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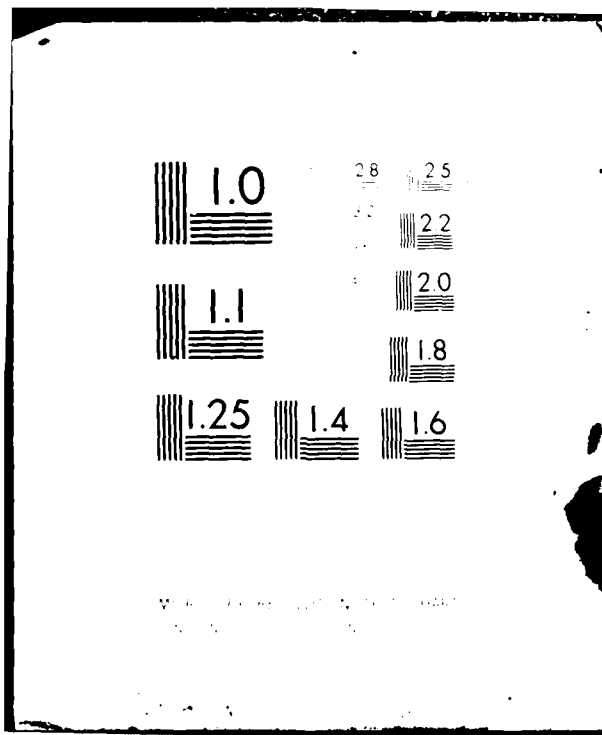
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SHOT BEE

A Test of the TEAPOT Series

22 MARCH 1955



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United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

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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, 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 atmospheric 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 is 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 Shot BEE is based on the historical record of military and technical documents associated with each of the nuclear weapons tests. Many of the documents pertaining specifically to DOD involvement during Shot BEE were found in the Defense Nuclear Agency Technical Library, the National Archives, 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 Shot BEE 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 Parsons' Operational Summary (WT-1158) and Eackler's Technical Air Operations (WT-1206). The Operational Summary provides an overview of all activities conducted during the testing, primarily those of AFSWP. Technical Air Operations,

however, is a more specific document, chronicling in detail the air operations of DOD personnel. Discrepancies as to numbers of aircraft actually participating in any single event exist between these two documents and other TEAPOT documents. When possible, these discrepancies were resolved through additional research. In those cases for which further research failed to resolve the problem, the Technical Air Operations report, WT-1206, was used because it deals specifically with air operations at TEAPOT and therefore is considered the more reliable document for determining the extent and nature of air operations.

CONTENTS OF TEAPOT REPORTS

This volume details participation by DOD personnel in Shot BEE, the sixth detonation 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
- Multi-shot Volume: Shots WASP through HORNET, the First Five TEAPOT Tests
- Shot Volume: Shot APPLE 2
- Multi-shot Volume: Shots ESS through MET and Shot ZUCCHINI, the Final TEAPOT Tests.

All volumes addressing the test events of Operation TEAPOT have been designed for use with one another. The Series volume contains information that applies to those dimensions of Operation TEAPOT that transcend specific events, such as historical background, organizational relationships, and radiological safety procedures. In addition, the Series volume contains a bibliography of works consulted in the preparation of all five Operation TEAPOT reports. The two single-shot volumes describe DOD participation in Shots BEE and APPLE 2, respectively. These two events have been bound separately because they included significant Exercise Desert Rock maneuvers involving large numbers of

DOD people. Each multi-shot volume combines shot-specific descriptions for several nuclear events. The shot and multi-shot volumes contain bibliographies of only those 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.

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

TABLE OF CONTENTS

<u>Chapter</u>	<u>Page</u>
PREFACE.	1
LIST OF ILLUSTRATIONS.	6
LIST OF TABLES	6
LIST OF ABBREVIATIONS AND ACRONYMS	7
SHOT BEE SYNOPSIS.	8
 1 INTRODUCTION TO SHOT BEE	
1.1 Setting and Characteristics of the BEE Detonation. .	10
1.2 Department of Defense Scientific, Operational Training, and Support Activities at Shot BEE	12
1.3 Exercise Desert Rock Activities at Shot BEE.	14
1.4 Organization of the Shot BEE Volume.	16
 2 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT BEE	
2.1 Troop Orientation and Indoctrination Projects at Shot BEE	18
2.2 Troop Tests at Shot BEE.	19
2.3 Technical Service Projects at Shot BEE	30
 3 JOINT TEST ORGANIZATION OPERATIONS AT SHOT BEE	
3.1 Field Command Military Effects Group Projects at Shot BEE.	33
3.2 Department of Defense Participation in Los Alamos Scientific Laboratory Test Group Projects at Shot BEE.	42
3.3 University of California Radiation Laboratory Test Group Projects at Shot BEE.	43
3.4 Department of Defense Participation in Civil Effects Test Group Projects at Shot BEE.	43
3.5 DOD Operational Training Projects at Shot BEE. . . .	44
3.6 Air Force Special Weapons Center Activities at Shot BEE.	46
 4 RADIATION PROTECTION AT SHOT BEE	
4.1 Desert Rock Radiation Protection Activities at Shot BEE.	51

TABLE OF CONTENTS (Continued)

<u>Chapter</u>	<u>Page</u>
4.2 Joint Test Organization Radiation Protection Activities at Shot BEE	52
4.2.1 Dosimetry Records	52
4.2.2 Logistical Data for Radiation Safety Equipment	52
4.2.3 Monitoring Activities	53
4.2.4 Recovery and Re-entry Procedures.	58
4.2.5 Decontamination Activities.	58
REFERENCES	59

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Page</u>
1-1 Location of Shot BEE in Nevada Test Site, in Relation to other Shots in TEAPOT Series.	11
2-1 Project 41.6, Marine Brigade Exercise.	25
4-1 Initial Survey for Shot BEE, 22 March 1955, 0540 to 0640 Hours	54
4-2 Resurvey for Shot BEE, 24 March 1955, 1026 to 1115 Hours	55
4-3 Resurvey for Shot BEE, 25 March 1955, 1026 to 1115 Hours	56
4-4 Resurvey for Shot BEE, 28 March 1955, 1115 to 1300 Hours	57

LIST OF TABLES

<u>Table</u>	<u>Page</u>
2-1 Exercise Desert Rock VI Projects, Shot BEE	17
3-1 Field Command Military Effects Group Projects, Shot BEE	34
3-2 Test Group Projects with DOD Personnel Involvement, Shot BEE	42
3-3 DOD Operational Training Projects, Shot BEE.	45
3-4 AFSWC Air Mission Support, SHOT BEE.	47

LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used in this volume:

AEC	Atomic Energy Commission
AFB	Air Force Base
AFSWC	Air Force Special Weapons Center
AFSWP	Armed Forces Special Weapons Project
BJY	Buster-Jangle "Y"
CETG	Civil Effects Test Group
CONUS	Continental United States
DOD	Department of Defense
DWET	Directorate Weapons Effects Tests
EG and G	Edgerton, Germeshausen, and Grier
FCDA	Federal Civil Defense Administration
GZ	Ground Zero
IBDA	Indirect Bomb Damage Assessment
JTO	Joint Test Organization
LASL	Los Alamos Scientific Laboratory
NTS	Nevada Test Site
OCAFF	Office, Chief of Army Field Forces
REFCo	Reynolds Electrical and Engineering Company
R/h	Roentgen(s) per hour
UCRL	University of California Radiation Laboratory
USAF	United States Air Force
UTM	Universal Transverse Mercator
3d MCPAEB	Third Marine Corps Provisional Atomic Exercise Brigade

SHOT BEE

SYNOPSIS

AEC TEST SERIES: TEAPOT
DOD EXERCISES: Desert Rock VI
DATE/TIME: 22 March 1955, 0505 hours
YIELD: 8 kilotons
HEIGHT OF BURST: 500 feet (tower shot)

Purpose of Test: Test of newly designed device for possible inclusion in U.S. arsenal.

DOD Objectives: (1) To field a demonstration test of a brigade assault on objectives in the area of a nuclear detonation
(2) To perform AFSWP military effects experiments to measure the effects of a nuclear weapon on military equipment, material, structures, and ordnance
(3) To provide DOD personnel an opportunity to observe a nuclear detonation and to become familiar with its effects
(4) To evaluate military equipment and tactics.

Weather: At shot-time, temperature at shot height was 4.5°C; pressure at 860 millibars; surface wind calm and 39 knots from the west-northwest at 40,000 feet.

Radiation Data: Ground intensities of 10 R/h were detected around ground zero during the initial survey, taken from 0540 to 0640 hours on shot-day. Lighter fallout, between 0.01 R/h and 0.1 R/h, extended more than 2,500 meters east of ground zero.

Participants: Exercise Desert Rock participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Test Manager's Organization, Los Alamos Scientific Laboratory, University of California Radiation Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 1

INTRODUCTION TO SHOT BEE

Shot BEE was a test of a nuclear device with a yield of eight kilotons conducted at 0505 hours on 22 March 1955, at the Nevada Test Site (NTS), the U.S. Atomic Energy Commission (AEC) continental nuclear test site located northwest of Las Vegas, Nevada (14). BEE was the sixth test of Operation TEAPOT, a series of 14 nuclear weapons tests and one non-nuclear test performed at the NTS between 18 February and 15 May 1955.

The nuclear device detonated at Shot BEE was developed and built for the AEC by the Los Alamos Scientific Laboratory (LASL), one of two AEC nuclear weapons development laboratories. The primary objective of BEE was to test a newly designed device for possible inclusion in the U.S. arsenal. Scientific experiments were conducted to evaluate the nuclear yield and the blast, thermal, and radiation phenomena produced by this device. Sixteen of these projects were conducted by LASL, and two were conducted by the University of California Radiation Laboratory (UCRL), the second AEC nuclear weapons development laboratory.

Twenty-two military effects projects were conducted by the Armed Forces Special Weapons Project (AFSWP) of the Department of Defense (DOD). These projects were conducted by the AFSWP Field Command Military Effects Group to evaluate the utility of the device for military applications, and to investigate additional specifications for future nuclear weapons development.

A number of other activities related to the conditions and phenomena produced by a nuclear detonation were also conducted at the BEE event. Four operational training projects were conducted by the Air Force and the Marine Corps to test equipment and to familiarize personnel with the effects of a nuclear

detonation. The Federal Civil Defense Administration (FCDA) conducted 11 projects to assess the effects of nuclear detonations on civilian populations and to evaluate Civil Defense emergency preparedness plans. DOD participation in these projects was limited to two projects.

The armed services fielded eight projects to evaluate military equipment and tactics as part of Exercise Desert Rock VI. In one troop test project, the Marine Corps fielded a demonstration test of a brigade assault on objectives in the area of nuclear detonation. The tactical exercise of the Third Marine Corps Provisional Atomic Exercise Brigade (3d MCPAEB), involving 2,271 Marines, included helicopter airlifts of assault troops, tactical air support, and air resupply. This was the largest single activity during Operation TEAPOT.

1.1 SETTING AND CHARACTERISTICS OF THE BEE DETONATION

The nuclear device tested at Shot BEE was positioned in a cab atop a 500-foot steel tower at UTM coordinates 867056* in Area 7 of Yucca Flat. Figure 1-1 shows the location of the BEE detonation (21).[†]

At the time of the BEE detonation, the sky was clear, the temperature at shot height was 4.5 degrees Celsius, and the pressure was 860 millibars. The wind was calm at the surface, 18 knots from the west-northwest at 10,000 feet, 43 knots from the

*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.

[†]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.

