

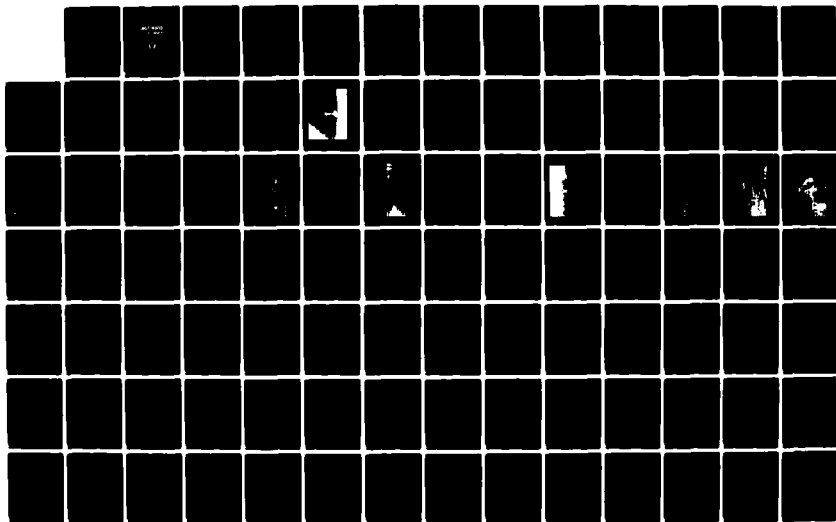
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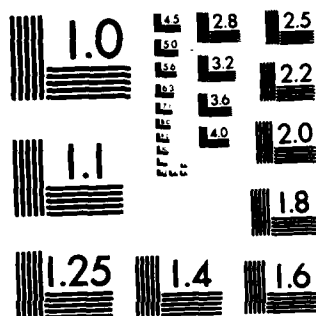
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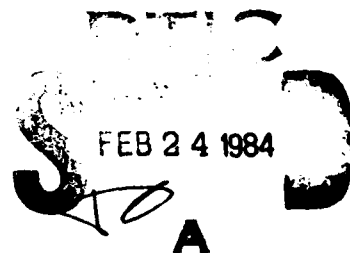
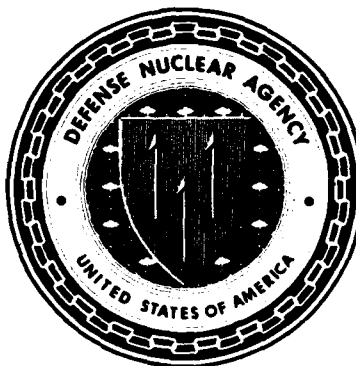
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SHOT HOOD

A Test of the PLUMBBOB Series



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United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

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

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DNA 6002F	2. GOVT ACCESSION NO. AD-A138 287	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) SHOT HOOD A Test of the PLUMBBOB Series		5. TYPE OF REPORT & PERIOD COVERED Technical Report, Supercedes First Edition, 27 Feb 1981
		6. PERFORMING ORG. REPORT NUMBER JRB 2-816-03-423-00
7. AUTHOR(s) Carl Maag, Martha Wilkinson, James Striegel, Burt Collins (Tech. Reps.)		8. CONTRACT OR GRANT NUMBER(s) DNA 001-79-C-0473
9. PERFORMING ORGANIZATION NAME AND ADDRESS JRB Associates, Inc. 8400 Westpark Drive McLean, Virginia 22102		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Subtask U99QAXMK506-08
11. CONTROLLING OFFICE NAME AND ADDRESS Director Defense Nuclear Agency Washington, D.C. 20305		12. REPORT DATE 13 May 1983
		13. NUMBER OF PAGES 108
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A since UNCLASSIFIED
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES For sale by the National Technical Information Service, Springfield, VA 22161 This work sponsored by the Defense Nuclear Agency under RDT&E RMSS Code B350079464 U99QAXMK50608 H2590D.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) HOOD Nevada Test Site PLUMBBOB AFSWP Ionizing Radiation AFSWC Exercise Desert Rock Nuclear Weapons Tests Nevada Test Organization Atmospheric Nuclear Tests		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes the activities of DoD personnel, both military and civilian, in Shot HOOD, the sixth nuclear test in the PLUMBBOB atmospheric weapons testing series. The test was conducted on 5 July 1957 and involved participants from Exercise Desert Rock VII, AFSWP, AFSWC, and AEC test groups. This volume also describes the radiological safety criteria and procedures in effect at Shot HOOD.		

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18. SUPPLEMENTARY NOTES (Continued)

The Defense Nuclear Agency Action Officer, Lt. Col. H. L. Reese, under whom this work was done, wishes to acknowledge the research and editing contribution of numerous reviewers in the Military Services and other organizations in addition to those writers listed in block 7.

20. ABSTRACT (Continued)

At the time of the first edition of SHOT HOOD, the after-action report describing the Marine brigade exercise (Provisional Atomic Exercise Brigade, Report of Exercise Desert Rock VII, Marine Corps) had not been located. For this edition, the after-action report has been used to corroborate, to correct, and to supplement accounts of the troop exercise drawn from planning documents and interviews. This has resulted in substantial revision of section 2.2.

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PREFACE

Between 1945 and 1962, the U.S. 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 United States 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. Of these, approximately 90,000 participated in the atmospheric 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 Centers for Disease Control* noted a possible leukemia cluster among a small group of soldiers at Shot SMOKY, another test of Operation PLUMBBOB, the series of nuclear weapons tests conducted in 1957. Since that initial report by the Centers for Disease Control, the Veterans Administration has received a number of claims for medical benefits from former military personnel who believe their health may have been affected by their participation in the weapons testing program.

In late 1977, the DOD began a study to provide data to both the Centers for Disease Control and the Veterans Administration on potential exposures to ionizing radiation among the military and civilian participants in the atmospheric nuclear weapons tests. The DOD organized an effort to:

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

*The Centers for Disease Control are 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.

METHODS AND SOURCES USED TO PREPARE THIS VOLUME

This report on Shot HOOD is based on the military and technical documents associated with this nuclear weapons test. Many of the documents pertaining specifically to DOD involvement in this event 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 most cases, the surviving historical documentation addresses test specifications and technical information rather than the personnel data critical to the study undertaken by the Department of Defense. Moreover, these documents sometimes reveal inconsistencies in vital facts, 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 usually occur between two or more documents but occasionally appear within the same document. Efforts have been made to resolve these inconsistencies where possible or to bring them to the attention of the reader.

In addition to these inconsistencies in information, documents from the Armed Forces Special Weapons Project (AFSWP) do not always present project titles and agencies consistently. To make this information as uniform as possible, this report uses weapons test report titles for each project. Information concerning the dates and yields of the test detonation may also vary among documents. All such information presented in this report is taken from the Department of Energy, Announced United States Nuclear Tests, July 1945 through 1979 (NVO-209). Other data on

the test, such as meteorological conditions and nuclear cloud dimensions, are taken from DNA 1251-1, Compilation of Local Fallout Data from Test Detonations 1945-1962, Volume 1, except in instances where more specific information is available elsewhere.

For several of the Exercise Desert Rock and test organization projects discussed in this volume, the only documents available are the Sixth Army Desert Rock operation orders and the Test Director's schedule of events from "Operation Order 1-57." These sources detail the plans developed by DOD and AEC personnel during Operation PLUMBBOB, but it is not known if all the projects were conducted as planned. Although some of the after-action documents summarize the projects performed during the PLUMBBOB series, they do not always supply shot-specific information. In the absence of shot-specific after-action reports, projects are described according to the way they were planned. The references indicate whether the description of activities is based on the schedule of events, operation orders, or after-action reports.

ORGANIZATION AND CONTENT OF THE PLUMBBOB SERIES REPORTS

This volume details participation by DOD personnel in Shot HOOD, the sixth detonation of the Operation PLUMBBOB nuclear weapons testing series. Seven other publications address DOD activities during the PLUMBBOB series:

- Series Volume: Operation PLUMBBOB Atmospheric Nuclear Weapons Tests, 1957
- Multi-shot Volume: Shots BOLTZMANN to WILSON, the First Four Tests of the PLUMBBOB Series
- Shot Volume: Shot PRISCILLA, a Test of the PLUMBBOB Series
- Multi-shot Volume: Shots DIABLO to FRANKLIN PRIME, the Mid-series PLUMBBOB Tests

- Shot Volume: Shot SMOKY, a Test of the PLUMBBOB Series
- Shot Volume: Shot GALILEO, a Test of the PLUMBBOB Series
- Multi-shot Volume: Shots WHEELER to MORGAN, the Final PLUMBBOB Tests.

The Operation PLUMBBOB volumes are designed for use with one another. The series volume contains general information on topics such as the historical background of the PLUMBBOB test events, organizational relationships, and radiation safety procedures. In addition, the series volume contains a bibliography of works consulted in the preparation of all eight Operation PLUMBBOB reports. The single-shot volumes, on the other hand, describe DOD participation in Shots HOOD, PRISCILLA, SMOKY, and GALILEO. These shots have been addressed in separate volumes because they involved substantial numbers of Desert Rock participants. The multi-shot volumes combine shot-specific descriptions for several nuclear events, each involving smaller numbers of DOD personnel. The shot and multi-shot volumes contain bibliographies only of the sources referenced in each text. Descriptions of activities concerning any particular shot in Operation PLUMBBOB may be supplemented by the general information on organization and radiological safety contained in the PLUMBBOB series volume.

