brn

Pan American University Library
ATTN: Librn

Passaic Public Library
ATTN: Li brn

Queens College
ATTN: Docs Dept

Pennsylvania State Library
ATTN: Gov Pubs Sec

Pennsylvania State University
ATTN: Lib Doc Sec

University of Pennsylvania
ATTN: Dir of Libraries

University of Denver
ATTN: Penrose Library

Peoria Public Library
ATTN: Business, Science & Tech Dept

Free Library of Philadelphia
ATTN: Gov Pubs Dept

Philipsburg Free Public Library
ATTN: Library

Phoenix Public Library
ATTN: Li brn

University of Pittsburgh
ATTN: Docs Office, G8

Plainfield Public Library
ATTN: Li brn

OTHER (Continued)

Popular Creek Public Library District
ATTN: Librn

Association of Portland Library
ATTN: Librn

Portland Public Library
ATTN: Librn

Portland State University Library
ATTN: Librn

Pratt Institute Library
ATTN: Librn

Louisiana Tech University
ATTN: Librn

Princeton University Library
ATTN: Docs Div

Providence College
ATTN: Librn

Providence Public Library
ATTN: Librn

Public Library Cincinnati & Hamilton County
ATTN: Librn

Public Library of Nashville and Davidson County
ATTN: Librn

University of Puerto Rico
ATTN: Doc & Maps Room

Purdue University Library
ATTN: Librn

Quinebaug Valley Community College
ATTN: Librn

Auburn University
ATTN: Microforms & Docs Dept

Rapid City Public Library
ATTN: Librn

Reading Public Library
ATTN: Librn

Reed College Library
ATTN: Librn

Augusta College
ATTN: Librn

University of Rhode Island Library
ATTN: Gov Pubs Ofc

University of Rhode Island
ATTN: Dir of Libraries

Rice University
ATTN: Dir of Libraries

Louisiana College
ATTN: Librn

OTHER (Continued)

Richland County Public Library
ATTN: Librn

Riverside Public Library
ATTN: Librn

University of Rochester Library
ATTN: Docs Sec

University of Rutgers Camden Library
ATTN: Librn

State University of Rutgers
ATTN: Librn

Rutgers University
ATTN: Dir of Libraries (Reg)

Rutgers University Law Library
ATTN: Fed Docs Dept

Salem College Library
ATTN: Librn

Samford University
ATTN: Librn

San Antonio Public Library
ATTN: Bus Science & Tech Dept

San Diego County Library
ATTN: C. Jones, Acquisitions

San Diego Public Library
ATTN: Librn

San Diego State University Library
ATTN: Gov Pubs Dept

San Francisco Public Library
ATTN: Gov Docs Dept

San Francisco State College
ATTN: Gov Pubs Coll

San Jose State College Library
ATTN: Docs Dept

San Luis Obispo City-County Library
ATTN: Librn

Savannah Public & Effingham Liberty Regional Library
ATTN: Librn

Scottsbluff Public Library
ATTN: Librn

Scranton Public Library
ATTN: Librn

Seattle Public Library
ATTN: Ref Docs Asst

OTHER (Continued)

Selby Public Library
ATTN: Librn

Shawnee Library System
ATTN: Librn

Shreve Memorial Library
ATTN: Librn

Silas Bronson Public Library
ATTN: Librn

Sioux City Public Library
ATTN: Librn

Skidmore College
ATTN: Librn

Slippery Rock State College Library
ATTN: Librn

South Carolina State Library
ATTN: Librn

University of South Carolina
ATTN: Librn

University of South Carolina
ATTN: Gov Docs

South Dakota School of Mines & Technical Library
ATTN: Librn

South Dakota State Library
ATTN: Fed Docs Dept

University of South Dakota
ATTN: Docs Librn

South Florida Unverslty Library
ATTN: Librn

Southeast Missouri State University
ATTN: Librn

Southeastern Massachusetts University Library
ATTN: Docs Sec

University of Southern Alabama
ATTN: Librn

Southern California Unverslty Library
ATTN: Docs Dept

Southern Connecticut State College
ATTN: Library

Southern Illinois Unverslty
ATTN: Librn

Southern Illinois Unverslty
ATTN: Docs Ctr

Southern Methodist University
ATTN: Librn

Unverslty of Southern Mississippi
ATTN: Librn

OTHER (Continued)

Southern Oregon College
ATTN: Library

Southern University in New Orleans Library
ATTN: Librn

Southern Utah State College Library
ATTN: Docs Dept

Southwest Missouri State College
ATTN: Library

University of Southwestern Louisiana Libraries
ATTN: Librn

Southwestern University
ATTN: Librn

Spokane Public Library
ATTN: Ref Dept

Springfield City Library
ATTN: Docs Sec

St Bonaventure University
ATTN: Librn

St Johns River Junior College
ATTN: Library

St Joseph Public Library
ATTN: Librn

St Lawrence University
ATTN: Librn

St Louis Public Library
ATTN: Librn

St Paul Public Library
ATTN: Librn

Stanford University Library
ATTN: Gov Docs Dept

State Historical Soc Library
ATTN: Docs Serials Sec

State Library of Massachusetts
ATTN: Librn

State University of New York
ATTN: Librn

Stetson University
ATTN: Librn

University of Steubenville
ATTN: Librn

Stockton & San Joaquin Public Library
ATTN: Librn

Stockton State College Library
ATTN: Librn

Albion College
ATTN: Gov Docs Librn

OTHER (Continued)