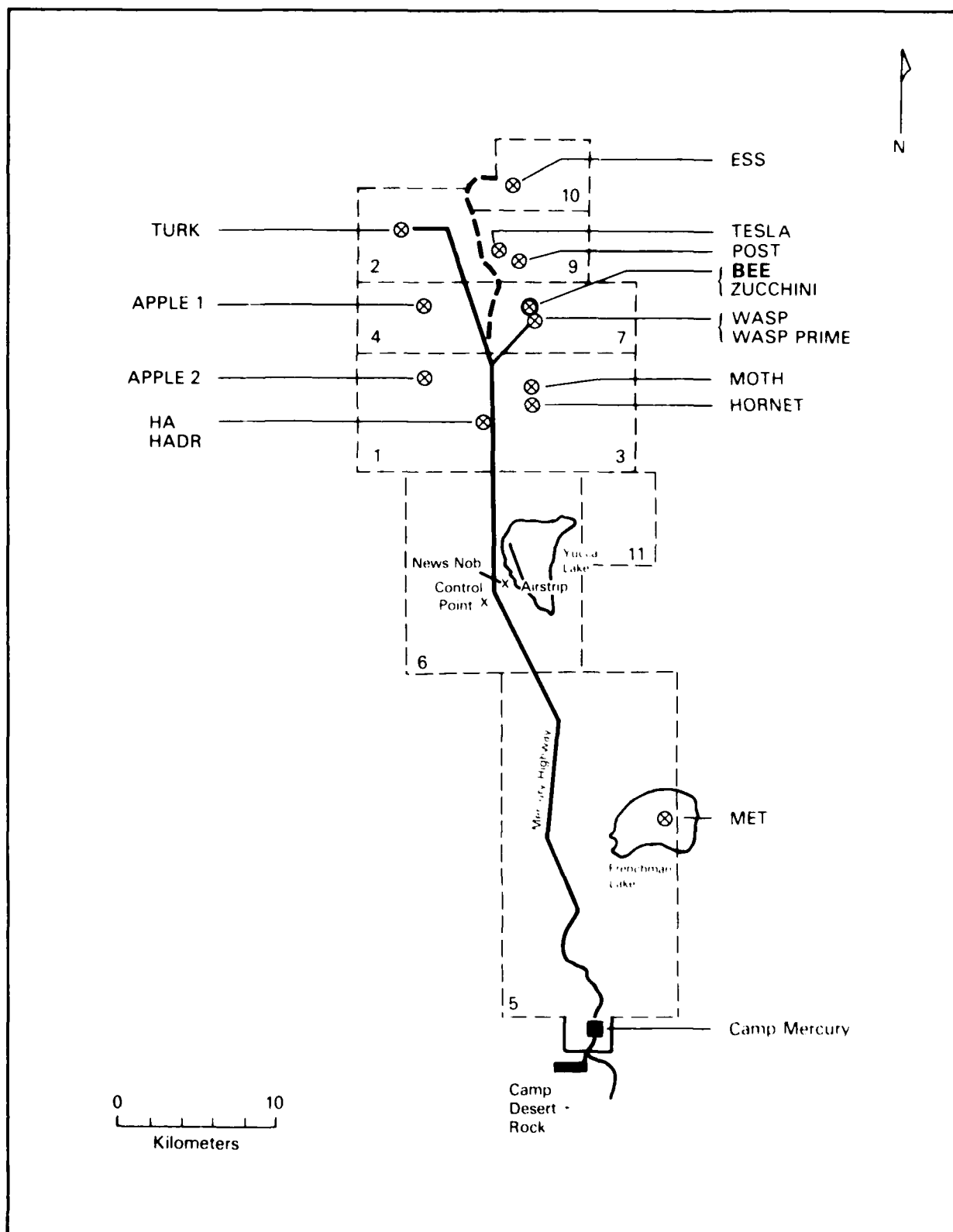


Figure 1-1: LOCATION OF SHOT BEE AT NEVADA TEST SITE,
IN RELATION TO OTHER SHOTS IN TEAPOT SERIES

northwest at 20,000 feet, 42 knots from the northwest at 30,000 feet, and 39 knots from the west-northwest at 40,000 feet.* The nuclear cloud top rose to an altitude of 39,700 feet. Fallout occurred to the east onsite and in a narrow band to the southeast offsite, extending into Arizona (21).

1.2 DEPARTMENT OF DEFENSE SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT BEE

The Joint Test Organization (JTO) was established for planning, coordinating, and conducting atmospheric nuclear weapons tests during Operation TEAPOT. All activities were under the control of an AEC-appointed Test Manager assisted by the Test Director. In addition to personnel from AEC, DOD, and ECDA, the JTO included representatives from the AFSWP Military Effects Group, the LASL Test Group, the UCRL Test Group, and the ECDA Civil Effects Test Group (CETG). These test groups conducted about 50 military effects and scientific projects at Shot BEE, more than half of which involved DOD participation. Four other projects were conducted by Air Force and Marine Corps personnel as part of the DOD operational training program. In addition to those people involved in experiments and training, other DOD staff and support personnel provided necessary services to other participants at the test site. These included Air Force Special Weapons Center (AFSWC) personnel flying special missions for the Test Manager, and soldiers from the 1st Radiological Safety Support Unit monitoring radiation.

Personnel from DOD agencies and all four armed services participated in the experiments conducted by the four test groups, whose activities were coordinated by the Test Director.

*Altitudes are measured from mean sea level while heights are measured from the ground. All vertical distances are given in feet. Yucca Flat is about 4,000 feet above mean sea level.

Although the largest DOD involvement was in the 22 military effects projects of the Military Effects Group, DOD personnel also assisted on a limited basis in eight of the projects conducted by the other test groups. Participants in the diagnostic experiments placed data-collection instruments around the ground zero area in the days and weeks preceding the scheduled event. Approximately 90 minutes after the detonation, when the Test Manager had determined that the radiological environment in the shot area would permit limited access, participants recovered instruments and equipment.

The four operational training projects, which involved both Marine Corps and Air Force personnel, were designed to test service tactics and equipment, and to train military personnel in the effects of a nuclear detonation.

One important support function during Shot BEE was provided by AFSWC, based at Kirtland Air Force Base (AFB), Albuquerque, New Mexico. This organization provided air support to the Test Manager and to the test group projects. During Operation TEAPOT, AFSWC was composed of units of the 4925th Test Group (Atomic), including the 4926th Test Squadron (Sampling) and the 4935th Air Base Squadron. These units operated from Indian Springs Air Force Base, 38 kilometers* southeast of the NTS, and were supported by the 4900th Air Base Group⁺ at Kirtland AFB. For BEE, AFSWC performed several missions, including security sweeps, cloud sampling, cloud tracking, radio relay, terrain surveys, and courier and transportation services.

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

⁺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 were established by the JTO to minimize exposure to ionizing radiation. Participants were to receive no more than 3.9 roentgens of whole-body gamma radiation for any 13-week period and 15 roentgens of whole-body gamma radiation annually. To ensure these criteria were followed, the 1st Radiological Safety Support Unit rigidly controlled access to radiation areas, and project personnel recovering test instruments from areas of high radiation intensity were accompanied by radiological safety monitors. The monitors continuously checked the radiation intensity in the recovery area and informed the project manager if intensities were too high or the length of time spent in the area was too long. Project personnel were issued film badges to wear at all times when in the shot area. These film badges were collected, developed, and evaluated periodically. Any individual whose accumulated exposure exceeded or would be expected to exceed the established limits was barred from further participation in project activities in shot areas. Although not implemented during TEAPOT, emergency evacuation procedures were prepared for all test events (13).

With one exception, the radiation protection procedures for the AFSWC aircrew and ground crew personnel were the same as those established for the JTO. The Test Manager authorized cloud sampler pilots to receive up to a total of 15 roentgens of gamma radiation throughout the TEAPOT Series. 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 then either decontaminated by washing or were isolated until radiation intensities had decayed to predetermined levels (13; 19).

1.3 EXERCISE DESERT ROCK ACTIVITIES AT SHOT BEE

About 3,000 DOD personnel participated in the eight projects fielded by Exercise Desert Rock VI, the Army testing and training

program conducted during Operation TEAPOT. These projects included four troop orientation and indoctrination projects, two troop tests, and two technical service projects.

The largest group of participants were the 2,271 Marines who conducted the Marine Corps Provisional Atomic Brigade Exercise (2). Another 517 individuals took part in four troop orientation and indoctrination projects, which required participants to observe the detonation from a trench position (29).

In addition to the Desert Rock exercise troops, about 2,000 Camp Desert Rock troops from various Army units maintained and operated Camp Desert Rock, providing transportation, communications, engineering, administrative, and security services (27). Of these Desert Rock troops, some worked in the forward areas of the NTS to construct observer positions, lay communication lines, provide transportation, and assist in preparing for Desert Rock projects. Soldiers from the 50th Chemical Service Platoon served as radiological safety monitors for Desert Rock project personnel during nuclear test events.

Radiation protection procedures at Exercise Desert Rock, as well as those of the JTO, are detailed in the TEAPOT Series volume. During Operation TEAPOT, Camp Desert Rock support personnel and exercise participants were limited to no more than six roentgens of whole-body gamma radiation during any six-month period. The radiation protection procedures for Exercise Desert Rock included provisions for (13; 27):

- 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

- Issuing film badges and monitoring the cumulative exposure of Desert Rock personnel
- Decontaminating all equipment and personnel leaving the shot area after the detonation.

1.4 ORGANIZATION OF THE SHOT BEE VOLUME

The remainder of this volume presents an account of DOD activities and the resulting potential for participant exposure to radiation during Shot BEE. Chapter 2 describes the Exercise Desert Rock VI military activities, while chapter 3 describes various training activities, scientific and military effects experiments, and support missions in which DOD personnel participated. These two chapters provide information about the number of DOD participants involved in specific projects fielded at Shot BEE; the time spent by project personnel in the test area; and their positions relative to the point of detonation and radiation areas before, during, and after the test. Chapter 4 of this volume describes the radiological environment and safety procedures pertinent to Shot BEE, including isointensity contour maps illustrating the radiation areas around ground zero after the detonation, and available shot-specific exposure data for individuals. Details of the overall radiation protection program at Operation TEAPOT are provided in the Series volume.

CHAPTER 2

EXERCISE DESERT ROCK VI OPERATIONS AT SHOT BEE

About 3,000 Department of Defense (DOD) personnel participated in eight Exercise Desert Rock VI projects conducted at Shot BEE. Of these, 2,271 individuals were part of the Third Marine Corps Provisional Atomic Exercise Brigade (3d MCPAEB). In addition, some of the 2,000 Camp Desert Rock support troops were probably present during BEE. This chapter is primarily concerned with Desert Rock activities before, during, and after the BEE detonation that may have exposed the participants to ionizing radiation. Table 2-1 lists the Desert Rock programs and subordinate projects.

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

Program Type	Project	Title	Participants	Estimated DOD Personnel
Troop Orientation and Indoctrination	41.3	Army Observers	Army	153
	41.4	Navy Observers	Navy	160
	40.11	Marine Observers	Marine Corps	92
	41.18	Air Force Observers	Air Force	112
Troop Tests	40.18	Location of Atomic Bursts	Battery C (1532nd Field Artillery (Observation) Battalion)	53
	41.6	Marine Brigade Exercise	Third Marine Corps Provisional Atomic Exercise Brigade	2271
Technical Service	40.19	Sixth Army CBR Defense Team Training	Sixth Army	22
	40.21	Ordnance Vehicular Equipment Test	Ballistic Research Laboratories; Army Chemical Center; 523rd Ordnance Company; Detroit Arsenal	*

*Unknown

2.1 TROOP ORIENTATION AND INDOCTRINATION PROJECTS AT SHOT BEE

Troop orientation and indoctrination was an observer program designed to orient armed services personnel regarding the effects of a nuclear detonation. The observer program at Shot BEE included several phases including a preshot orientation, observation of the detonation itself, and postshot inspection of an equipment display area. The 160 Navy observers in Project 41.4 were also involved in Project 40.9, Navy Passive Defense Training, during the ESS detonation of 23 March 1955. Their activities in Project 40.9 are discussed in the ESS to MFT and Shot ZUCCHINI volume. Although the observers were differentiated by project, they operated as a single unit throughout their stay at Camp Desert Rock, following the procedures outlined below (22; 29).

After the observers arrived at Camp Desert Rock, they participated in an orientation program of lectures and films on the characteristics of a nuclear detonation, and the procedures to follow during a detonation. On 15 March, the observers made a preshot tour of the equipment display area.

At 0335 hours on 22 March, the day of the BEE detonation, the observers were transported by Camp Desert Rock personnel to trenches located 3,200 meters southwest of ground zero. During the detonation, the observers crouched in the trenches, shielded from the nuclear blast. At 0535 hours, 30 minutes after the detonation, once Desert Rock radiological safety monitors had surveyed the area, the observers proceeded forward through the equipment display area, which began 640 meters toward ground zero.

in front of the observer trenches. Their tour through the display area is estimated to have proceeded as follows (5; 22; 27):

<u>Equipment Location</u>	<u>Observers' Arrival Time</u>
2,560-meter display	0545 hours
2,100-meter display	0555 hours
1,740-meter display	0605 hours
1,000-meter display	0625 hours
640-meter display, including displays to 460 meters	0650 hours

The observers left the innermost display about 500 meters from ground zero at 0705 hours and returned to the trench area at 0740 hours. At approximately 0750 hours, they departed in convoy from the trench area to return to Camp Desert Rock (22).