The first chapter of this volume describes the physical setting of the HOOD detonation and introduces the Desert Rock maneuvers and those Nevada Test Organization (NTO) diagnostic and scientific activities in which DOD personnel participated. Chapter 2 describes the Exercise Desert Rock VII and VIII military projects conducted at Shot HOOD, while chapter 3 describes various training activities, scientific experiments, and support missions conducted by the NTO but with DOD participants. In chapter 4, the radiological environment and safety procedures are described. Details of the overall radiological

protection program at Operation PLUMBBOB are provided in the series volume.

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

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LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used in this volume:

AEC	Atomic Energy Commission
AFB	Air Force Base
AFSWC	Air Force Special Weapons Center
AFSWP	Armed Forces Special Weapons Project
BJY	Buster-Jangle "Y"
CETG	Civil Effects Test Group
DOD	Department of Defense
FCDA	Federal Civil Defense Administration
LASL	Los Alamos Scientific Laboratory
LVTs	Landing Vehicles, Tracked
NTO	Nevada Test Organization
NTS	Nevada Test Site
REECo	Reynolds Electrical and Engineering Company
R/h	Roentgen per hour
UCRL	University of California Radiation Laboratory
USAF	United States Air Force
UTM	Universal Transverse Mercator

HOOD

SHOT SYNOPSIS

AEC TEST SERIES: PLUMBBOB
DOD EXERCISES: Desert Rock VII
DATE/TIME: 0440 hours, 5 July 1957
YIELD: 74 kilotons
HEIGHT OF BURST: 1,500 feet (balloon shot)

AEC Objective: To evaluate the nuclear yield and the blast, thermal, and radiation phenomena produced by this nuclear device.

DOD Objectives: (1) To obtain and evaluate information on the effects of a nuclear weapon.

(2) To train military personnel in nuclear weapons effects and to test military tactics and theory on a simulated nuclear battlefield.

Weather: At shot-time, the temperature was 21°C, relative humidity was 19 percent, and pressure was 876 millibars. The wind was calm at surface level. At 20,000 feet, the wind was from the south at about 10 knots. At 40,000 feet, the wind was from the southwest at 23 knots.

Radiation Data: About one hour after the shot, radiation intensities greater than 0.1 R/h were confined to within 2,000 meters of ground zero. Intensities between 0.01 and 0.1 R/h extended up to 3,100 meters from ground zero. Minor offsite fallout occurred to the north-northeast of the NTS.

Participants: Atomic Energy Commission, Los Alamos Scientific Laboratory, University of California Radiation Laboratory, Exercise Desert Rock troops, Air Force Special Weapons Center, Armed Forces Special Weapons Project, Department of Defense Laboratories, Federal Civil Defense Administration, DOD contractors.

CHAPTER 1

INTRODUCTION

Shot HOOD was a test of a 74-kiloton nuclear device conducted at 0440 hours Pacific Daylight Time on 5 July 1957 at the Nevada Test Site, the U.S. Atomic Energy Commission continental nuclear test area located northwest of Las Vegas. HOOD was the sixth nuclear test of Operation PLUMBBOB, a series of 24 nuclear weapons tests and six safety experiments conducted between 24 April and 7 October 1957.

The HOOD nuclear device was sponsored, designed, and built for the Atomic Energy Commission by the University of California Radiation Laboratory (UCRL). The primary objective of the HOOD test was to evaluate nuclear yield and blast, thermal, and radiation phenomena. To fulfill this objective, UCRL and the Los Alamos Scientific Laboratory fielded scientific and diagnostic experiments to study the characteristics of the detonation. The Armed Forces Special Weapons Project of the Department of Defense also performed experiments to determine the effects of the detonation on military equipment, material, structures, and ordnance.

Other activities at Shot HOOD included Exercise Desert Rock VII. As part of this exercise, the armed services fielded eight projects to evaluate military equipment and tactics. In one project, the Marine Corps conducted a troop maneuver in the test area immediately after the detonation. This maneuver, which involved a Marine brigade and supporting units, included helicopter airlifts of assault troops, tactical air support, and air resupply. This was the largest single military activity in Operation PLUMBBOB.

In addition to the eight Desert Rock projects, the Department of Defense conducted four operational training projects at HOOD. The Federal Civil Defense Administration (FCDA) conducted another ten projects to assess the effects of nuclear detonations on civilian populations and to evaluate Civil Defense emergency preparedness plans. Department of Defense participation in these projects was limited.

1.1 SETTING AND CHARACTERISTICS OF THE HOOD DETONATION

Shot HOOD was originally scheduled for 27 June 1957. When Shot DIABLO, which was planned for 25 June 1957, was delayed by technical difficulties, HOOD was rescheduled for 3 July 1957. Additional difficulties further delayed the HOOD detonation until 5 July.

The nuclear device tested at Shot HOOD was suspended from a balloon 1,500 feet above Area 9 at UTM coordinates 852100,* in the northeastern part of Yucca Flat. Figure 1-1 indicates the location of the HOOD detonation in relation to other shots in Operation PLUMBBOB, and figure 1-2 shows the detonation.

At the time of the detonation, the wind was calm at surface level. Minutes after the detonation, the nuclear cloud reached 35,000 to 48,000 feet,⁺ where the winds were from the southwest at 19 and 31 knots respectively. The residual radiation consisted primarily of neutron-induced activity around ground zero.

*Universal Transverse Mercator (UTM) coordinates are used in this report. The first three digits refer to a point on an east-west axis, and the second three refer to a point on a north-south axis. The point so designated is the southwest corner of an area 100 meters square.

⁺Altitudes are measured from mean sea level, unless otherwise noted.

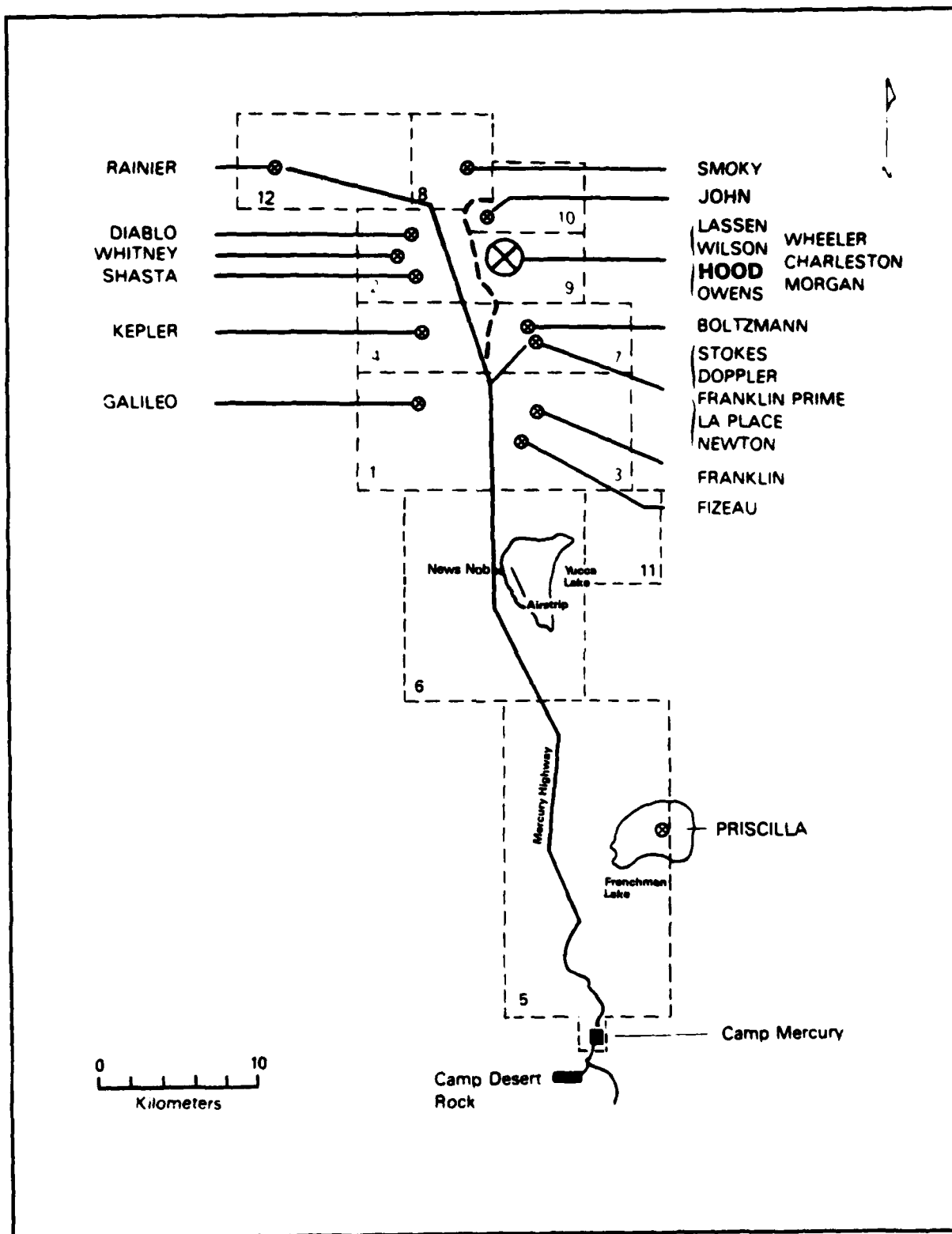


Figure 1-1: LOCATION OF SHOT HOOD IN THE NEVADA TEST SITE, IN RELATION TO OTHER SHOTS IN THE PLUMBBOB SERIES



Figure 1-2: VIEW OF SHOT HOOD DETONATION
FROM NEWS NOB

Offsite fallout from HOOD was minor and occurred in an area north-northeast of the NTS (20).*

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

The Nevada Test Organization was established to plan, coordinate, and conduct atmospheric nuclear weapons tests during Operation PLUMBBOB. All activities of the NTO were under the overall control of an AEC-appointed Test Manager, assisted by the Test Director. The NTO was staffed by personnel from the Atomic Energy Commission, the Department of Defense, and the Federal Civil Defense Administration, and included representatives from the AFSWP Weapons Effects Test Group (WETG), the LASL Test Group, the UCRL Test Group, and the FCDA Civil Effects Test Group (CETG). These test groups conducted more than 40 military effects and diagnostic projects at Shot HOOD. More than half of these projects had DOD participants. Air Force and Marine personnel performed four other projects as part of the DOD operational training program.