Superior Public Library
ATTN: Librn

Swarthmore College Library
ATTN: Ref Dept

Syracuse University Library
ATTN: Docs Div

Tacoma Public Library
ATTN: Librn

Hillsborough County Public Library at Tampa
ATTN: Librn

Temple University
ATTN: Librn

Tennessee Technological University
ATTN: Librn

University of Tennessee
ATTN: Dir of Libraries

College of Idaho
ATTN: Librn

Texas A & M University Library
ATTN: Librn

University of Texas at Arlington
ATTN: Library Docs

University of Texas at San Antonio
ATTN: Library

Texas Christian University
ATTN: Librn

Texas State Library
ATTN: U. S. Docs Sec

Texas Tech University Library
ATTN: Gov Docs Dept

Texas University at Austin
ATTN: Docs Coll

University of Toledo Library
ATTN: Librn

Toledo Public Library
ATTN: Social Science Dept

Torrance Civic Center Library
ATTN: Librn

Traverse City Public Library
ATTN: Librn

Trenton Free Public Library
ATTN: Librn

Trinity College Library
ATTN: Librn

Trinity University Library
ATTN: Docs Coll

OTHER (Continued)

Tufts University Library
ATTN: Docs Dept

University of Tulsa
ATTN: Librn

UCLA Research Library
ATTN: Pub Affairs Svc/U.S. Docs

Uniformed Services University of the Health Sciences
ATTN: LRC Library

University Libraries
ATTN: Dir of Lib

University of Maine at Orono
ATTN: Librn

University of Northern Iowa
ATTN: Library

Upper Iowa College
ATTN: Docs Coll

Utah State University
ATTN: Librn

University of Utah
ATTN: Special Collections

University of Utah
ATTN: Dir of Library

Utica Public Library
ATTN: Librn

Vallencia Library
ATTN: Librn

Vallparaiso University
ATTN: Librn

Vanderbilt University Library
ATTN: Gov Docs Sec

University of Vermont
ATTN: Dir of Libraries

Virginia Commonwealth University
ATTN: Librn

Virginia Military Institute
ATTN: Librn

Virginia Polytechnic Institute Library
ATTN: Docs Dept

Virginia State Library
ATTN: Serials Sec

University of Virginia
ATTN: Pub Docs

Volusia County Public Library
ATTN: Librn

OTHER (Continued)

Washington State Library
ATTN: Docs Sec

Washington State University
ATTN: Lib Docs Sec

Washington University Libraries
ATTN: Dir of Lib

University of Washington
ATTN: Docs Div

Wayne State University Library
ATTN: Librn

Wayne State University Law Library
ATTN: Docs Dept

Weber State College Library
ATTN: Librn

Wesleyan University
ATTN: Docs Librn

West Chester State College
ATTN: Docs Dept

West Covina Library
ATTN: Librn

University of West Florida
ATTN: Librn

West Georgia College
ATTN: Librn

West Hills Community College
ATTN: Library

West Texas State University
ATTN: Library

West Virginia College of Grad Studies Library
ATTN: Librn

University of West Virginia
ATTN: Dir of Libraries (Reg)

Westerly Public Library
ATTN: Librn

Western Carolina University
ATTN: Librn

Western Illinois University Library
ATTN: Librn

Western Washington University
ATTN: Librn

Western Wyoming Community College Library
ATTN: Librn

Westmoreland City Community College
ATTN: Learning Resource Ctr

OTHER (Continued)

Whitman College
ATTN: Librn

Wichita State University Library
ATTN: Librn

Williams & Mary College
ATTN: Docs Dept

Emporia Kansas State College
ATTN: Gov Docs Div

William College Library
ATTN: Librn

Williamantic Public Library
ATTN: Librn

Winthrop College
ATTN: Docs Dept

University of Wisconsin at Whitewater
ATTN: Gov Docs Lib

University of Wisconsin at Milwaukee
ATTN: Lib Docs

University of Wisconsin at Oshkosh
ATTN: Librn

University of Wisconsin at Platteville
ATTN: Doc Unit Lib

University of Wisconsin at Stevens Point
ATTN: Docs Sec

University of Wisconsin
ATTN: Gov Pubs Dept

University of Wisconsin
ATTN: Acquisitions Dept

Worcester Public Library
ATTN: Librn

Wright State University Library
ATTN: Gov Docs Librn

Wyoming State Library
ATTN: Librn

University of Wyoming
ATTN: Docs Div

Yale University
ATTN: Dir of Libraries

Yeshiva University
ATTN: Librn

Yuma City County Library
ATTN: Librn

Simon Schwob Mem Lib, Columbus Co1
ATTN: Librn