2.2 TROOP TESTS AT SHOT BEE

The two troop tests were conducted to provide data on military tactics and doctrine, as well as to train command and staff personnel in planning and conducting combat operations under the anticipated conditions of a nuclear battlefield.

Project 40.18, Location of Atomic Bursts, was conducted by 53 participants from Battery C (-),* 532nd Field Artillery Battalion (Observation) (27). The objectives of Project 40.18 were to test equipment and train troops in locating and determining the yield of a nuclear detonation. To perform the project, field surveys were conducted using AN/TVS-1 cameras, MK-11 Bhangmeters, AN/MPQ-21X radar sets, and microphones. Personnel manned ten survey stations located ten to 18 kilometers south to southwest of ground zero. During the detonation, the

*Some subordinate units were not present.

people at the stations attempted to identify the burst location on a three-dimensional grid and to assess the yield of the burst (27). The station locations follow (35).

UTM COORDINATES

Flash Location 1	759988
Flash Location 2	775976
Flash Location 3	794969
	794964
Sound Control Point	796984
Flash Control Point	810961
Flash Location 4	824953
Flash Location 5	834945
Sound Control Point	858874
(Alternate)	

Project personnel were to travel to the above stations at 1630 hours on 21 March, twelve-and-one-half hours before the BFF detonation, to set up the equipment at each designated station location. They were to remain at the stations during the detonation and after the shot until data collection was completed. All stations were located between 10 kilometers southwest and 18 kilometers south of ground zero (35).

Project 41.6, the Third Marine Corps Provisional Atomic Brigade Exercise, included 299 officers and 1,972 enlisted men of the Third Marine Corps Provisional Atomic Exercise Brigade (3d MCPAEB).^{*} This project marked the first use of tactical air support for military maneuvers at the Nevada Test Site (NTS).

^{*}Of these personnel, 432 were not encamped at Camp Desert Rock. These participants were the pilots, maintenance, and support personnel from the Marine Corps Auxiliary Air Station, Mojave, California. The pilots were the only MAG 15 personnel who actually participated in Project 41.6 at the NTS. They simulated the air attack in support of the ground personnel.

The Commandant of the Marine Corps stated the following objectives for the Marine Brigade Exercise at Shot BEE (2):

- To afford commanders and staffs realistic training in planning and conducting operations supported by nuclear weapons
- To further test and evaluate tactics and techniques for the execution of air-ground task missions involving the use of nuclear weapons
- To develop new tactics and techniques to exploit the effects of a nuclear explosion when nuclear weapons are employed in support of air-ground task forces
- To familiarize personnel with the phenomena incident to a nuclear explosion and the resulting effects
- To familiarize personnel with passive defense measures to minimize or protect against the effects of a nuclear explosion.

On 27 September 1954, the Assistant Chief of Staff for Operations, Marine Corps Headquarters, informed Marine Corps Test Unit 1 of Camp Pendleton, California, of the decision to conduct an air-ground maneuver during the upcoming TEAPOT Series, and ordered the unit to begin planning for the operation. The Marine Corps Test Unit 1, comparable in size to a reinforced infantry battalion, was activated in the summer of 1954 to field test new concepts of tactical assault. Although these Marines were engaged in many tests and experiments, the highlight of their activities was the Marine Brigade Exercise conducted at Shot BEE.

In developing plans for the exercise, officers of the Marine Corps Test Unit 1 attended a planning conference on 27 October 1954 at Sandia Base, Albuquerque, New Mexico, and requested permission from the Armed Forces Special Weapons Project (AFSWP) to conduct their exercise at Shot ZUCCHINI. On 17 November, at an Air Force Special Weapons Center (AFSWC) planning conference

at Kirtland AFB, the Marine Corps received approval to stage an air-ground maneuver at Shot ZUCCHINI. On 13 December, the Commandant of the Marine Corps directed that the 3d MCPAEB be organized at Camp Pendleton. The 3d MCPAEB included units from the Marine Corps Test Unit 1, whose commanding officer was designated Chief of Staff. The 3d MCPAEB included units from the First Marine Division and Aircraft, Fleet Marine Force Pacific.

The air operations units for the 3d MCPAEB were to be provided by the Commanding General of Fleet Marine Force Pacific. On 3 January 1955, several helicopter squadrons from Marine Helicopter Transport Group 36 from Marine Air Group 15, and Marine Air Support Squadron 3(-)* were directed to Desert Rock, Nevada, and the Marine Corps Auxiliary Air Station, Mojave (2).

On 10 January, representatives from the newly formed 3d MCPAEB attended a Desert Rock VI planning meeting at Sixth Army Headquarters in San Francisco. During this meeting, the Marines were informed that their maneuver had been rescheduled for Shot TURK because the Army wished to conduct a field exercise at Shot ZUCCHINI. The Commander of the exercise questioned this reassignment, since detailed plans had already been made for ZUCCHINI. Only five weeks remained before TURK's scheduled detonation on 15 February 1955, a period of time considered insufficient for reorganizing the Marine maneuver plans. Subsequently, during a 17 January 1955 conference at Headquarters Marine Corps, the Marine Corps and the Army agreed that the exercise could be conducted during Shot BEE, which was scheduled for 18 March.

Within the next week, the 3d MCPAEB made the necessary changes in its operating plans and on 25 January the Deputy Exercise Director approved the new plans. The Marine Corps then sought approval from the Test Director of the Joint Test organization (JTO). The Test Director concurred in all aspects

* Some scheduled units were not present.

of the Marine Corps plans, including encampment of Marines at the NTS on the day before the shot.

The 3d MCPAEB also included two smaller components, a Marine Camp Detachment and a Helicopter Support Unit. The Marine Camp Detachment administered the Marine camp at Desert Rock, and the Helicopter Support Unit served as a task support unit for the helicopters of the brigade (3).

On 25 February 1955, the Marine Camp Detachment left Camp Pendleton for Camp Desert Rock by air and ground convoy. By the following day, all 168 members of the Marine Camp Detachment had arrived at Camp Desert Rock. On 8 and 9 March, a vehicle convoy departed from Camp Pendleton for Camp Desert Rock. The convoy included 871 members of Marine Corps Test Unit 1, surface elements of Marine Helicopter Transport Group 36 (-), and Marine Air Support Squadron 3 (-). The convoy arrived at Camp Desert Rock on 10 March.

The surface elements of Marine Air Group 15(-) arrived at the Marine Corps Auxiliary Air Station, Mojave, California, on 10 March. They were followed by the air elements on 11 March. Marine Air Group 15 (-) operated from Mojave, rather than from Camp Desert Rock. This group would simulate an air attack on assault objectives during the exercise and return to Mojave. The Marine Helicopter Transport Group 36 (-) probably traveled to Camp Desert Rock at the same time as the other units of the 3d MCPAEB.

The main elements of the 3d MCPAEB, including the Headquarters and Service Company, left on 10 March in 39 R5D aircraft belonging to Air Fleet Marine Force Pacific and operating from El Toro Marine Corps Air Station, Santa Ana, California, near Camp Pendleton. This airlift transported over 1,400 Marines to Indian Springs AFB, near Desert Rock (2).

From 11 to 21 March, the 3d MCPAEB engaged in preparations for the maneuver at Shot BEE (2).

- On 12 March, an unknown number of Marines observed the detonation of Shot HORNET.
- On 16 March, an officer from the Deputy Exercise Director's staff conducted a radiological safety orientation for all brigade personnel.
- On 17 and 19 March, the tactical portion of the exercise was rehearsed at the NTS.
- On 20 March, a live monitoring exercise was conducted in the area of the Shot TURK ground zero to prepare for radiological monitoring at the landing zones.

The exercise began on 21 March, when Marine units left Camp Desert Rock for the NTS. Figure 2-1 shows the positions occupied by the Marines at the NTS during the exercise.

At 1300 hours on 21 March, Headquarters and Service Company, Marine Air Support Squadron 3 (-), and the command personnel of Marine Helicopter Transport Group 36 left for their command posts in a convoy of 46 vehicles. They arrived at their destination at 1426 hours. The Headquarters and Service Company was located about 14 kilometers southwest of ground zero. This location served as the Brigade Command Post. The command post for Marine Helicopter Transport Group 36 (-) was in about the same location or 940 meters west of Loading Zone 2. Marine Air Support Squadron 3 (-) was located at the Brigade Direct Air Support Center, where all Marine Corps air operations were regulated under the supervision of the Air Operations Center. The Direct Air Support Center was 13 kilometers southwest of ground zero. Together, the three posts formed the headquarters for Marine Corps activities during Project 41.6 (1; 28).

The first convoy of Marine assault units left Camp Desert Rock at 1315 hours. They traveled in 36 vehicles and arrived at

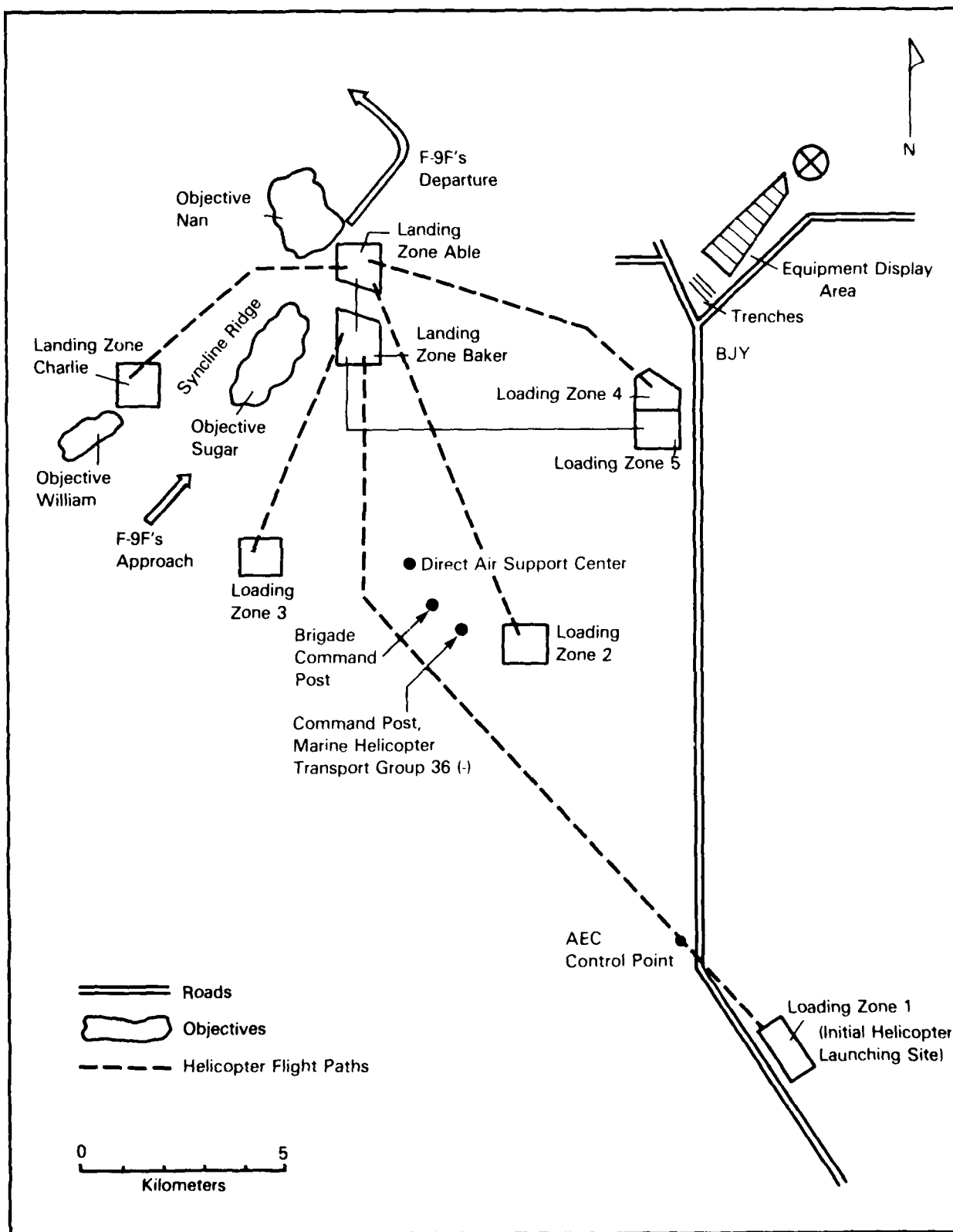


Figure 2-1: PROJECT 41.6, MARINE BRIGADE EXERCISE

loading Zone 3 at 1456 hours. At 1330 hours, 30 vehicles carrying more Marines left Camp Desert Rock for Loading Zones 1 and 2. They reached the loading zones at 1449 hours (28).