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. The largest DOD involvement, totaling at least 200 individuals, was in the military effects projects of the Weapons Effects Test Group. Only about 50 DOD personnel assisted in the projects conducted by the LASL, UCRL, and CETG test groups. Participants in the scientific and diagnostic experiments placed data-collection instruments around the point of detonation in the days and weeks preceding the scheduled event. Participants began

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

recovering the instruments and equipment after the Test Manager declared recovery hour at 0608 hours on shot-day (18).

The operational training projects, which involved about 14 Air Force personnel and 19 Marines, were designed to test service tactics and equipment and to instruct military personnel in the effects of a nuclear detonation. Three of these projects required aircrews to fly their aircraft in the vicinity of the Nevada Test Site to observe or photograph the fireball and the rise of the resulting nuclear cloud. The fourth project evaluated the accuracy of bomb damage assessment equipment on an aircraft. These projects, like those of the test groups, were approved and coordinated by the Test Director.

In addition to those personnel involved in experiments and training, staff and support personnel provided necessary services to other participants at the test site. About 500 DOD personnel were involved in these activities.

One important support function during Shot HOOD was provided by the Air Force Special Weapons Center (AFSWC), based at Kirtland Air Force Base (AFB), New Mexico. AFSWC provided air support to the Test Manager and to three test group projects. During Operation PLUMBBOB, the principal AFSWC units were the 4950th Test Group (Nuclear), the 4926th Test Squadron (Sampling), and the 4935th Air Base Squadron. A total of 493 airmen and 23 officers of the 4950th were stationed at Indian Springs AFB, 28 kilometers* east of Camp Mercury (17). Support was also provided by the 4900th Air Base Group at Kirtland AFB. At Shot HOOD,

*Throughout this report, surface distances are given in metric units. The metric conversion factors include: 1 meter = 3.28 feet; 1 meter = 1.09 yards; and 1 mile = 1.61 kilometers. Altitudes and other vertical distances are given in feet.

AFSWC performed several missions, including aircraft control, security sweeps, cloud-sampling, cloud-tracking and penetration, a radio relay, terrain surveys, and courier services.

To minimize exposure to ionizing radiation, the NTO established radiation protection criteria and procedures. Participants were to receive no more than 3 roentgens of whole-body gamma radiation for any 13-week period and 5 roentgens of whole-body gamma radiation annually. To ensure that these criteria were followed, access to contaminated areas was rigidly controlled, and project personnel recovering test instruments from highly contaminated areas were accompanied by radiological safety monitors. The monitors, who continuously checked the radiation intensity in the recovery area, had the authority to order a halt to recovery operations if intensities were too great or the length of time spent in the area were too long. Project personnel were issued film badges to wear when in the test area. These film badges were collected and processed at regular intervals. Any individual whose accumulated exposure exceeded or came close to the established limits was barred from further participation in project activities in the test area. Although not implemented during PLUMBBOB, emergency evacuation procedures were prepared for all test events (46). Radiation protection procedures of the NTO are detailed in the PLUMBBOB series volume.

With one exception, the radiation protection procedures for the Air Force Special Weapons Center air and ground crews were the same as those established for NTO activities. As the single exception, the Test Manager authorized cloud sampler pilots to receive up to a total of 7.5 roentgens of gamma radiation annually. Complete decontamination, including showers and changes of clothing, was required of all aircrew members following each project mission, regardless of the exposure received on the flight. Aircraft either were decontaminated by

washing or were isolated until radiation intensities had decayed to predetermined levels.

1.3 EXERCISE DESERT ROCK ACTIVITIES AT SHOT HOOD

At Shot HOOD, over 3,000 DOD personnel participated in the eight projects of Exercise Desert Rock VII, the Army testing and training program conducted during Operation PLUMBBOB. These projects included two troop observer and indoctrination projects, one troop test, two radiological training projects, and three technical service projects.

The largest group of participants were the 2,025 Marines who performed Project 52.1. This group consisted of the 4th Marine Corps Provisional Atomic Exercise Brigade and support units not present at the NTS. This project tested a task force assault following a nuclear detonation. Most of the participants in this exercise observed the detonation from trenches nearly five kilometers southwest of ground zero. Elements of one company watched from an area near the Control Point, more than 20 kilometers south of ground zero. After the detonation, participants conducted a coordinated air-ground maneuver against the attack objective. When the maneuver was over, the Marines were transported to the equipment display area to view the effects of the detonation.

Another 970 individuals took part in the other seven Exercise Desert Rock projects. These projects involved exposing military equipment to a detonation to evaluate the damage sustained, testing military equipment and techniques for detecting nuclear bursts and fallout, and training military personnel.

In addition to the Desert Rock exercise troops, about 2,000 support troops from various Army units maintained and operated

Camp Desert Rock, providing transportation, communications, engineering, administrative, and security services. Some of these Desert Rock support troops worked in the forward area of the Nevada Test Site to construct observer facilities, lay communication lines, provide transportation and security, and assist in preparing for the Desert Rock projects. Soldiers from the 50th Chemical Platoon served as radiation safety monitors for Desert Rock project personnel during nuclear test events.

Radiation protection procedures at Exercise Desert Rock are detailed in the PLUMBBOB series volume. The procedures were designed to minimize potential exposure to ionizing radiation while allowing participants to accomplish the project objectives. Camp Desert Rock support personnel and exercise participants were limited to no more than 5 roentgens of whole-body gamma radiation during any six-month period. The radiation protection procedures of Exercise Desert Rock included provisions for (28):

- Maintaining minimum safe distances from nuclear detonations
- Enforcing protective procedures for personnel observing the detonation
- Controlling access to contaminated areas
- Film badging Desert Rock personnel and monitoring their cumulative exposure
- Decontaminating equipment and personnel leaving the test area after the detonation.

This report documents the activities of the Desert Rock troops and other DOD personnel who participated in Shot HOOD. The activities of Desert Rock and NTO support personnel are detailed in the PLUMBBOB series volume.

CHAPTER 2

EXERCISE DESERT ROCK VII OPERATIONS AT SHOT HOOD

Department of Defense personnel participated in eight Exercise Desert Rock VII projects at Shot HOOD. Of the approximately 3,000 participants, 2,025 men were involved in a single project, the Marine Brigade Exercise.

The projects conducted at Exercise Desert Rock VII at Shot HOOD were divided into the four programs listed in table 2-1. The Troop Observer Indoctrination Program was designed to instruct military personnel in the effects of a nuclear detonation. The Troop Test Program was designed to test military tactics and doctrine and to train command staff personnel in planning and conducting combat operations on a simulated nuclear battlefield. The Radiological Training Program provided practice in applying radiological protection procedures under conditions similar to those of a nuclear battlefield. The Technical Service Program tested the effects of nuclear weapons on ordnance material, fortifications, structures, and equipment and tested techniques for detecting nuclear detonations.

2.1 TROOP OBSERVER INDOCTRINATION PROJECTS AT SHOT HOOD

Two troop observer indoctrination projects were conducted at Shot HOOD: Project 50.2, Troop Observers, and Project 53.3, Aircrew Observers. Project 50.2 engaged 308 observers from the Army, one from the Navy, two from the military of the United Kingdom, and one civilian (28). Project 53.3 involved five Air Force observers. The 20 Marine Corps observers at Shot HOOD were affiliated with the Marine Brigade Exercise.

Table 2-1: EXERCISE DESERT ROCK VII PROJECTS, SHOT HOOD

<i>Program Type</i>	<i>Project</i>	<i>Title</i>	<i>Estimated Number of DOD Personnel</i>	<i>Participants</i>
Troop Observer Indoctrination	50.2	Troop Observers	312	Army; Navy; United Kingdom Military Personnel
	53.3	Aircrew Observers	5	Air Force
Troop Test	52.1	Marine Brigade Exercise	2,025	4th Marine Corps Provisional Atomic Exercise Brigade
Radiological Training	53.4	Radiological Defense Training	36	Radiological Defense School, Lowry AFB, Denver, Colorado
		Sixth Army Chemical, Biological, and Radiological Defense Training	24	Sixth Army
Technical Service	50.3	Evaluation of Medium Range Detonation-detection and Cloud Tracking Systems	25	Army Signal Research and Development Laboratories
	50.7	Test of Ordnance Material	10	Ballistic Research Laboratories; Continental Army Command; Detroit Arsenal
	50.8	Detection of Atomic Burst and Radioactive Fallout	557	Army Artillery and Guided Missile School; Chemical Corps; Air Defense Board; Artillery Board; Air Weather Service

The observers arrived at Camp Desert Rock about three days before the scheduled detonation. Two days before the shot, they received an eight-hour preshot orientation. The day before the shot, they were briefed on observation procedures in the morning and escorted on a tour of the NTS in the afternoon (28).

On shot-day, the observers viewed the detonation either from the main trenches with the Marines of Project 52.1 or from an observer area located 10 kilometers southwest of ground zero (28). From one to three hours after the detonation, they inspected the equipment in the Marine equipment display area, shown in figure 2-1.