At 1430 hours, the air elements of Marine Helicopter Transport Group 36 left Camp Desert Rock for Loading Zone 1. The contingent was to consist of 30 helicopters and their pilots, one officer, and eight enlisted men. The surface elements of Transport Group 36 traveled by convoy to their assigned positions at Loading Zone 1. These elements spent the night before the BEE detonation encamped in the forward area (3).

At 0217 hours on 22 March, a convoy of 15 vehicles left Camp Desert Rock, arriving at the trench area 3,200 meters from ground zero, at 0339 hours. The last convoy of Marines departed from Camp Desert Rock at 0232 hours on 22 March, traveling in a convoy of 14 vehicles. They reached the trench area at 0352 hours. Documentation indicates that Camp Desert Rock support elements transported troops to the trench area, and parked their vehicles at News Nob near Yucca Pass (28). Four F-9Fs of Marine Air Group 15(-) left the Mojave Marine Corps Auxiliary Air Station at 0415 hours and arrived over Lathrop Wells at 0450 hours. A total of 22 aircraft left Mojave at approximately 45-minute intervals, four aircraft at a time, and followed the same flight pattern (2; 3). After each set of aircraft made the strike objective, they returned to Mojave and began the pattern again.

At 0502 hours, three minutes before the detonation, some Marines crouched in the trenches, 3,200 meters southwest of ground zero. At the same time, other Marines further from ground zero sat down and faced away from the point of detonation, shielding their eyes with their hands or arms. The planned

disposition of these ground personnel in the NTS at the time of the detonation was as shown below (3).

<u>At the Command Post</u>	<u>Number of Personnel</u>
● Headquarters and Service Company	158
● Marine Helicopter Transport Group 36(-)	90
● Marine Air Support Squadron 3(-)	42
<u>At Loading Zone 1</u>	
● Marine Corps Test Unit 1	96
● Marine Helicopter Transport Group 36, 30 of whom were helicopter pilots	39
● Helicopter Support Unit	1
● Public Information Office representatives	9
<u>At Loading Zone 2</u>	
● Marine Corps Test Unit 1	202
● Helicopter Support Unit	45
● Marine Helicopter Transport Group 36(-)	23
<u>At Loading Zone 3</u>	<u>Number of Personnel</u>
● Marine Corps Test Unit 1	220
● Helicopter Support Unit	18
● Marine Helicopter Transport Group 36(-)	9
<u>In the trench area</u>	
● Marine Corps Test Unit 1	594
● Marine Camp Detachment	157
● Marine Helicopter Transport Group 36(-)	20
● Public Information Office representatives	4

The remaining 544 Marines were Marine aircrew and ground personnel operating from Marine airbases in California, and Marine Corps administrative personnel at Camp Desert Rock.

In addition to the Marines, various equipment was positioned in the loading zones. Thirty Marine Corps helicopters were in Loading Zone 1, and simulated palletized supplies were in Loading Zone 2. Six 75mm pack howitzers, six 4.2-inch mortars, and three 75mm recoilless rifles were located in Loading Zone 3 (2).

At 0510 hours, five minutes after the detonation, the maneuver began. It consisted of an airlift, an assault on the objectives, and a tour of the equipment display area. All participants in the exercise maneuvered in the areas west and southwest of the BEE ground zero.

At 0512 hours, two helicopters, each carrying a radiological safety monitoring team, flew from Loading Zone 1 to Landing Zones Able and Baker (2). At 0515 hours, after the radiological safety monitors had declared the landing zones safe, the remaining 28 helicopters, in attack formation, followed the lead helicopters. These 28 helicopters were to fly 102 troops. The airlift helicopters then landed, and the troops disembarked.

The first flight of four F-9Fs from Marine Air Group 15 conducted a strike over Syncline Ridge at the objectives 90 seconds before the second wave of helicopters touched down on Landing Zones ABLE and BAKER. Since the initial two helicopters left at 0512 hours, three minutes elapsed before the second wave was signaled to leave. It is assumed that the first group of F9Fs made their strike between 0515 and 0518 hours, when the first helicopters of the second wave had already landed. The air strikes probably continued at 45-minute intervals until the end of the maneuver (2; 3).

Upon completion of the initial helicopter lift, Marine Corps Helicopter Transport Group 36 began the second phase of the airlift. It was planned that 318 troops would be transported in 114 sorties from Loading Zones 1, 2, and 3 to Landing Zones Able and Baker (3). They completed the airlift at 0623 hours.

Concurrently, Marines located in the trenches marched to Loading Zones 4 and 5. The Marine Camp Detachment did not accompany these troops, since their participation was limited to observing BEE from the trenches (2). The helicopters returned from the final lift between Loading Zones 1, 2, and 3 and the Landing Zones, and transported Marines and equipment from Loading Zone 4 to landing Zone Able and from loading Zone 5 to landing Zone Baker.

This third airlift phase was to transport 594 Marines in 160 loads (3). The lift from all five loading Zones was completed by 0900 hours (2).

The fourth airlift phase began at 0955 hours, after all the Marines had been transported to their assigned landing zones. The Second Platoon, consisting of 48 troops from A Company, Marine Corps Test Unit 1, was airlifted from Landing Zone Able to Landing Zone Charlie (2; 3).

Upon disembarking from the helicopters, the Marines fanned out to seize their attack objectives. Those at Landing Zone Able assaulted Objective Nan; those at Landing Zone Baker attacked Objective Sugar; and those at landing Zone Charlie seized Objective William. The maneuver ended at 1500 hours with the capture of all objectives (2). The Marines were then transported to the equipment display area.

The display area was located southwest of the BEE ground zero, at a distance ranging between 460 meters and 2,560 meters

from ground zero. The area featured equipment, such as tanks and mortars, and mannequins dressed in Marine Corps uniforms. The assault units toured the display area between 1500 and 1730 hours, after the maneuver was completed. After touring the equipment display, these Marines checked in at the Decontamination Station at Yucca Pass. They reached Camp Desert Rock at 2000 hours (2).

Documentation indicates that the Marine Camp Detachment, which observed BEE from the trenches but did not participate in the maneuver, may have toured the display area with the troop orientation and indoctrination observers at 0535 hours and then returned with the observer convoy to Camp Desert Rock at 0750 hours (28).

The Brigade Direct Air Support Center, under the supervision of the Air Operations Center, coordinated the 30 H-19 helicopters that airlifted the Marines to their attack objectives during the exercise. Other air support was provided by the 22 F-9F aircraft of Marine Air Group 15, which staged from the Marine Corps Auxiliary Air Station, Mojave, California, and by four R-40 aircraft from the First Air Delivery Section, Fleet Marine Force Atlantic; with loading personnel from the First Combat Service Group, Fleet Marine Force Pacific. The R-40 aircraft, which staged from El Toro Marine Corps Air Station, Santa Ana, California, delivered supplies for assault personnel beginning at 1358 hours. These F-9F and R-40 aircraft were also controlled by the Air Operations Center (3).

2.3 TECHNICAL SERVICE PROJECTS AT SHOT BEE

During Operation TEAPOT Technical Service Projects were designed to test the effects of nuclear weapons on ordnance, material, fortifications, structures, and equipment. Two technical service projects were conducted by Exercise Desert Rock VI at Shot BEE, as listed in table 2-1.

The Specific objectives of Project 40.19, Sixth Army CBR Defense Team Training were to (30):

- Determine the capabilities of Chemical, Biological, Radiological (CBR) teams to perform emergency radiological defense missions
- Provide CBR teams training under actual radiological conditions
- Determine the adequacy of the organization and monitoring equipment provided by Department of the Army directives concerning CBR teams.

At BEE, two CBR teams consisting of a total of 22 men performed radiological surveys of the test area on shot-day and on the two following days. The teams were required to determine the isointensity lines from 1 to 16 roentgens per hour (R/h), to delineate areas of maximum intensity, and to plot the findings (30).

Project 40.21, Ordnance Vehicular Equipment Test, was conducted by the Ballistic Research Laboratories. The principal participant in the project was the 573rd Ordnance Company, which positioned the test equipment with the assistance of Detroit Arsenal personnel. Ballistic Research Laboratories personnel from Project 3.1 recorded blast pressures from gauges located on or near the test equipment, while Army Chemical Corps personnel from Project 2.7 took radiation measurements (38).

The objectives of Project 40.21 were to determine the effects of roll-over safety bars in minimizing damage to wheeled vehicles, in order to obtain experimental data for the future design of military vehicles, and to investigate the shielding effect of armor against gamma radiation (38). The equipment was placed in 11 positions, at distances of 240 meters to 1,110 meters from ground zero. The vehicles included three M-48 tanks, one M59 armored personnel carrier, one T97 self-propelled gun, six jeeps, four five-ton cargo trucks, and twelve 2.5-ton trucks. Project personnel were not required to be in the area

area at the time of the BEE detonation. Dosimetry data were recovered after the detonation, when radiation intensities permitted, and the equipment was removed for use at subsequent events (27; 38).

CHAPTER 3

JOINT TEST ORGANIZATION OPERATIONS AT SHOT BEE

During Shot BEE, Department of Defense (DOD) personnel participated in a variety of diagnostic, military effects, and training projects, as well as Air Force Special Weapons Center (AFSWC) support missions. These activities required Department of Defense personnel to enter the forward area before, during, and after the shot. The Test Manager declared the area open for recovery operations at 0644 hours, one hour and 39 minutes after the detonation. The military personnel of the Armed Forces Special Weapons Project (AFSWP) Field Command Military Effects Group conducted 22 projects during the BEE event. In addition, AFSWP coordinated four operational training projects conducted by personnel of the Marine Corps and Air Force (Tactical Air Command and others). DOD personnel were also involved in seven projects conducted by the Los Alamos Scientific Laboratory (LASL) Test Group, the University of California Radiation Laboratory (UCRL) Test Group, and the Federal Civil Defense Administration Civil Effects Test Group (CETG).

Detailed descriptions of project objectives and general project activities are contained in the TEAPOT Series volume. The information contained in this chapter addresses only those project operations unique to Shot BEE.

3.1 FIELD COMMAND MILITARY EFFECTS GROUP PROJECTS AT SHOT BEE

In order to study the yield characteristics and weapons effects of nuclear devices relevant to military applications, the AFSWP Military Effects Group sponsored the weapons effects projects at Shot BEE as shown in table 3-1. Because, in most cases, many of the same people performed both preshot and postshot

Table 3-1: FIELD COMMAND MILITARY EFFECTS GROUP PROJECTS, SHOT BEE

Project	Title	Participants	Estimated Personnel
1.2	Shock Wave Photography	Naval Ordnance Laboratory	2
1.10	Overpressure and Dynamic Pressure versus Time and Distance	Stanford Research Institute	15
1.14b	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	5
2.5.1	Fallout Studies	Chemical Research Laboratory, Chemical Warfare Laboratory	*
2.8a	Contact Radiation Hazard Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
2.8b	Manned Penetrations of Atomic Clouds	Air Force Special Weapons Center	2
3.1	Response of Drag type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	5
5.1	Destructive Loads on Aircraft in Flight	Wright Air Development Center	*
5.2	Effects on Fighter Type Aircraft in Flight	Wright Air Development Center	2
6.1.1a	Evaluation of Military Radiac Equipment	Army Signal Corps Engineering Laboratories	3
6.1.1b	Evaluation of a Radiological Defense Warning System	Army Signal Corps Engineering Laboratories	3
6.3	Missile Detonation Locator	Army Signal Corps Engineering Laboratories	*
6.4	Test of IBDA Equipment	Wright Air Development Center	14
6.5	Test of Airborne Naval Radars for IBDA	Bureau of Aeronautics	3
8.1	Measurement of Direct and Ground reflected Thermal Radiation at Altitude	Bureau of Aeronautics	4
8.4b	Thermal Measurements from Fixed Ground Installations	Naval Radiological Defense Laboratory	3
8.4d	Spectrometer Measurements	Naval Radiological Defense Laboratory	*
8.4f	Bolometer Measurements	Naval Radiological Defense Laboratory	
9.1	Technical Photography	Lookout Mountain Laboratory, AFSWC, Air Force Missile Test Center, EG and G	
9.4	Atomic Cloud Growth Study	Air Force Cambridge Research Center, U.S. Weather Bureau, EG and G	*

* Unknown

activities, estimates reflect the maximum number of DDB participants who would have been involved in the project.

Most Military Effects Group projects required personnel to assemble diagnostic equipment and instruments in the field several days or weeks before the shot, and to retrieve the experiments or record data after the detonation. When the Test Manager declared recovery hour at 0644 hours, the project personnel were authorized to proceed, with a radiological safety monitor, to recover data from their experiments.

Project 1.2, Shock Wave Photography, was designed to photograph the progression of the blast. Four cameras were used from a camera station located approximately 2,900 meters from ground zero. The location was just outside the 0.01 R/h initial survey radiological safety line. The film was probably recovered late on shot-day by two persons in one hour (35; 39).

For Project 1.10, Overpressure and Dynamic Pressure versus Time and Distance, 24 channels of instrumentation were placed at six stations radiating from ground zero to determine pressure variations produced by the detonation. Measurements of side-on and dynamic pressure were taken using pitot-tube gauges at three- and ten-foot elevations above the surface. Side-on pressure was also measured at ground level and at ten feet. The closest instrumentation station was 390 meters south of ground zero, with the recording shelter 510 meters from ground zero. About 15 men spent eight days building the instrumentation shelter and installing the instrumentation before Shot BFF. Project personnel did not reenter the area until sometime after recovery hour. Five persons probably spent three days recovering the data for Shot BFF and removing the instrumentation and towers (35; 45).

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was designed to measure pressure

variations produced by the detonation. Self-recording gauges were placed on two lines extending from ground zero, one running to the northeast and the other to the southwest. Both instrument lines had station locations ranging from 325 to 1,150 meters from ground zero. Preshot surveying, construction of instrumentation mounts, installation, and checking of gauges for BEE probably took six persons two weeks. Postshot recovery of data was probably accomplished on shot-day at the stations farthest from ground zero, by two persons in four hours. Recovery of the data from the stations closest to ground zero was probably accomplished by three persons over a two-day period, beginning sometime after recovery hour (7; 35).

For Project 2.1, Gamma Exposure versus Distance, 24 dosimeter stations were arranged along a line between 475 meters and about 2,710 meters from ground zero to determine gamma radiation hazard at various distances. One hour after the Test Manager declared that recovery operations could begin, three persons in one vehicle, accompanied by a radiological safety monitor also from the Army Signal Engineer Laboratories, began to recover dosimeters from stations located south of ground zero. The project personnel were to start recovery operations from the farthest station location and work toward ground zero as far as the radiation situation permitted. It was estimated that these project personnel spent about 20 minutes in the shot area (23; 35).

Project 2.2, Neutron Flux Measurements, was designed to evaluate the neutron radiation hazard at various distances from the detonation. Neutron detectors were all connected to a cable laid from 180 meters to 910 meters from ground zero. After recovery hour, five persons in one vehicle, including one monitor from the 1st Radiological Safety Support Unit, entered the shot area to pull the cable out to an area of low radiointensity and recover the neutron detectors. This party spent about 30 minutes in the shot area recovering all detectors (25; 35).

Project 2.5.1, Fallout Studies, involved soil sampling to evaluate the radiation hazard caused by fallout. Information concerning personnel activities for Project 2.5.1 was found only as it pertained to Shot ESS. The number of DOD personnel involved for Shot BEE and their activities therefore are not known (46).

For Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, approximately five individuals surveyed the same T-33 aircraft surface at distances of one centimeter, eight centimeters, 0.3 meters, and one meter to determine how the degree of contamination varied as a function of distance. The aircraft survey took approximately two hours, and was repeated over the next two days to document decay rates on portions of the aircraft that ground-crews would be likely to contact (14; 35).

For Project 2.8b, Manned Penetrations of Atomic Clouds, one T-33 aircraft with a pilot and a radiological safety monitor took off from Indian Springs AFB and recorded an intensity of 500 R/h in the nuclear cloud at an altitude of 35,000 feet, 31 minutes after the detonation. The aircraft spent about 18 seconds within the cloud, and returned directly to Indian Springs AFB, where the pilot and passenger were monitored and decontaminated. The external dose, as measured by the pilot's chest badge, was approximately 2 to 2.5 roentgens. The internal and external exposures measured by film badges were about the same (6; 35).

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, was designed to examine the ability of vehicles to withstand blast effects from the detonation. On one side of the BEE shot-tower was a large asphalt area and on the other side a desert area. Eight 1/4-ton trucks were arrayed from 540 to 765 meters on both sides of the BEE tower, on the desert and asphalt surfaces. In addition, several pieces of Marine Corps equipment were also exposed (50).

It is estimated that before Shot BEE, five persons each spent two days placing and instrumenting the 16 vehicles and the Marine Corps equipment. After BEE, it is estimated that four individuals, including a crane operator, took one day to clear the area after recovery hour (35).

Project 5.1, Destructive Loads on Aircraft in Flight, was conducted to determine the ability of aircraft to survive the gust loading from the detonation. Personnel were responsible for maintaining and operating a drone and the director aircraft involved in the project. One QF-80A drone was launched to determine the effects of a nuclear detonation on telemetered signals (43).

Project 5.2, Effects on Fighter Type Aircraft in Flight, involved two F-84F aircraft provided by AFSWC to determine the ability of fighter planes to survive the blast forces produced by the detonation. At detonation, the first aircraft was at a slant range of about 3,000 meters from the burst and at an altitude of 7,795 feet above burst height, oriented in level-flight position tail-on to the blast. The second aircraft was positioned in a level-flight altitude to receive symmetrical and asymmetrical side-on gusts from the blast. At detonation, the second aircraft was at a slant range of about 5,240 meters and at an altitude of 10,330 feet above burst height (35; 44).

For Project 6.1.1a, Evaluation of Military Radiac Equipment, dosimeters in tubes were placed at 13 locations between 900 and 2,700 meters from ground zero. They were retrieved by three persons, including a radiological safety monitor, approximately two hours after recovery operations were permitted by the Test Manager. While in the shot area, project personnel placed additional dosimetry equipment to measure radiation decay rates. It was retrieved on the second day after the BEE detonation (11; 35).

For Project 6.1.1b, Evaluation of a Radiological Defense Warning System (also known as Project CLOUDBURST), two radiological defense warning systems were installed south of ground zero, 18.7 and 28.6 kilometers, respectively, and a third was located 16.1 kilometers southwest of ground zero. Before the detonation, three persons probably spent two days selecting site locations, mounting the detectors, and checking equipment. Post-shot recovery of the detector systems was probably accomplished by three persons in one day (35; 40).

Project 6.3, Missile Detonation Locator, was fielded to evaluate a radar system used to determine the location of a nuclear detonation from a tactical range by detection and analysis of the electromagnetic radiation emitted by the burst. The locator system consisted of broad-band receivers set up in California on baselines approximately 115 and 320 kilometers from the test site. Radio links between the stations provided the time comparisons necessary to determine relative electromagnetic pulse time of arrival at each station (35; 37).

Project 6.4, Test of IBDA Equipment, was conducted to evaluate the Indirect Bomb Damage Assessment (IBDA) system that was designed to determine the location, height of burst, and yield of a nuclear detonation. The IBDA system was installed in a B-50D aircraft and consisted of the standard radar set, AN/APQ-24; a bomb-damage evaluation group, AN/APA-106 (XA-1), a recording set, light and time, AN/ASH-4 (A-1), and a k-17 aerial camera. Two F-94 aircraft were each instrumented with one recording set and one bomb-spotting camera to determine the maximum operating range of the yield-measuring component of the system.

The B-50 staged out of Kirtland AFB and normally had a crew of ten. Since engineering evaluation tests were being conducted, two individuals (one engineer and one technician) went along

monitor and ensure the operation of the IBDA system. It was positioned by radar navigation, simulating a drop aircraft, and at zero time was located about five nautical miles from ground zero. The F-94s, each with two crewmen, staged out of Indian Springs AFB. They were positioned by radio navigational aids at altitudes off 30,000 and 35,000 feet and at distances of about 180 to 210 kilometers west-southwest from ground zero (15; 19; 35).

The objective of Project 6.5, Test of Airborne Naval Radars for IBDA, was to evaluate the suitability of standard Navy radar to determine height of burst, location, and yield of a detonation. Two AJ-2 aircraft were to participate in this event, but one aborted because of mechanical difficulty. The remaining AJ-2, with a crew of three, was at an altitude of 34,000 feet on a 311-degree heading inbound, about 17 kilometers southeast of ground zero at the time of detonation (19; 35; 47).

Project 8.1, Measurement of Direct and Ground-reflected Thermal Radiation at Altitude, was conducted to determine the ability of Navy aircraft to withstand the thermal radiation produced by a nuclear detonation. At the time of the burst, an AD-5 aircraft, with a crew of two, was at a slant range of about 3,400 meters and at a height of 6,755 feet above the burst. An AD-6 aircraft, also with a crew of two, was at a slant range of about 5,100 meters and at a height of 14,255 feet above the burst. A third AD aircraft was used as a standby (35; 36).

Project 8.4b, Thermal Measurements from Fixed Ground Installations, was conducted to measure the thermal radiation from the detonation at ranges where damage to military targets results. The installations were located 1,580 and 2,010 meters from ground zero. It is estimated that preshot selection of the sites and placement of project instrumentation probably took two persons 12 hours. Postshot recovery of data was probably accomplished by two project personnel and a radiological safety monitor in one hour on shot-day (31; 35).

Project 8.4d, Spectrometer Measurements, was conducted to measure the thermal radiation produced by the detonation as a function of time. The recording spectrometer used in this project was located in Building 410, near the Control Point area in Yucca Pass (35; 42).

Project 8.4f, Bolometer Measurements, was designed to determine changes in the amount of thermal radiation produced at various times after a detonation. All data were taken from Building 410, situated near the Control Point area at Yucca Pass, providing line-of-sight to the BEE ground zero (32; 35; 41).

Project 9.1, Technical Photography, was conducted to document project activities and results. The project was conducted primarily by Edgerton, Germeshausen, and Grier (EG and G), a government contractor, but also included personnel from the 1352nd Motion Picture Squadron of the Air Force Lookout Mountain Laboratory (18; 19; 35). Project 9.1 called for an aerial photographic mission. An RC-47 flew a six-minute holding pattern located from 10 to 16 kilometers southeast 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 did the photographic work. Its crew numbered three, and three photographers were also aboard (19).

Project 9.4, Atomic Cloud Growth Study, was designed to study the changes in the nuclear cloud. DOD involvement included the Air Force Cambridge Research Center, who collaborated with the U.S. Weather Bureau to measure the rate of cloud rise and maximum cloud height. Theodolite, used as a measuring device, was located at the north fence of the Control Point in Yucca Pass (24).

3.2 DEPARTMENT OF DEFENSE PARTICIPATION IN LOS ALAMOS SCIENTIFIC LABORATORY TEST GROUP PROJECTS AT SHOT BEE

LASL, a weapons development laboratory of the AEC, developed nine of the 13 nuclear devices tested during the TEAPOT Series, including the BEE nuclear device. LASL also sponsored and performed 16 diagnostic experiments to measure the outputs and effects of the BEE detonation. Of these 16 projects, only four included DOD personnel, as listed in table 3-2.

Table 3-2: TEST GROUP PROJECTS WITH DOD PERSONNEL INVOLVEMENT, SHOT BEE

Project	Title	Sponsor	DOD Agency	Capacity	Estimated DOD Personnel
11.2 21.2	Radiochemistry Sampling Sample Collecting	LASL UCRL	4926th Test Squadron, AFSWC	Cloud Sampling	6
18.3	Time Interval Measurements	LASL	Naval Research Laboratory	Fielding and Recovering	*
18.4	Spectroscopy	LASL	Naval Research Laboratory	Fielding and Recovering	*
18.5	Disturbed Air Element	LASL	Naval Research Laboratory	Fielding and Recovering	*
31.6	Methods for Determining Yields and Locations of Nuclear Explosions	Federal Civil Defense Administration	Army Chemical Center, Ballistics Research Laboratory	Consultants	*
39.7	Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects	Federal Civil Defense Administration	Air Force School of Aviation Medicine; Naval Research Laboratory	Fielding and Recovering	2

* Unknown

Project 11.2, Radiochemistry Sampling, was performed by AFSWC and is discussed in section 3.6.