The Army's Final Report of Operations lists the participation of 299 Camp Desert Rock support troops at Shot HOOD (28). Their specific activities are unknown, although they probably observed the shot from News Nob, near the Control Point. The Control Point was about 23 kilometers south of the HOOD ground zero.

2.2 TROOP TEST PROJECT AT SHOT HOOD

The only troop test conducted at Shot HOOD was Project 52.1, the Marine Brigade Exercise. The largest exercise ever performed at the NTS, this project engaged 2,025 members of the 4th Marine Corps Provisional Atomic Exercise Brigade (55). To determine the participating units, Marine Corps researchers studied shots with similar activities, such as Shot BEE in Operation TEAPOT, in which the 3d Marine Corps Provisional Atomic Exercise Brigade participated. This study yielded a list of units that probably took part in the Marine Brigade Exercise at HOOD. A search through the unit diaries revealed that these units actually were at the shot. In addition, the diaries identified the men who had been temporarily assigned to Camp Desert Rock to take part in HOOD. The unit diaries were cross-checked against muster rolls

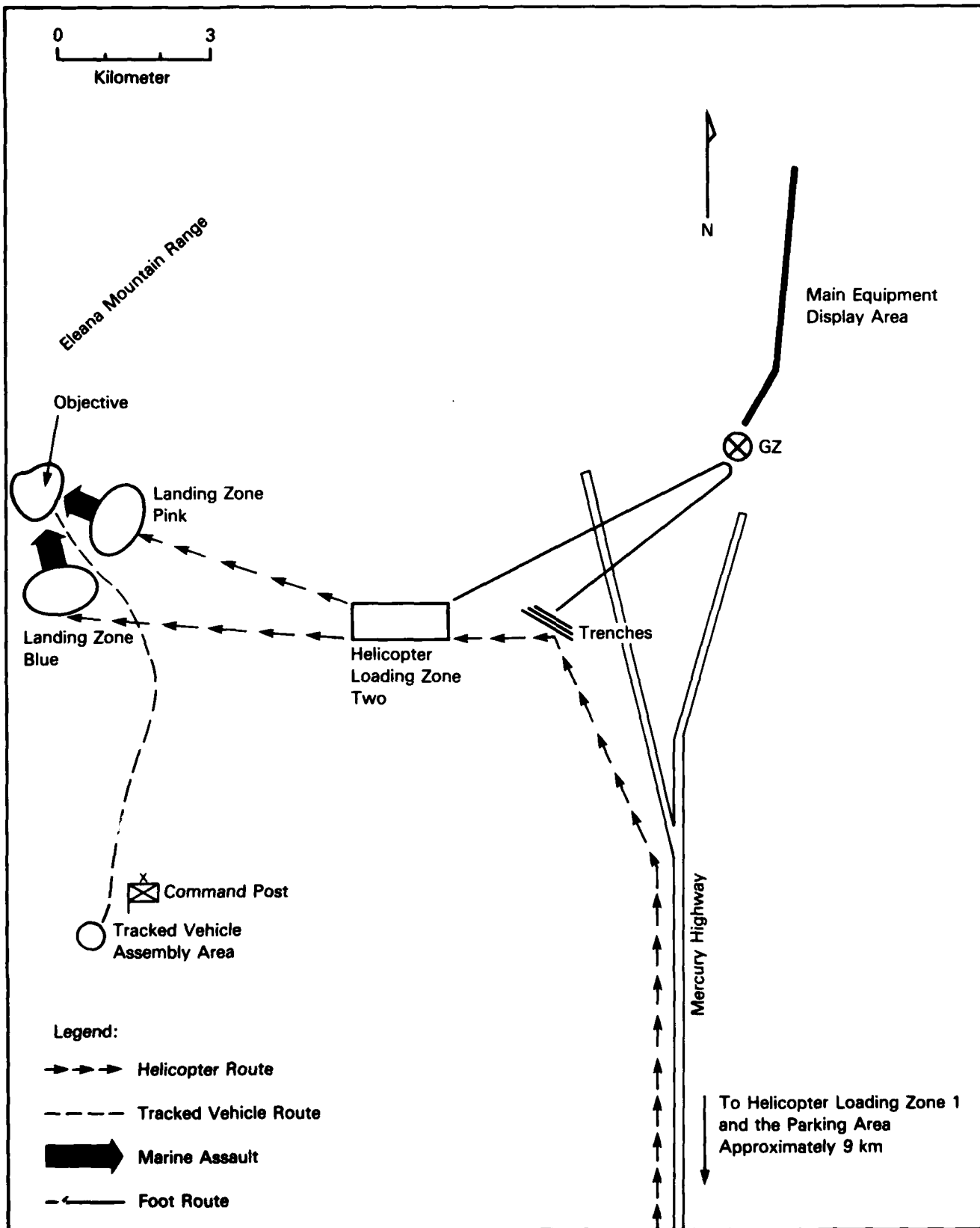


Figure 2-1: TROOP MOVEMENT IN DESERT ROCK PROJECT 52.1

for the units and against the listing of individuals who had been issued film badges for the time period encompassing the 5 July detonation of Shot HOOD (25). Researchers concluded that about 300 members of Camp Desert Rock support units, most of whom were drivers from the Transportation Corps units that drove the Marines to and from the forward area, were onsite in addition to the project participants. Table 2-2 gives the subunits of the 4th Marine Corps Provisional Atomic Exercise Brigade that participated in Project 52.1 at the Nevada Test Site. The principal participating units were from the First Marine Division, Camp Pendleton, California, and the 3d Marine Aircraft Wing from the Marine Corps Air Station, Santa Ana, California.

Project 52.1 had five objectives (28):

- To train command and staff personnel in planning and implementing operations to deal with tactical nuclear weapons
- To formulate new tactics and techniques for dealing with nuclear weapons
- To acquaint personnel with the effects of nuclear weapons
- To test and evaluate military doctrine concerning nuclear warfare
- To familiarize personnel with passive defense measures against the effects of nuclear weapons.

Originally planned to take place during Shot DIABLO on 27 June 1957, Project 52.1 called for some of the troops to take part in a command post exercise and others in a troop maneuver. The command post exercise was to start at noon on the day before the shot and end no later than one hour before the detonation. Participants in the command post exercise would then join the rest of the Marines in observation trenches. Following the detonation, command post exercise personnel were to be transported to an equipment display area to view the effects of the nuclear detonation on Marine equipment and uniforms.

Table 2-2: SUBUNITS OF THE 4TH MARINE CORPS
PROVISIONAL ATOMIC EXERCISE BRIGADE

1st Marine Division

Headquarters Company, Headquarters Battalion
Headquarters and Service Company, 1st Service Regiment
Headquarters and Service Company, 2d Battalion, 5th Marine
Regiment
Company E, 2d Battalion, 5th Marine Regiment
Company F, 2d Battalion, 5th Marine Regiment
Company G, 2d Battalion, 5th Marine Regiment
Company H, 2d Battalion, 5th Marine Regiment
Company C, 1st Pioneer Battalion
Battery E, 2d Battalion, 11th Marine Regiment
Platoon, Company A, 1st Anti-tank Battalion (Ontos)
1st Hospital Company, 1st Medical Battalion
1st Light Support Company, 1st Service Battalion
3d Light Support Company, 1st Service Battalion
Company B, 1st Motor Transport Battalion
Company A, 3d Amphibious Tractor Battalion (Amtrac)
Company C, 3d Amphibious Tractor Battalion
3d Amphibious Truck Company, 3d Amphibious Tractor Battalion

3d Marine Aircraft Wing

Headquarters, 3d Marine Aircraft Wing
Headquarters and Headquarters Squadron, Marine Air Group
Light Transport Helicopter 36
Headquarters and Headquarters Squadron, Marine Air
Group 33
Headquarters and Maintenance Squadron, Marine Air Group
Light Transport Helicopter 36
Marine Light Helicopter Transport Squadron 361, Marine Air
Group Light Transport Helicopter 36
Marine Light Helicopter Transport Squadron 362, Marine Air
Group Light Transport Helicopter 36
Marine Light Helicopter Transport Squadron 363, Marine Air
Group Light Transport Helicopter 36
Marine Attack Squadron 223, Marine Air Group 15
Marine Observation Squadron 6, Marine Air Group Light
Transport Helicopter 36

The troop maneuver was planned as a postshot exercise involving a coordinated air-ground assault by a reinforced Marine battalion against a military objective. For safety reasons, the objective was to be located far from ground zero. Most Marine participants were to witness the shot from trenches five kilometers southwest of ground zero. The trench area is shown in figure 2-2. Elements of one company would observe the detonation from Loading Zone One (near Yucca Lake) with the helicopter squadrons. After the detonation, the helicopters were to transport troops to landing zones near the attack objective. A ground assault on the objective, supported by artillery and tactical aircraft, would follow the airlift. In the meantime, one company would march toward ground zero until it reached the radiological safety limit. That company would then march back to the loading zone near the observation trenches, board helicopters for the airlift, and join the ground attack on the objective. Another company would be transported by LVTs (landing vehicles, tracked) to the objective. After the ground assault was completed, all Marines would be transported to the equipment display area to view the effects of the detonation.

The 4th Marine Corps Provisional Atomic Exercise Brigade arrived at Camp Desert Rock on 19 and 20 June 1957. After orientation, participants rehearsed the maneuvers planned for 27 June. The air portion of the exercise was rehearsed beginning at 0500 hours on 21 June. During this rehearsal, the helicopters (without troops aboard) flew from Loading Zones One and Two to Landing Zones Pink and Blue. A modified rehearsal of the field exercise was conducted on 23 June. Marines traveled by bus from Camp Desert Rock to the DIABLO trenches. The troops were led through the DIABLO equipment display area, and levels of damage were predicted to prepare the troops for the postshot tour of the display. On 24 June, 480 officers and enlisted men from the brigade observed Shot PRISCILLA (55).