Project 18.3, Time Interval Measurements, was performed for LASL by the Naval Research Laboratory. Project personnel photographically measured the time interval for the emission of

gamma rays released from the detonation of BEE. The project camera station was located about 18 kilometers from the BEE ground zero. Project personnel arrived at the station before the shot to load film in cameras, and returned after the detonation to recover the film for processing (35).

The remaining two projects, 18.4, Spectroscopy, and 18.5, Disturbed Air Element, were conducted by the Naval Research Laboratory of Washington, D.C., and LASL (35).

3.3 UNIVERSITY OF CALIFORNIA RADIATION LABORATORY TEST GROUP PROJECTS AT SHOT BEE

The University of California Radiation Laboratory Test Group conducted two projects at BEE. Of these two projects, only Project 21.2, Sample Collecting, involved DOD participation, as discussed in section 3.6, the AFSWC portion of this chapter.

3.4 DEPARTMENT OF DEFENSE PARTICIPATION IN CIVIL EFFECTS TEST GROUP PROJECTS AT SHOT BEE

The FCDA Civil Effects Test Group (CETG) sponsored 11 projects at Shot BEE. Two of these projects, as indicated in Table 3-2, involved DOD personnel. 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 in fielding operations at the NTS. Project 31.6, Methods for Determining Yields and Locations of Nuclear Explosions, involved personnel from the Army Chemical Center only on a consulting basis. AFSWC personnel also flew a C-47 for radio-relay required by Project 37.1, Factors Influencing the Biological Fate and Persistence of Radioactive Fallout, and Project 37.2, Phenomenology of Fallout at Near Distance. This mission is discussed in section 3.6.

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, the radiation dose and effect from nuclear devices expected to yield high ratios of neutron to gamma radiation. This objective was accomplished by exposing neutron detector foils, tissue-equivalent chambers, and animals to the nuclear detonation. At midnight on 21 March 1955, four parties of project personnel placed the foils, chambers, and animals at stations ranging between 420 meters and 1,650 meters east and southeast from ground zero (35). Ten minutes after the detonation, the same four parties drove to the test stations and retrieved the instruments and animals. Entering the area this soon after the shot would have required special permission from the Test Manager. The length of their stay in the test area is not known. According to the Project 39.7 Weapons Test Report, DOD participation in the project was limited to one person from the School of Aviation Medicine who was probably an adviser to the project, and one person from the Naval Research Laboratory, who may have been with the fielding and recovery parties (26).

3.5 DOD OPERATIONAL TRAINING PROJECTS AT SHOT BEE

Four DOD operational training projects were conducted at Shot BEE as shown in table 3-3. This table also indicates the type and number of aircraft used in these projects. The primary aims of these operational training projects were to test service tactics and equipment and to train military personnel in the effects of nuclear detonations.

Table 3-3: DOD OPERATIONAL TRAINING PROJECTS, SHOT BEE

Project	Title	Sponsor	Type Mission	Type Aircraft	No. Aircraft	Staging Base	No. DOD Personnel
40.3	Crew Indoctrination	Tactical Air Command	Air	F-84	4	George AFB, California	4
40.6	Calibration of Electromagnetic Effects	Air Force	Ground Air	Helicopter	1	Camp Mercury, Nevada	5
40.8	Calibration of Bomb Debris	Air Force	Air	F 84	1	Indian Springs AFB, Nevada	1
40.13	Tactical Indoctrination for a Marine Aircrew	Marine Corps	Air	F3D	7	El Toro Marine Base, California	7

Project 40.3, Crew Indoctrination, involved four F-84s operating from George AFB, California. Before the detonation, the aircraft maintained their position 110 to 130 kilometers east of ground zero. They then flew at 28,000 to 29,000 feet on a 270-degree vector toward the NTS. Two minutes before the detonation, the aircraft descended from 28,000 feet to 19,000 feet. Within eight kilometers of ground zero, the planes turned to a heading of 360 degrees until the arrival of the blast wave. After blast-wave arrival, the planes returned to their home base (4; 19).

Project 40.6, Calibration of Electromagnetic Effects, was performed by Air Force personnel to study the characteristics of the electromagnetic pulse following the detonation of a nuclear device. At 1300 hours the day before the BEE detonation, three persons in a helicopter were to depart from station 40.6b on Yucca Lake, 10.5 kilometers south of the BEE ground zero, to service eight sets of unmanned recording equipment located around ground zero at distances between 10 and 20 kilometers. Estimated time for their activity was four hours. Two hours before the detonation, two persons in two vehicles were to arrive at station 40.6b on Yucca Lake to operate the equipment until two hours after the detonation. In addition, two more persons were to man station 40.6c, 12 kilometers northwest of ground zero, to operate

equipment until one hour after the shot. This latter activity, however, was cancelled (19; 35).

Project 40.8, Calibration of Bomb Debris, was sponsored by Air Force personnel to determine the relative yields of all pertinent nuclear products and residues useful in characterizing nuclear weapons. Gaseous samples were taken of the nuclear cloud debris by one F-84 aircraft from the AFSWC 4926th Test Squadron pilot, in conjunction with the cloud sampling performed for LASL Project 11.2 and UCRL Project 21.2. This operation is detailed in section 3.6.

Project 40.13, Tactical Indoctrination for a Marine Aircrew, involved seven F-3Ds, operating from El Toro Marine Corps Air Station, Santa Ana, California. The aircraft left El Toro 40 minutes before the BEE detonation, arrived over Lathrop Wells just before detonation, and then circled the area at 12,000 to 24,000 feet following the detonation (4; 16).

3.6 AIR FORCE SPECIAL WEAPONS CENTER ACTIVITIES AT SHOT BEE

AFSWC performed several support missions during Shot BEE, including nuclear cloud-sampling and sample-courier missions in support of LASL Project 11.2, Radiochemistry Sampling; the operational training Project 40.8, Calibration of Bomb Debris; and aerial surveying and cloud-tracking missions. Table 3-4 indicates DOD personnel involvement in the AFSWC missions, along with the type and number of aircraft used.

Table 3-4: AFSWC AIR MISSION SUPPORT, SHOT BEE

Program/Project	Mission	Type Aircraft	Number of Aircraft	Estimated DOD Personnel
11.2/21.2/40.8	Cloud Sampling	F-84	6	6
37.1/37.2	Radio Relay	C-47	1	4
11.2/21.2/40.8	Courier Service	C-47	1	3
		C-119	2	8
		B-25	1	5
_____	Cloud Tracking	B-29	1	11
		B-25	1	5
		B-50	1	12
_____	Aerial Survey of Terrain	C-47*	1	3
		H-19	3	15

*Same C-47 as in the Radio Relay Mission

Cloud Sampling

Cloud Sampling, for LASL Project 11.2, UCRI Project 21.2, and operational training Project 40.8, involved six F-84 samplers. The aircraft departed from Indian Springs AFB after the detonation and flew at altitudes of 25,000 to 38,000 feet. The first penetration of the nuclear cloud occurred two hours after detonation, at about 0705 hours. No difficulties or unusual incidents were recorded except for one faulty wing tip ion chamber on one of the F-84s.

Each F-84 flew at a different altitude. The lowest aircraft, at 25,000 feet, remained in the cloud for one minute and 50 seconds. Two flew at 32,000 feet, remaining in the cloud three minutes and 12 seconds each. A fourth flew at 37,000 feet and remained in the cloud for 14 minutes. The fifth flew at 37,500 feet and remained 14 minutes in the nuclear cloud. The last F-84 flew at two altitudes, 37,000 and 38,000 feet, remaining 50 seconds and 60 seconds on its two passes through the nuclear cloud. The entire sampling mission lasted from the 1205 hours.

Following its penetration of the nuclear cloud, each F-84 returned directly to Indian Springs AFB, where samples were removed and the pilot was lifted from the aircraft by a forklift, and taken to the decontamination facility (19; 20).

Radio-relay

A C-47 operating from Indian Springs acted as a radio-relay for CETG Projects 37.1 and 37.2. It was equipped with a VHF-FM radio relay to provide communications between the headquarters of Projects 37.1 and 37.2 and their ground vehicles (19; 20).

Courier Service

As part of Projects 11.2, 21.2, and 40.8, four AFSWC aircraft delivered samples gathered from the BEE nuclear cloud within six hours after Shot BEE from Indian Springs AFB to Albuquerque, Oakland, and Washington, D.C. Two C-119s carried samples for LASL; one C-47 transported samples for UCRL; and a B-25 took samples to the Naval Research Laboratory in Washington, D.C., for the Air Force. A fifth plane, a twin Bonanza from CARCO, a commercial carrier, delivered samples from Albuquerque to LASL (19; 20).

Cloud Tracking

The mission of cloud-tracking aircraft was to follow the nuclear cloud and plot its course for the Test Manager. This task was accomplished by three AFSWC aircraft, a B-29, a B-25, and a B-50, flying at 29,000 feet, 20,000 to 23,000 feet, and 12,000 to 13,000 feet, respectively. The B-50 and the B-29 originated from Kirtland AFB, while the B-25 operated out of Indian Springs AFB. The B-50 aborted one hour after the detonation and returned to base. The remaining aircraft followed the cloud for three hours and 25 minutes after the detonation, tracking it southeast of the NTS above U.S. Highway 95 to slightly north of Kingman, Arizona (19; 20).

Aerial Surveys of Terrain

After Shot BEE, the AFSWC C-47 aircraft that performed the radio-relay also conducted a low-altitude survey of the NTS at a height of 300 to 500 feet (16). The radiological safety monitor was from the 1st Radiological Safety Support Unit, working with the JTO. Three H-19 helicopters also performed aerial surveys of terrain. Their crews were probably from AFSWC, while the radiological safety monitor was likely from the 1st Radiological Safety Support Unit (19; 20).

CHAPTER 4

RADIATION PROTECTION AT SHOT BEE

To protect participants from the radiation associated with the detonation of a nuclear device, Exercise Desert Rock VI, the Joint Test Organization (JTO), and the Air Force Special Weapons Center (AFSWC) each developed its own criteria and procedures to ensure the radiological safety of its members. These safety criteria and procedures, as well as the organizations developed to implement these procedures, are described in chapter 5 of the TEAPOT Series volume.

The purpose of the various radiation protection procedures developed for Operation TEAPOT was to ensure that individual exposure to ionizing radiation was as low as possible while still allowing participants to accomplish their objectives. Some of the procedures described in the series volume involved the development of records that enabled Exercise Desert Rock, the JTO, and AFSWC to evaluate the effectiveness of their radiation protection programs. Such records included film badge data and isointensity maps.

Additional records indicating the results of these precautions during Shot BEE are available for the JTO and a small percentage of Desert Rock and AFSWC participants. Data indicating the results of the JTO radiation protection procedures are available from two sources: the Radiological Safety Report and the Final Dosage Report. The Radiological Safety Report summarizes the activities that took place at each shot during the TEAPOT Series (10). The Final Dosage Report contains a listing of film badge readings greater than 0.01 roentgens for all DOE personnel and civilians who received film badges issued by the 1st Radiological Safety Support Unit (9). Although this report

contains individual names, units, and cumulative exposures, it does not list exposure dates. However, memoranda have been found addressing shot-specific overexposures.

Although the After-Action Report for the Marine Corps exercise at Shot BEE is available, it contains few details of the radiation protection activities conducted since these were implemented by personnel of the 50th Chemical Service Platoon attached to Camp Desert Rock (2). The Operation Orders for Shot BEE and for the Marine Corps exercise, however, do list planned activities (26), as presented in this chapter.

4.1 DESERT ROCK RADIATION PROTECTION ACTIVITIES AT SHOT BEE

One project distinguishing Shot BEE from the rest of the TEAPOT Series was Desert Rock Project 41.6, the Marine Brigade Exercise conducted by the 3d MCPAEB. The particular radiation protection plans for this test are described below. For all other Desert Rock projects performed at BEE, standard radiation protection procedures were followed.

Seven minutes after the detonation, two helicopters with monitoring teams were to precede the main attack element to monitor contamination levels in the objective area. The main element, airlifted by 30 helicopters, began its attack three minutes after the monitoring teams began their survey. These two monitoring teams pronounced the two landing zones radiologically safe. Monitoring teams were also scheduled to accompany the assault forces. It is not known how many teams accompanied the forces, nor is it known how many individuals made up each monitoring team (2, 26).

Although the After-Action Report does not address this subject, the Operation Plan for the Marine Brigade Exercise specifies that each person was required to wear a film badge and a pocket dosimeter (3). Film badge data were found for about 20

percent of the 2,373 Marines who participated in Shot BEE. The single-badge readings were all less than 0.8 roentgens, and the mean exposure was approximately 0.4 roentgens (13).

4.2 JOINT TEST ORGANIZATION RADIATION PROTECTION ACTIVITIES AT SHOT BEE

All JTO onsite radiation protection activities were performed by military personnel, all members of the 1st Radiological Safety Support Unit. The activities that these DOD personnel performed, and some of the records generated during those activities, are presented below.

4.2.1 Dosimetry Records

During the period 21 March through 22 March 1955, film badge readings indicated that 13 people accumulated total exposures of greater than 2.0 roentgens but less than the JTO-authorized limit of 3.9 roentgens. On these two days, the Dosimetry and Records Section issued 238 film badges and 170 pocket dosimeters (9; 10).

Film badge readings are available for AFSWC members involved in cloud sampling and in Project 2.8b, Manned Penetration of Atomic Clouds, at Shot BEE. Six F-84G aircraft, each with a crew of one, took cloud samples at Shot BEE. The film badge readings for these six pilots ranged from 0.36 to 0.62 roentgens of gamma exposure (16). Two persons involved in Project 2.8b had film badge readings of 2.1 and 2.5 roentgens of gamma radiation exposure (7; 48).

4.2.2 Logistical Data for Radiation Safety Equipment

For Shot BEE, the General Supply Section issued 1,514 pieces of protective clothing and 231 respirators, and the Instrument Repair Section issued 395 radiation-survey instruments (10).

4.2.3 Monitoring Activities

At 0507, two minutes after the detonation, the initial survey team of 12 monitors in six vehicles, together with the north and south road patrols and the checkpoint teams, were dispatched from Gate 4. At 0540 hours, the radiological safety officer permitted the teams to begin their survey, which they completed an hour later, at 0640 hours. A copy of the initial isointensity map is shown in figure 4-1. The survey was routine. By 0600 hours, the area access checkpoints had been established, and the main checkpoint had been established by 0610 hours. The average film badge exposure for the initial survey party was 0.36 roentgens. In addition to the initial survey, resurveys were conducted on 24, 25, and 28 March. Figures 4-2, 4-3, and 4-4 represent the isointensity maps generated from these resurveys. At 0507 hours, the helicopter survey team of five people left the Control Point area and completed its survey at 0626 hours. The Monitoring Section provided monitors to a number of projects including recovery operations in radiation areas after the BEE event. The assignment of these radiological safety monitors is summarized below (10).

<u>Project</u>	<u>Number of Monitors</u>
39.7	4
30.3	2
6.1.1	2
40.9	1
13.0	1
13.3	1
40.1.5	1
12.0	1
2.2	1
8.4	1

The Reynolds Electrical and Engineering Company was provided three monitors for its activities during BEE.