Figure 2-2: AERIAL VIEW OF TRENCHES TO BE OCCUPIED BY 4th MARINE CORPS
ATOMIC EXERCISE BRIGADE

When Shot DIABLO was postponed from 27 June to 28 June, a large part of the brigade was already in position for the firing. Not yet aware that the shot would be delayed, the Marines had begun the command post exercise portion of Project 52.1 at 1330 hours on 26 June. They completed it at 0130 on 27 June (55). On 28 June, the command post exercise personnel were transported to the trenches to observe DIABLO with the rest of the 4th Marine Corps Provisional Atomic Exercise Brigade. At 0430, DIABLO failed to detonate because of electrical problems, and the Marines returned to Camp Desert Rock, as shown in figure 2-3.

Shot DIABLO was eventually rescheduled for 12 July 1957. Because this delay would have prolonged the Marines' stay at Camp Desert Rock still further, it was decided to have the 4th Marine Corps Provisional Atomic Exercise Brigade perform the troop test at Shot HOOD, scheduled for 3 July.

Several exercise facilities were modified to accommodate the high yield anticipated for Shot HOOD. Observation trenches dug for Shot SHASTA had to be quickly altered to accommodate 1,900 Marines. These trenches were about six feet deep and were located about five kilometers southwest of the HOOD ground zero (28; 55). In addition, the DIABLO equipment display was moved to the HOOD ground zero area.

The equipment display was designed to demonstrate the effect of a nuclear detonation on Marine equipment and clothing. The main equipment display consisted of ten positions to the northeast of ground zero, as shown in figure 2-1. The equipment, consisting of items as diverse as trucks and rocket launchers and telephones and radios, was placed 270 to 1,980 meters from ground zero to the northeast. Four groups of mannequins were placed in various stances at distances ranging from about 3,470 meters to



Figure 2-3: MARINES RETURN TO CAMP DESERT ROCK AFTER SHOT DIABLO FAILS
TO DETONATE

4,300 meters from ground zero to the northeast and just beyond the observation trenches to the southwest (26; 54).

The troop exercise portion of Project 52.1 began at 2230 on 2 July. Because the command post exercise had already been performed in conjunction with one of Shot DIABLO's postponements, it was not repeated. Instead, half the command post exercise participants were trucked with the maneuver troops to the trenches and half were sent to the Command Post area to observe Shot HOOD. The maneuver troops of the 2d Battalion, 5th Marines, left Camp Desert Rock in a five-unit march column commanded by the Motor Transport Officer of Exercise Desert Rock (9; 13; 44). Along the way, elements of Company G disembarked at Loading Zone One at Yucca Pass. The first march unit left Camp Desert Rock at 2233 hours on 2 July, and the last arrived at the trench area at 0032 on 3 July (55). The convoy vehicles retired to a designated parking area where they remained on-call to return the troops to Camp Desert Rock after the maneuver. Troops were already in the trench area when the 3 July firing of Shot HOOD was postponed until 0440 hours on 5 July. The activities described above were repeated beginning at 2230 hours on 4 July (55).

According to the HOOD operation order, three helicopter squadrons, each consisting of eight helicopters of Marine Air Group 36, were to leave Camp Desert Rock at 2230 hours on 4 July for Loading Zone One, near the Yucca Pass airstrip (24). However, it is unlikely that the helicopters would have flown at night. Instead, they probably left Camp Desert Rock before sunset and arrived at Loading Zone One approximately ten minutes later. Marine helicopter pilots have confirmed this assumption (13; 38).

Two hours before the shot, personnel rehearsed trench procedures. Personnel were ordered to take position in their assigned trenches 23 minutes before the detonation; they were

instructed to don their gas masks and crouch two minutes before the shot (55). The Marines were apparently positioned at shot-time as follows (27):

- 2d Battalion, 5th Marines (with the exception of Company G), and the Headquarters Company in the trenches
- Detachments of the 1st Motor Transport Battalion, the 3d Amtrac Battalion, and the 1st Anti-tank Battalion at the vehicle assembly area
- The 3d Light Support Company and Desert Rock transport unit at the parking area on Mercury Highway
- Marine Helicopter Squadrons 361, 362, and 363 of Marine Air Group Light Transport Helicopter 36, 3d Marine Aircraft Wing, and Company G, 2d Battalion, 5th Marines, at Loading Zone One at Yucca Psss.

The locations of Marine Observation Squadron 6 of Marine Air Group Light Transport Helicopter 36 and the Marine Aircraft Wing Headquarters have not been documented, but these units were probably in the trenches with the 1st Marine Division.

As a loudspeaker announced the countdown, observers at the vehicle assembly area and News Nob covered their eyes and turned away from the detonation, as shown in figure 2-4. At 0440, Shot HOOD was detonated. The heat of the detonation ignited many brush fires, and the shock caused some of the trenches to collapse; however, there were no serious cave-ins or personnel casualties (55). In the mining communities north of the NTS, windows shattered and buildings shook. The light from the detonation was seen in San Francisco, and the blast was felt in Los Angeles.

Fifteen minutes after the detonation, the maneuver troops left their trenches. Company F, 2d Battalion, 5th Marines, marched west to Loading Zone Two, shown in figure 2-1, to wait for the helicopter airlift. Company H waited in the trench area for the truck convoy that would transport it to the vehicle



Figure 2-4: OBSERVERS AT NEWS NOB DURING THE COUNTDOWN FOR SHOT HOOD

assembly area. In the meantime, Company E, led by its commanding officer and executive officer, formed two columns and marched northeast toward ground zero. Company E was preceded and accompanied by radiological safety monitors who measured the levels of radioactivity encountered. In an apparent contradiction, the after-action report states that Company E, in stopping about 370 meters from ground zero, did not exceed the radiation safety criteria (55). Derivative reference material contains similar statements (28), and some participants have made similar estimates, although they cannot explain how the distance would have been accurately determined in the field (34; 56). From AEC radiological survey data (such as that presented in chapter 4, especially figure 4-3) and calculations of the unit's rate of advance, the 5 R/h line is determined to have been about 1,000 meters from ground zero (54). After spending five to ten minutes in the area, Company E marched back to Loading Zone Two near the observation trenches, arriving there at 0700 hours.

While Company E was on its march, a truck convoy left the parking area to the rear of the Command Post; drove to the trenches; picked up Company H; and brought Company H to the vehicle assembly area. From there, parts of the 3d Amtrac Battalion, preceded by Ontos vehicles of the 1st Anti-tank Battalion, traveled to the objective. Figure 2-5 shows one of the Ontos anti-tank vehicles.

Because dust was obscuring visibility in Loading Zone Two, the helicopters delayed their departure from Yucca Pass one hour (55). At 0615, the helicopters landed at Loading Zone Two, as shown in figure 2-6, and began the airlift of Company F and the battalion command elements. Figure 2-7 shows Marines boarding one of the helicopters. Elements of Company G boarded at Loading Zone One. Company E joined the airlift after the company returned from its march toward ground zero (27; 34).



**Figure 2-5: MARINE CORPS ONTOS VEHICLE WITH THE SHOT HOOD CLOUD
IN THE BACKGROUND**



Figure 2-6: MARINE CORPS HELICOPTERS LANDING TO RECOVER MEN AND SUPPLIES
AFTER THE DETONATION OF HOOD



Figure 2-7: MARINES BOARDING HELICOPTERS AFTER SHOT HOOD

The helicopters were of the HRS and HUS types. Each had a crew of three, and each carried five to seven Marines for this mission (13; 30; 38; 44). The helicopters carried Company G to Landing Zone Blue, depicted in figure 2-1. Companies E and F were flown to Landing Zone Pink, also shown in figure 2-1. Helicopters completed the airlift from Loading Zone Two to the two landing zones by 0821 (27). By 0900, the LVT force had linked up with the helicopter force in the area of the objective (55).

During the airlift, air support was provided by 24 F9F aircraft of Marine Attack Squadron 223, Marine Air Group 15, from the Marine Corps air facility at Mojave, California. The first of these aircraft, each flown by one pilot, arrived at the NTS at 0510. The fighters, flying in groups of four, shuttled between Mojave and the NTS for approximately seven hours. After returning to Mojave, they were decontaminated by Marine Air Group 15 ground personnel (3).

Upon arriving at Landing Zone Pink, Company F joined Company H in the attack against the objective, while Company E remained at Landing Zone Pink to back up the attacking companies. Upon landing at Landing Zone Blue, the remaining unit, Company G, also attacked the objective (6).

According to one participant, Company G had about 30 "casualties" due to heat exhaustion. These men were taken to a special assembly area by helicopter and allowed to rest for one hour. They then marched to the helicopter landing zone to wait for the end of the assault (30).

While the tactical exercise was taking place, about 300 Marines from the service and support elements of the 4th Brigade toured the equipment display area. Upon completion of the helicopter lift and before returning to Camp Desert Rock, 90 pilots

and crew members of Marine Air Group 36 were taken through the display area. The Equipment Officer, who belonged to the G-3 Section of Headquarters Battalion, 1st Marine Division, conducted the tours of the display area. Marine Corps monitoring teams checked all vehicles and personnel for contamination before they left the display area (35; 55).

When the objective was seized at 1030, the tactical exercise was concluded. After having lunch in the objective area, the elements of the 3d Amtrac Battalion and 1st Anti-tank Battalion withdrew to the vehicle assembly area and were transported by Company B, 1st Motor Transport Battalion, to the Marine equipment display area. The 2d Battalion, 5th Marines, was transported east from the assault areas to the nearest road. From there, they were trucked to the equipment display area, where they arrived at about 1400 hours. After viewing the display area, they returned to Camp Desert Rock, arriving there at about 1700 (27; 55).