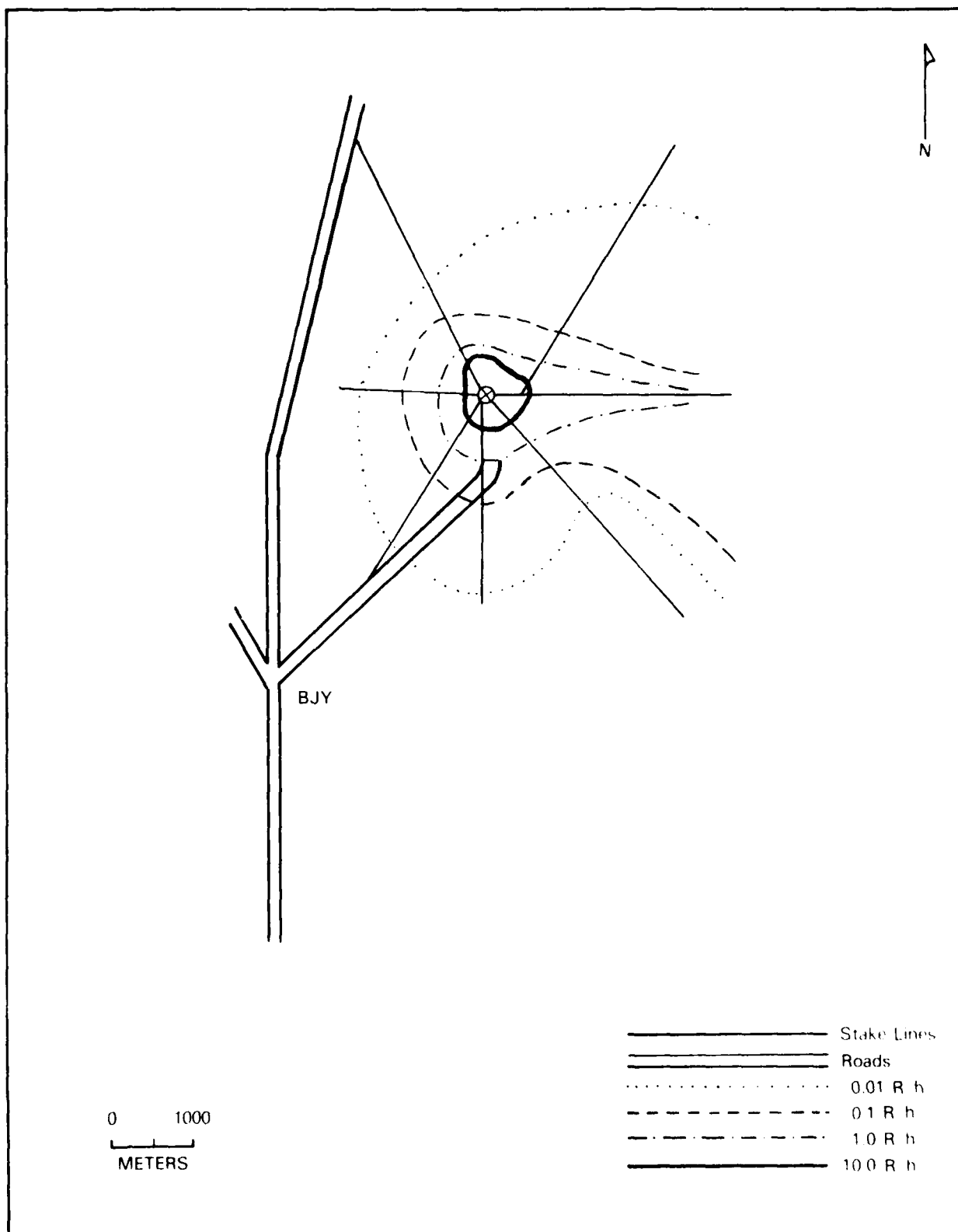


Figure 4-1: INITIAL SURVEY FOR SHOT BEE, 22 MARCH 1955,
0540 TO 0640 HOURS

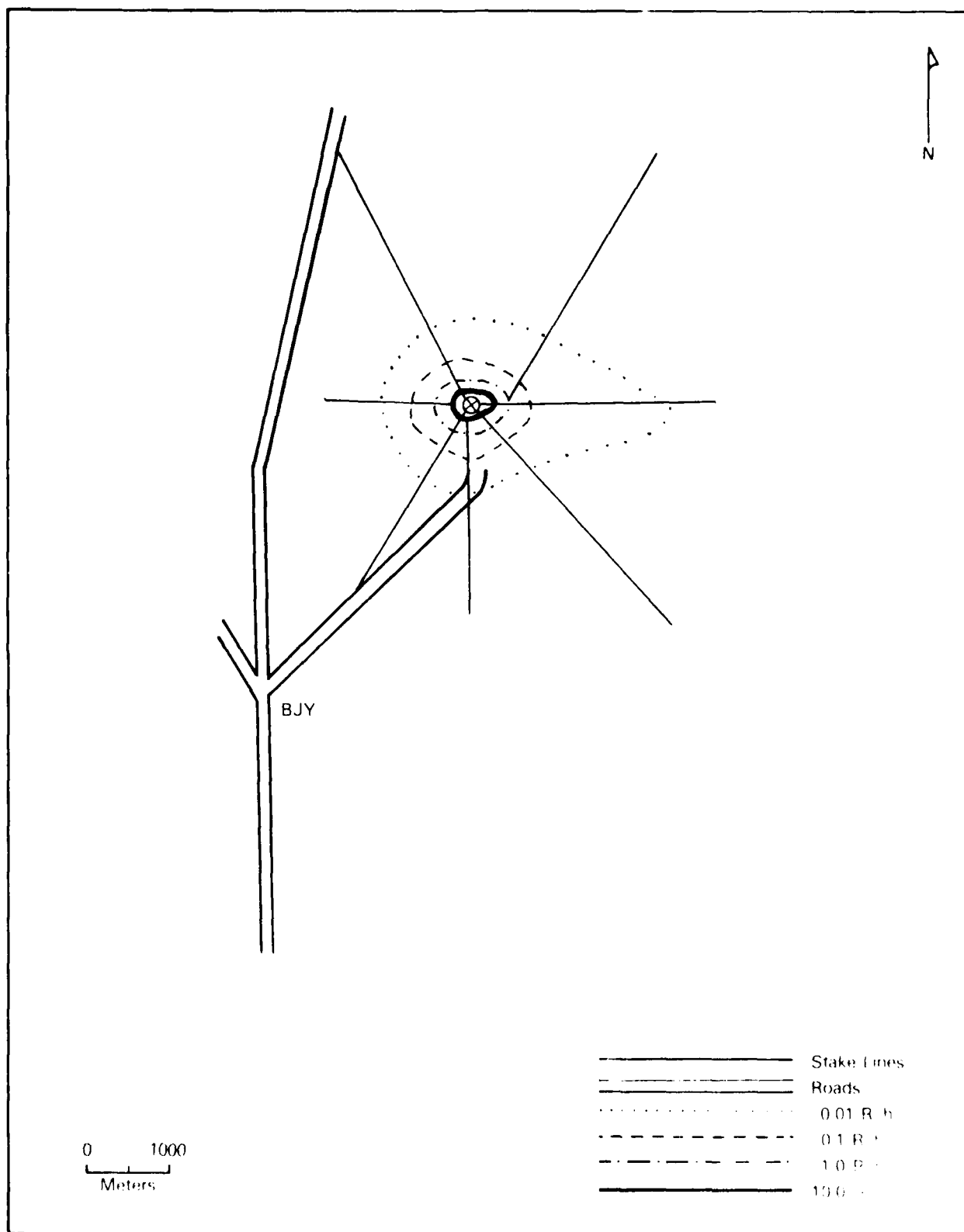


Figure 4-2: RESURVEY FOR SHOT BEE, 24 MARCH 1955, 1026 TO 1115 HOURS

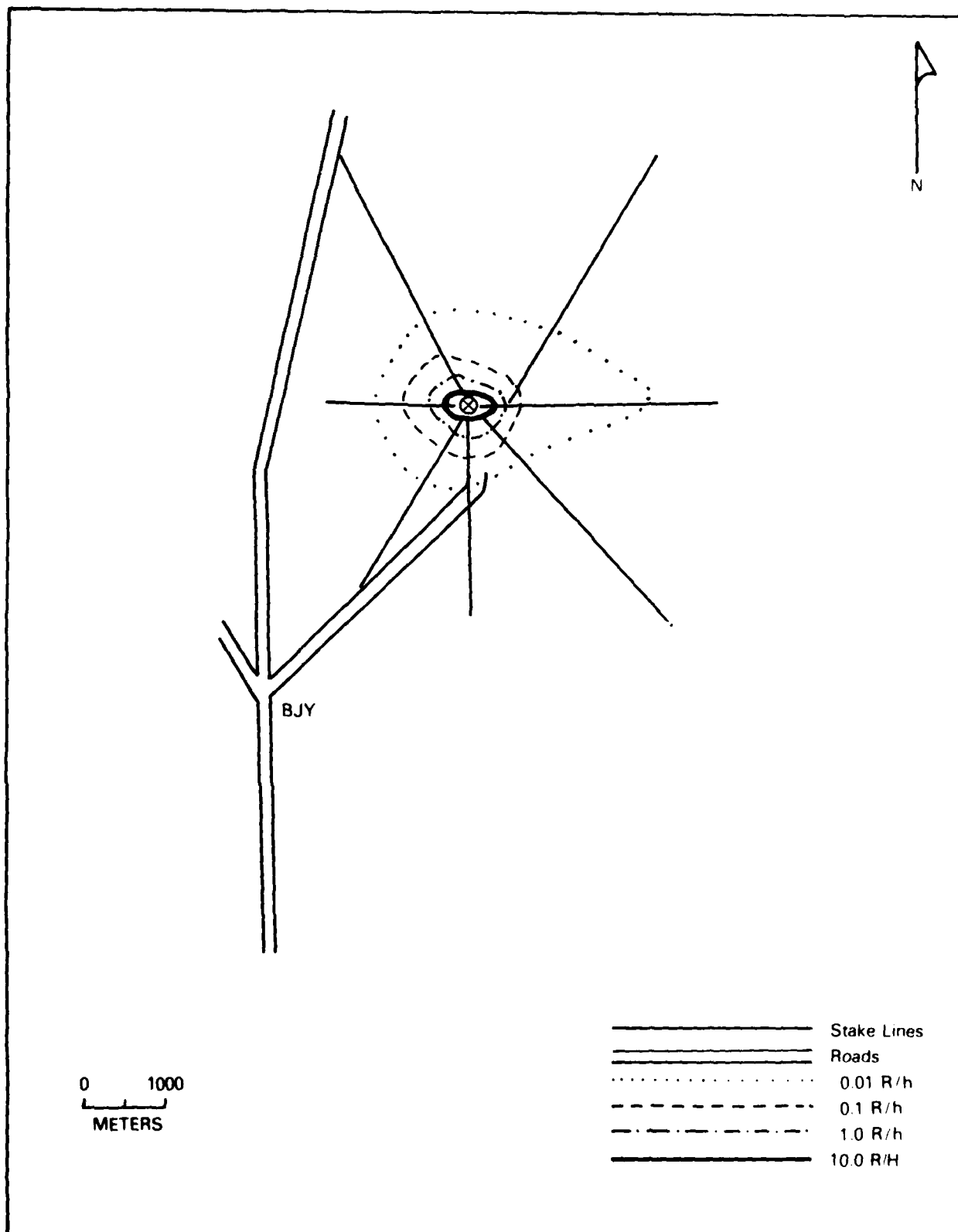


Figure 4-3: RESURVEY FOR SHOT BEE, 25 MARCH 1955, 1026 TO 1115 HOURS

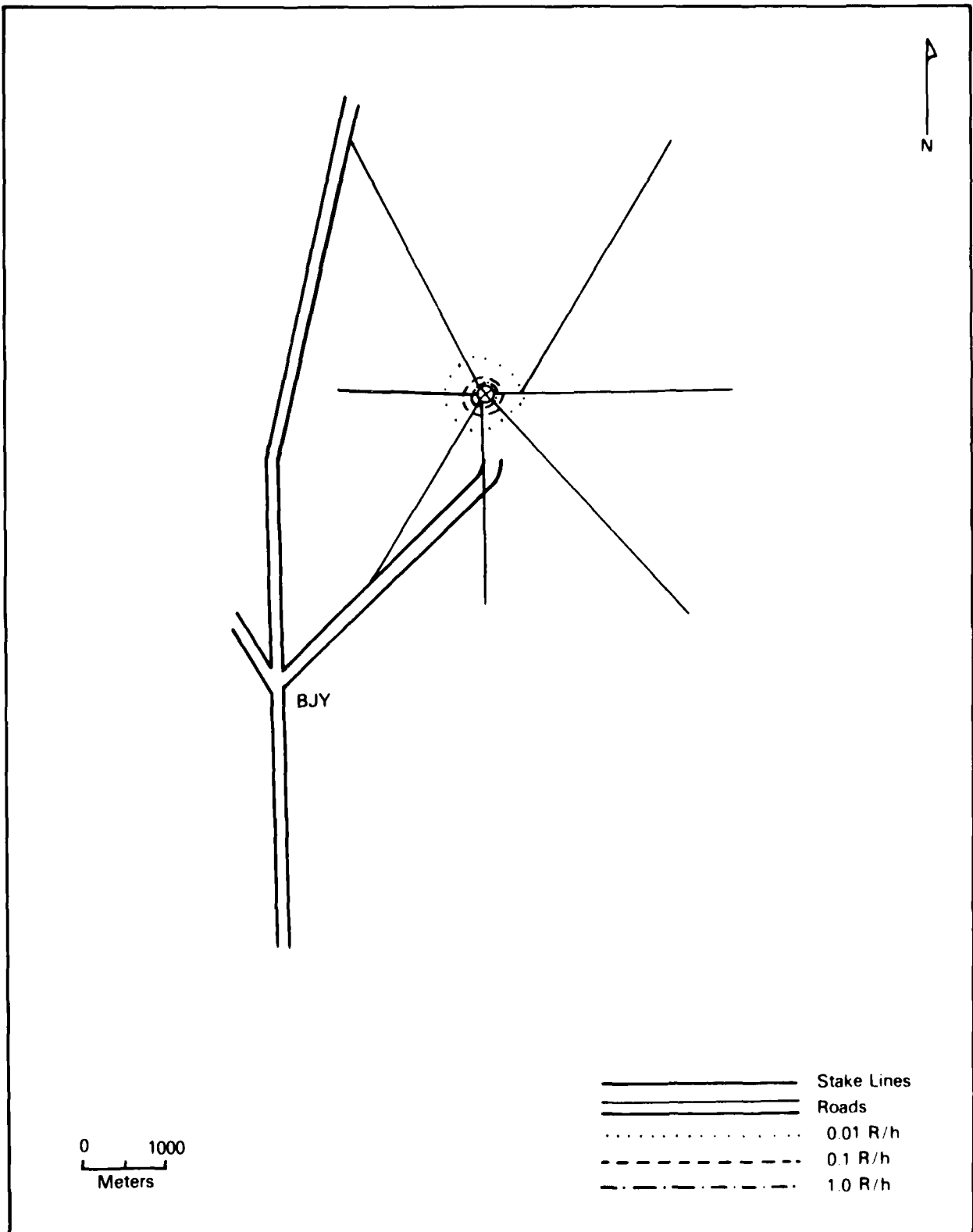


Figure 4-4: RESURVEY FOR SHOT BEE, 28 MARCH 1955, 1115 HOURS TO 1300 HOURS

4.2.4 Recovery and Re-entry Procedures

The Plotting and Briefing Section cleared 24 parties for entry into the shot area on 22 March. Special permission was given for four parties from Civil Effects Test Group (CETG) Project 39.7 to enter the shot area ten minutes after the detonation, and for these parties to enter areas of radiation intensities in excess of ten roentgens per hour.

In the days after Shot BEF, the following numbers of parties entered the shot area (10; 32):

<u>Date</u>	<u>Number of Parties</u>
23 March	13
24 March	23
25 March	4

4.2.5 Decontamination Activities

On shot-day, 22 March, 12 vehicles and five items of equipment were placed in the hot park by members of the Decontamination Section. No personnel required decontamination (10).

SHOT BEE REFERENCE LIST

The following list of references represents only those documents cited in the BEE volume. When a DASA-WT or DNA-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

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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.

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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

Monrhead State College
ATTN: Library

Mt. Prospect Public Library
ATTN: Govt Info Div

Murray State University Library
ATTN: Lib

ALIR (Continued)

Nassau Library System
ATTN: Librn

Nebraska 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 (Rec)

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 (Rec)

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: Arch Control Cultural Id 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

ALIR (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 Docs 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 St Div Docs

North Dakota State University Library
ATTN: Docs Librn

University of North Dakota
ATTN: Librn

North Georgia College
ATTN: Librn

Minnesota Dir of Emergency Svcs
ATTN: Librn

List continued

Northeast Missouri State University
ATTN: Librn

Northeastern Oklahoma State University
ATTN: Librn

Northeastern University
ATTN: Dodge Library

Northern Arizona University Library
ATTN: Gov Docs Dept

Northern Illinois University
ATTN: Librn

Northern Michigan University
ATTN: Docs

Northern Montana College Library
ATTN: Librn

Northwestern Michigan College
ATTN: Librn

Northwestern State University
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Northwestern State University Library
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Northwestern University Library
ATTN: Gov Pubs Dept

Norwalk Public Library
ATTN: Librn

Northeastern Illinois University
ATTN: Library

University of Notre Dame
ATTN: Doc Ctr

Oakland Community College
ATTN: Librn

Oakland Public Library
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Oberlin College Library
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Ocean County College
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Ola State Library
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Ola State University
ATTN: Librn Div

Ola State University Library
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Ola State University Library
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Oklahoma Department of Libraries
ATTN: LIS. Gov Docs

University of Oklahoma
ATTN: Docs Div

Oklahoma University
ATTN: Lib. Dept. Div

Olivet College Library
ATTN: Librn

Omaha Publ. Library-Clark Branch
ATTN: Librn

Ondaga County Public Library
ATTN: Gov Docs Div

Oregon State Library
ATTN: Librn

University of Oregon
ATTN: Docs Div

Quachita Baptist University
ATTN: Librn

Ran American University Library
ATTN: Librn

Rassak Publ. Library
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Racine College
ATTN: Docs Dept

Pennsylvania State Library
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Pennsylvania State University
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University of Pennsylvania
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University of Oregon
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Popular Creek Public Library District
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Association of Portland Library
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Portland Public Library
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Portland State University Library
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Scott Institute Library
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Washington Tech. University
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Washington University Library
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Washington College
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Willamette Community College
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Oliver College Library
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Oregon Library System
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Owens Memorial Library
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Palmerston Public Library
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Park College Library
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Park College
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Park College State College Library
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South Carolina State Library
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University of South Carolina
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University of South Carolina
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South Dakota School of Mines & Technical Library
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South Dakota State Library
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University of South Dakota
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St. Florida University Library
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Southeast Missouri State University
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Southeastern Massachusetts University Library
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University of Southern Alabama
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Southern California University Library
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Southern Connecticut State College
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Southern Illinois University
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Southern Illinois University
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Southern Methodist University
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University of Southern Mississippi
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See continued

Southern Oregon College
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Southern University in New Orleans Library
ATIN: 1 ibn

Southern Utah State College Library
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Southwest Missouri State College
ATIN: 1 ibn

University of Southwestern Louisiana Library
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Southwestern University
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Spokane Public Library
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Springfield City Library
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St. Bonaventure University
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St. Louis River Junior College
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St. Joseph Public Library
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St. Lawrence University
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St. Louis Public Library
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St. Paul Public Library
ATIN: 1 ibn

Stanford University Library
ATIN: 1 ibn

State Technical Lib. Library
ATIN: 1 ibn

State Library of Massachusetts
ATIN: 1 ibn

State University of New York
ATIN: 1 ibn

Stetson University
ATIN: 1 ibn

University of Steubenville
ATIN: 1 ibn

Stockton San Joaquin Public Library
ATIN: 1 ibn

Stockton State College Library
ATIN: 1 ibn

Union College
ATIN: 1 ibn

Index (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: Lib. Doc. 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

Touhigman-type Center Library
ATTN: Librn

Traverse City Public Library
ATTN: Librn

Union Free Public Library
ATTN: Librn

University of Illinois Library
ATTN: Librn

University of Iowa Library
ATTN: Librn

Index (continued)

Tufts University Library
ATTN: Docs Dept

University of Tulsa
ATTN: Librn

UCLA Research Library
ATTN: Pub Affairs Sec/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 Collection

University of Utah
ATTN: Dir of Library

Utica Public Library
ATTN: Librn

Valencia Library
ATTN: Librn

Urbana 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: Gov. Docs Sec

University of Virginia
ATTN: Librn

Virginia 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

Willimantic 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 Schwab Mem Lib, Yountville, CA
ATTN: Librn

DEPARTMENT OF DEFENSE CONTRACTORS

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ATTN: Mr. Lee

AMCOR

ATTN: A. Nelson
214 AFM: Health & Environment Div

Amesbury

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ATTN: E. Martin

Amesbury

ATTN: W. Miller

Amesbury Associates, Inc.

Amesbury, Mass.
ATTN: J. Novak

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105-8