Marine personnel who participated in Project 52.1 passed through the decontamination station at Yucca Pass, as did the other participants in Shot HOOD. The radiological safety measures used to protect the Marine participants in Project 52.1 are discussed in chapter 4.

Most personnel left Camp Desert Rock on 5 and 6 July, with the last remnants departing by 12 July (55).

2.3 RADIOLOGICAL TRAINING PROJECTS AT SHOT HOOD

The two radiological training projects conducted at Shot HOOD were Air Force Project 53.4, Radiological Defense Training, and the Sixth Army Chemical, Biological, and Radiological Defense Training, which was an unnumbered project.

Thirty-six members of the Air Force Radiological Defense School, located at Lowry AFB in Denver, Colorado, participated in Project 53.4. Participants viewed the detonation from the 50th Chemical Platoon Decontamination Station at Yucca Pass (28). After the shot, a representative from the 50th Chemical Platoon escorted the participants to a specially selected area outside the 5 R/h line. The participants reported radiation intensities at designated markers. These readings were reported to control stations by radio and plotted on a map. The representative from the 50th Chemical Platoon remained with the project participants to enforce radiological protection procedures and to give technical assistance when needed.

The Sixth Army also conducted a monitoring exercise at Shot HOOD. Although no detailed final report has been located, dosimetry records indicate that two chemical, biological, and radiological defense teams, consisting of 12 men each, participated. The teams originated from Camp Hanford, Washington, and Fort Mason, California (4; 39).

2.4 TECHNICAL SERVICE PROJECTS AT SHOT HOOD

The Army conducted three technical service projects at Shot HOOD, as listed in table 2-1. The DOD personnel who took part in these projects also performed them at other PLUMBBOB shots both before and after Shot HOOD.

Project 50.3, Evaluation of Medium Range Detonation-detection and Cloud Tracking Systems, was fielded by the Army Signal Research and Development Laboratories of Fort Monmouth, New Jersey. The project was designed, first, to test the ability of Army radar equipment to detect nuclear detonations and track radioactive clouds and, second, to examine Army fallout prediction methods. The project required the use of three radar

sets located at unknown distances from ground zero. A total of 25 Army personnel were directly involved in this project (28). In addition, an unspecified number of military personnel were attached to the Fallout Prediction Unit, part of the Test Manager's organization headquartered at Camp Mercury. This unit, operating from an M-109 mobile van next to the weather station at Camp Mercury, gathered data and estimated the direction of fallout.

Project 50.7, Test of Ordnance Materiel, sponsored by the Ballistic Research Laboratories, had four subprojects, three of which were conducted at Shot HOOD:

- Vehicle Damage Test
- Radiation Test
- Foxhole Test.

The Vehicle Damage Test was performed by the Detroit Arsenal and was designed to measure the effects of a nuclear detonation on vehicles situated near ground zero. Five days before the shot, Desert Rock personnel positioned three tanks, four hemispheres of conventional and experimental types of tank armor, and three light-armored vehicles 900 meters southeast of ground zero. They placed another light-armored vehicle 720 meters southeast of the area. These vehicle displays were studied after the detonation, when radiation levels permitted (28).

In the Radiation Test, fielded by the Ballistic Research Laboratories, the four hemispheres were exposed to ionizing radiation from the shot. Four participants from Field Command Weapons Effects Test Group Project 2.4 installed gauges for measuring gamma and neutron radiation on three M-48 tanks, which would be exposed to the blast. Following the shot, six participants aided Desert Rock personnel in compiling dosimetry readings from this subproject (28).

The Foxhole Test, fielded by the Continental Army Command, was designed to evaluate the protection afforded by positioning tanks over three revetted and three unrevetted foxholes. These foxholes were located 900 meters southeast of ground zero (28).

Project 50.8, Detection of Atomic Burst and Radioactive Fallout, was conducted by the Army Artillery and Guided Missile School, with support from the Chemical Corps, the Air Defense Board, the Artillery Board, and the Air Weather Service. The chief purpose of the project was to assess how well equipment found in a typical Army unit could determine the location, height of burst, and yield of a nuclear detonation. At Shot HOOD, the project involved 557 Army participants: 59 officers and 498 enlisted men. Participants in Project 50.8 included (28):

- One field artillery observation battery
- Three field artillery meteorological sections
- One tactical support center detachment
- One fire support coordination center detachment
- One Army aviation detachment
- One Air Weather Service detachment
- Six Army Chemical Corps monitoring parties (three aerial, three ground)
- One Army Chemical Corps radiological monitoring control party
- One Army Air Defense Board test and evaluation unit
- One Army Artillery Board test and evaluation group
- One Test Director detachment.

The participants worked at distances between 10 and 80 kilometers from ground zero.

Part of Project 50.8 required two H-34 helicopters and one H-13 helicopter to fly aerial monitoring surveys and a B-26 aircraft to track the HOOD cloud. The purpose of these surveys was to test how well Army personnel could predict and monitor radioactive fallout. The helicopters flew at altitudes of 6,000 feet. The crews probably consisted of three men each, although the H-34 could carry 12. Before the shot, the B-26, with a crew of four, was flying a holding pattern at 18,000 feet (3). Details of the B-26 activities in tracking the nuclear cloud are not documented.

Available documents differ as to whether other Army technical service projects were conducted at Shot HOOD. The Exercise Desert Rock Final Report of Operations indicates that 11 men participated in Projects 50.4, 50.5, and 50.6 (28). However, other sections of this source, as well as the AFSWP Operation Summary (18), indicate that these projects were not performed at HOOD.

CHAPTER 3

NEVADA TEST ORGANIZATION OPERATIONS AT SHOT HOOD

At Shot HOOD, DOD personnel participated in scientific, diagnostic, and training projects coordinated by the Nevada Test Organization. They were involved in all 19 projects conducted by the AFSWP Field Command Weapons Effects Test Group, one project of the Los Alamos Scientific Laboratory Test Group, and one project fielded by the University of California Radiation Laboratory Test Group. DOD personnel also participated in six projects conducted by the Federal Civil Defense Administration Civil Effects Test Group. In addition, Air Force and Marine personnel conducted four operational training projects. Finally, Army and Air Force personnel supported the test groups and the Test Manager. More than 200 DOD personnel participated directly in the projects, more than 500 provided air and ground support, and approximately 100 personnel provided administrative support.

Detailed descriptions of project objectives and general project activities are contained in the PLUMBBOB series volume. The information contained in this chapter addresses only those project operations conducted at Shot HOOD. The two primary sources of this information are the Schedule of Events, a preshot document, and the postshot weapons test reports for each project.

3.1 FIELD COMMAND WEAPONS EFFECTS TEST GROUP PROJECTS AT SHOT HOOD

The Weapons Effects Test Group of AFSWP Field Command conducted the projects listed in table 3-1. This table also indicates the agencies that fielded the projects and, when possible, the estimated numbers of participants.

**Table 3-1: FIELD COMMAND WEAPONS EFFECTS TEST GROUP
PROJECTS, SHOT HOOD**

Project	Title	Participating Agency	Estimated Number* of Personnel
1.1	Basic Airblast Phenomena	Ballistic Research Laboratories	5
2.2	Neutron-induced Activities in Soil Elements	Naval Radiological Defense Laboratory	4
2.3	Neutron Flux from Selected Nuclear Devices	Army Chemical Warfare Laboratories	3
2.4	Neutron and Initial-gamma Shielding	Ballistic Research Laboratories; Army Chemical Warfare Laboratories	6
2.5	Initial Gamma Radiation Intensity and Neutron-induced Gamma Radiation of NTS Soils	Army Signal Research and Development Laboratories	4
2.6	Evaluation of New Types of Radiac Instruments	Army Signal Research and Development Laboratories	40
2.7	Radio-wave Attenuation Studies	Naval Research Laboratory	14
2.8	Evaluation of Military Radiac	Naval Material Laboratory	6
2.10	Initial Neutron and Gamma Air-earth Interface Measurements	General Mills Company	9
4.2	Evaluation of Eye Protection Afforded by an Electromechanical Shutter	Wright Air Development Center	17
5.3	In-flight Structural Response of the FJ-4 Aircraft to a Nuclear Detonation	Naval Air Special Weapons Facility; North American Aviation, Inc.	†
5.4	In-flight Structural Response of the A4D-1 Aircraft to a Nuclear Detonation	Navy Bureau of Aeronautics; Douglas Aircraft Company	†
5.5	In-flight Structural Response of the F-89D Aircraft to a Nuclear Detonation	Wright Air Development Center; Northrop Aircraft	†
6.2	Measurement of the Magnetic Component of the Electromagnetic Field Near a Nuclear Detonation	Diamond Ordnance Fuze Laboratories	21
6.2a	Effect of Nuclear Radiation on Semi-conductor Devices	Diamond Ordnance Fuze Laboratories	**
6.4	Accuracy and Reliability of the Short-baseline NAROL System	Air Force Cambridge Research Center	†
6.5	Effects of Nuclear Detonations on Nike Hercules	Army Missile Test Center; Bell Telephone Laboratories	23
8.2	Prediction of Thermal Protection of Uniforms and Thermal Effects on Standard-reference Material	Naval Material Laboratory	7
9.1	Technical Photography	Lookout Mountain Laboratory; Edgerton, Germeshausen and Grier	†

* Minimum estimates based on Schedule of Events.

† Unknown.

** Project 6.2a personnel are included in Project 6.2 estimate.

Project 1.1, Basic Airblast Phenomena, was conducted to obtain data on overpressure and dynamic pressure as a function of time and distance from ground zero. Project personnel also evaluated the performance of various pressure gauges and measurement devices.

Before shot-day, project participants installed 24 gauges for measuring dynamic and static pressure at 14 stations. These stations were located at points approximately 300 to 910 meters from ground zero along a blast line extending to the southeast. Project participants also placed pressure gauges at the Yucca Lake radio station, located over 19 kilometers south of ground zero, and at the helicopter pad near Yucca Pass, nearly 24 kilometers south of ground zero. The data were recorded at each station. Project participants recovered the records from the two distant stations one hour after the burst (53). The gauges located along the blast-line in the shot area were recovered when radiation intensities allowed (8). The team spent 30 to 45 minutes in recovery activities (53).

The objective of Project 2.2, Neutron-induced Activities in Soil Elements, was to gather information concerning the radioactivity produced by the interactions of neutrons from a nuclear device with soil and to correlate this information with measurements of the resulting gamma radiation fields. At Shot HOOD, project participants studied neutron-induced activity in an M-48 tank rather than in soils.

About two days before the detonation, Army personnel placed the M-48 tank, which was used in Desert Rock Project 50.7, 910 meters southeast of ground zero. Personnel from Projects 2.2 and 2.4 moved the tank to a position 2,440 meters from ground zero about eight hours after the detonation in order to measure the induced radiation of the tank. Nine hours and 30 minutes after the detonation, four project participants measured the gamma

radiation levels of the tank. The readings were 1.5 R/h at the rear and 0.4 R/h immediately in front of the tank. The radiation intensity 45 meters from the tank was 0.003 R/h; at 60 meters from the tank, the intensity was 0.0025 R/h. Twelve hours after the detonation, the radiation levels were measured again. Three readings of 0.6 R/h were measured inside the tank, while external readings ranged from 0.35 R/h on the front of the tank to 0.7 R/h on the rear. Project 2.2 participants also measured the gamma spectrum with a mobile scintillation spectrometer (11; 49).

Project 2.3, Neutron Flux from Selected Nuclear Devices, was designed to measure the neutron output from nuclear devices. However, at Shot HOOD, Project 2.3 personnel only provided instruments to other Program 2 studies. They supplied neutron and gamma detectors for Project 2.4 and furnished the detectors that were suspended from balloons in Project 2.10 (37).

Project 2.4, Neutron and Initial-gamma Shielding, was a study of the shielding effectiveness of several types of metals, military vehicles, and foxholes in reducing radiation levels. Although the Army Chemical Warfare Laboratories planned the project, placed the instruments, and reported the results, other Program 2 participants and DOD agencies assisted. The Ballistic Research Laboratories provided the ordnance equipment, the Evans Signal Laboratory was responsible for the gamma film packet measurements, Project 2.3 personnel measured neutron flux, Project 2.5 participants kept the records of initial gamma intensity versus time, and the Air Force School of Aviation Medicine provided the chemical dosimetry instruments.

A few days before the HOOD shot, Desert Rock Project 50.7 personnel and Program 2 participants placed M-48 tanks, Ontos vehicles, and metal hemispheres and dug foxholes at intervals of

15 to 30 meters on an arc about 910 meters southeast of ground zero. Several gamma and neutron detectors and dosimeters were contained in each item. According to the Schedule of Events, a recovery party was to leave 15 minutes after the shot to retrieve the detectors and dosimeters. About eight hours after the shot, Project 2.2 and 2.4 personnel moved one M-48 tank to a location 2,440 meters from ground zero so that Project 2.2 personnel could take readings using a gamma dose ratemeter, as described for Project 2.2 (43).

Project 2.5, Initial Gamma Radiation Intensity and Neutron-induced Gamma Radiation of NTS Soils, was designed to determine the intensities of gamma radiation in the soil shortly after detonation. The original project plans called for the Signal Research and Development Laboratory to measure the initial gamma intensity. However, before Operation PLUMBBOB started, the project was expanded to include support of other Program 2 studies. Personnel from AFSWC and the Rand Corporation also assisted.

Before the detonation, project participants assembled and tested the instrumentation in the quonset hut area at Camp Mercury. The detectors were calibrated both before and after the shot. In the days preceding Shot HOOD, personnel from Projects 2.5 and 2.10 transported the instrumentation racks to ground stations in the shot area. Because the instrumentation racks weighed several hundred pounds and were about ten feet tall, participants used a truck with a monorail to emplace them. The seven ground stations, located at 460-meter intervals between 460 and 3,200 meters south-southeast of ground zero, had been constructed at the beginning of Operation PLUMBBOB and were used at several of the PLUMBBOB events. The Project 2.5 work party was scheduled to have finished installing the instrumentation racks by 2200 hours on the day before the shot.

The recovery team reentered the shot area when radiological conditions permitted. Recovery was completed within three to four days after the shot. Participants transported the instruments back to the quonset hut area, where the data were processed (18).

Project 2.5 participants also helped Project 2.10 personnel to suspend electronic detectors from balloon cables and tether and launch the balloons on the day before the shot. In addition, they assisted in modifying and installing an instrument system in an M-48 tank for the Project 2.4 study of neutron and gamma shielding.

Project 2.6, Evaluation of New Types of Radiac Instruments, had two parts. The first part tested the ability of a new gamma-neutron ion chamber dosimeter to detect and measure initial radiation. Project personnel placed the dosimeters in cylindrical tubes and mounted them between steel stakes at six locations ranging from 1,500 to 2,000 meters south of ground zero. About four hours after the detonation, project personnel recovered the dosimeters and took them to Camp Mercury, where they were read and interpreted.

The second part of this project was designed to evaluate the new beta-gamma ion chamber ratemeter for Army field use. According to the Schedule of Events, one individual was to leave for the shot area about 30 minutes after the burst to take beta and gamma readings at the 3 R/h line. The Weapons Test Report states that 26 experienced Desert Rock radiological safety personnel were given the new IM-123 beta-gamma radiac meters and the standard AN/PDR-39 radiac meters. The Desert Rock participants entered the shot area about 11 hours after the burst to survey a 90-meter wide area located between 365 and 1,100 meters from ground zero. They resurveyed the area 29 and 32 hours after the detonation. Fifty-five hours after the burst, project

personnel and six inexperienced Desert Rock personnel made radiological surveys in the same area. Intensities of 0.2 R/h to 5 R/h of gamma radiation were measured during these surveys.

In addition to these manual surveys of the shot area, participants placed a recording station about 870 meters south of ground zero. The station was installed two hours after the shot and recovered 27 hours later. Project personnel made periodic surveys at the station using the IM-123, AN/PDR-39, and the 1002 beta meter two, four, and 11 hours after the shot. During these 20- to 30-minute surveys, personnel wore protective clothing and used respirators (10).

Project 2.7, Radio-wave Attenuation Studies, studied the interference of high levels of radiation with radio transmissions and radar operations. Two transmitters and equipment for measuring gamma rays and monitoring the effect on the transmitters of the electromagnetic signal from the detonation were installed in two shielded bunkers located 1,160 and 1,460 meters north of ground zero. Receivers were located in Building 400 near the Control Point, 22 kilometers south of ground zero. From 2200 hours to 0100 hours the night before the shot, two parties were in the shot area to activate the stations. Personnel began recovering data and records about eight hours after the detonation and spent several days in this activity. Personnel also installed scintillation detectors near the bunkers and obtained readings from these detectors after the shot (22; 49).

Project 2.8, Evaluation of Military Radiac, was intended to determine the accuracy of several types of Navy radiac equipment in measuring radiological hazards in the field under the conditions of nuclear warfare. The experimental equipment consisted of three masonite phantoms and a dosimeter rack. Two phantoms were loaded with selectively shielded standard depth-dose detectors and dosimeters, and the third held two recording ratemeters.

About two hours after the detonation, participants, misled by an erroneous AN/PDR-43 reading, placed the two dosimeter phantoms, the ratemeter phantom, and the dosimeter rack in a 2 to 3 R/h field instead of a 5 R/h field as planned. Because the radiation intensity in this field was too low to obtain good data, the dosimeter phantoms and rack were moved to a 7 R/h field about 30 minutes later. The ratemeter phantom could not be transported to a more intense field, because the power trailer serving the ratemeter recorder was shared with another project and could not be moved. The ratemeter phantom was recovered 32 hours after the detonation, and the dosimeter phantoms and rack were recovered 56 hours after the detonation.

According to the Schedule of Events, six project participants used three vehicles to place the dosimeter arrays. These personnel were accompanied by a radiation monitor (15; 49).

Project 2.10, Initial Neutron and Gamma Air-earth Interface Measurements, was conducted by AFSWC, with assistance from the General Mills Company. The study investigated the effect of the air-ground interface on radiation resulting from a nuclear detonation. Project personnel measured integrated gamma dose and neutron readings and gamma dose rates at points on the ground and at corresponding points in the air at heights up to about 950 feet. Four tethered balloons, supplied and handled by the General Mills Company with technical assistance from Sandia Laboratory, were used to elevate the equipment and other instruments.

On the day before the shot, nine Project 2.10 participants assisted by personnel from Project 2.5, were scheduled to go to the project area at 1300 hours to fill the balloons with helium, install instruments, and moor the balloons at positions 1,830, 2,290, 2,780, and 3,270 meters south-southeast of ground zero. The men were to have completed these tasks and left the area by

2400 hours. Two hours after the shot, eight men in two vehicles were to recover the instruments from the balloon stations. The balloons themselves were destroyed by the blast and thermal effects of the shot (47; 49).

Project 4.2, Evaluation of Eye Protection Afforded by an Electromechanical Shutter, was designed to determine the effectiveness of a prototype electromechanical shutter in preventing or minimizing flash blindness. The Tactical Air Command supplied the C-47 aircraft in which the experiment took place and the six volunteer subjects. The Air Force School of Aviation Medicine furnished a trained examiner for each of the subjects. Personnel from the Navy Radiological Defense Laboratory, the Wright Patterson Aero Medical Laboratory, and the Nellis AFB Hospital provided technical support.

The C-47 had special modifications for six test subjects. These modifications included six portholes with facilities for mounting four shutters. One of the prototype electromechanical shutters used in the test was intentionally inoperative. In addition, at least one window of the aircraft had been replaced with a sandblasted diffusing screen to simulate the illumination of a nuclear detonation as seen by an aircrew flying above, below, or within a cloud layer. Four or more rabbits were also used as test subjects. The rabbits were placed in a holder designed to minimize movement and ensure that their eyes would be exposed to the light from the detonation.

The C-47 took off from Nellis AFB at 0310 hours. At shot-time, the aircraft was about 30 kilometers southeast of ground zero at an altitude of 9,000 feet. After the detonation, the examiners determined the time needed for the volunteers to recover useful vision, as measured by the ability to read aircraft instruments, and to recover night vision, as measured on a nyctometer. The volunteers averaged a minimum time of 10 seconds

to recover aircraft instrument recognition and a maximum time of 90 seconds to recover night vision. Separate results for the volunteer with the inoperative shutter are not available. The aircraft landed at Nellis AFB at 0517. The test subjects received a complete ophthalmological evaluation at Nellis AFB (3; 52).

Project 4.2 plans also called for four men to operate a ground station from four hours and 30 minutes before the shot to 30 minutes after the shot. This station may have been intended as a second observation post for the experiment. However, the weapons test report does not describe any Project 4.2 ground activities at Shot HOOD (49; 52).

Project 5.3, In-flight Structural Response of the FJ-4 Aircraft to a Nuclear Detonation, was designed to measure the thermal and blast wave response of the FJ-4 aircraft and to determine its performance and delivery capabilities during a nuclear detonation. The operational phase of this project was conducted by the Naval Air Special Weapons Facility, staging from Indian Springs AFB during the test. North American Aviation, Inc., supplied the specially instrumented test aircraft and the personnel required to maintain it. Personnel involved in Project 5.3 were the aircraft crew, the air traffic controllers, and the maintenance personnel.

The FJ-4 took off from Indian Springs AFB at 0345 and arrived over the test area at 0354 hours. It established an orbiting point southwest of ground zero at an altitude of 20,000 feet. The aircraft was positioned nearly over ground zero, at a slant range of about 4,600 meters, in a level flight attitude, tail-on to the blast at the time of shock arrival. The aircraft landed at Indian Springs AFB at 0449. A standby aircraft was positioned at 20,000 feet over Indian Springs AFB during the detonation and landed at 0456 (3). Total gamma dose in the test

aircraft was recorded by film badges located in the cockpit, ammunition bay, right drop tank, and nose-wheel well (29).

Project 5.4, In-flight Structural Response of the A4D-1 Aircraft to a Nuclear Detonation, was fielded by the Navy Bureau of Aeronautics, supported by the Douglas Aircraft Company. Its objective was to measure the thermal and blast wave response of the A4D-1 aircraft during flight and to determine its performance and delivery capabilities during a nuclear detonation. Personnel involved in Project 5.4 were the aircraft crew, the ground controllers, and the maintenance personnel responsible for the special painting and instrumentation of the aircraft.

Two aircraft were originally scheduled to participate at Shot HOOD, but difficulties with communications equipment caused one of the A4D-1 aircraft to abort (3). The aircraft that did participate was to obtain gust response at a relatively low incidence angle. The aircraft took off from Indian Springs AFB at 0400 hours, entered an orbit pattern at 0408 hours, made two practice orbits in a pattern approximately 35 nautical miles in length, and made a run-in over ground zero five minutes before the detonation.

At the time of detonation, the A4D-1 was located 7,800 feet above terrain, at a slant range of 4,160 meters north of the detonation. When the shock wave arrived, the aircraft was 7,800 feet above terrain at a slant range of 9,300 meters further north (3). Ten minutes after the detonation, the plane landed at Indian Springs AFB. Nuclear radiation in the aircraft was measured by four film badges located in the bottom of the nose section, six film badges in the cockpit map case, and other dosimeters located in the nose wheel door and the leg pocket of the pilot's flight suit (3; 45).

Project 5.5, In-flight Structural Response of the F-89D Aircraft to a Nuclear Detonation, was designed to determine the structural response of the F-89D aircraft in flight to the blast and thermal effects of a nuclear detonation. Northrop Aircraft Corporation had a contract with the Wright Air Development Center to assist in planning and conducting the test. Northrop was responsible for calibrating, maintaining, and operating the instrumentation and associated equipment, as well as analyzing the data collected. Northrop and Wright Air Development Center jointly determined positions and positioning methods.

The F-89D aircraft left Indian Springs AFB at 0410 hours, arriving at its designated preshot position northeast of ground zero at 0417 hours. The aircraft established a holding pattern northeast of ground zero at an altitude of 26,000 feet. At the moment of detonation, the aircraft was about 11,000 meters south-southwest of ground zero on a heading of 200 degrees. At the time of shock arrival, the aircraft had traveled approximately 6,000 meters further from the shot and was continuing on the same heading. The aircraft left the area at 0443 hours and landed at Indian Springs AFB at 0446 (3; 42).

Project 6.2, Measurement of the Magnetic Component of the Electromagnetic Field near a Nuclear Detonation, was conducted by Diamond Ordnance Fuze Laboratories. The project determined the characteristics of the electromagnetic pulse from a nuclear detonation as a function of time and distance. This study used five self-powered recording stations located at distances of about 170, 320, 750, 1,520, and 2,890 meters from ground zero.

Before Shot HOOD, the project staff, which had 21 members, installed sensors and recording devices at each station. The devices were buried in holes lined with concrete and then covered with sandbags. The preparation of these stations required the support of between 10 and 15 members of the project staff.

According to the Schedule of Events, three men were to occupy a station at UTM coordinates 895855 between Yucca Lake and Mercury Highway from two hours before to one hour after the shot.

Recovery operations began about four hours after shot-time. Recovery of some of the recording devices took only about 90 minutes, but the recovery of others was considerably more difficult because the protecting sandbags had disintegrated and the holes had to be dug out before the recording packages could be retrieved. Recovery operations within the four days after the shot involved eight to ten men who spent one to two days working in the field (21; 49; 51).

Project 6.2a, Effect of Nuclear Radiation on Semiconductor Devices, was conducted by Project 6.2 personnel. The objective of the project was to ascertain the effects of neutron, gamma, and electromagnetic radiation on commercially available transistors, diodes, and electronic circuits using these components. The major project effort was at Shot PRISCILLA. Project personnel placed transistors and diodes in aluminum cans, which in turn were packed in insulated plywood boxes. The one box used at Shot HOOD was buried 240 meters from ground zero and was probably recovered within a few days after the shot (50).

Project 6.4, Accuracy and Reliability of the Short-baseline NAROL System, had three objectives:

- To study the ability of the NAROL System to detect the position and measure the yield of a nuclear detonation
- To detect accurately the electromagnetic pulse from nuclear bursts
- To collect data on the propagation of that pulse as it travels over land.

The NAROL geometry tested during PLUMBBOB consisted of one inverse LORAN net, with stations at Albuquerque, New Mexico; Vale, Oregon; and Rapid City, South Dakota (18).

Project 6.5, Effects of Nuclear Detonations on Nike Hercules, investigated the effects of nuclear detonations on the structural and operational characteristics of components, materials, and electronic systems of the Nike Hercules guided-missile system. At Shot HOOD, however, the only objective was to investigate radar signal propagation through a nuclear cloud. The project was fielded by 23 personnel from the Army Missile Test Center of the White Sands Missile Range, New Mexico. They were assisted by four employees of the Systems Test Division of the Bell Telephone Laboratories, Whippany, New Jersey.

The project procedure actually used differed considerably from that planned because of an instrument malfunction. For attenuation measurements, the plan was to locate a Nike beacon on a mountain high enough so that a radar signal sent from another mountain station could pass through the nuclear cloud and illuminate the beacon. Before detonation, however, the clock on the radio relay used to energize the beacon malfunctioned, and the beacon failed to activate. The radar signal that reflected from the mountain where the beacon was located was then used to make the attenuation measurements (16).

At 2330 hours on the day before the shot, ten project participants went to the radar station, located near Syncline Ridge at UTM coordinates 765103. The radar station was manned through shot-time. Personnel left the area two hours after the shot (16; 49).

Project 8.2, Prediction of Thermal Protection of Uniforms and Thermal Effects on Standard-reference Material, investigated the ability of laboratory experiments to predict accurately the effects of intense thermal radiation on live skin and tissue covered by various uniform materials. Laboratory results were compared with actual burns in selected materials exposed to

thermal radiation from a nuclear detonation. Although two equipment stations were planned for this project, only one station, containing recording instruments and selected materials, was installed 3,180 meters from ground zero. Protective covers were removed from exposure assemblies the evening before the detonation. Seven men returned to the station to retrieve samples and instruments after recovery hour was declared at 0608 hours (14; 49). It is not known how long the recovery team spent in these activities.

Project 9.1, Technical Photography, provided technical photography and documented detonations for historical purposes and for release to the press through the Joint Office of Test Information. In addition, the project provided cameras for Project 8.2.

An airborne camera station, manned by personnel from the Lookout Mountain Laboratory, and a camera station in the forward area, operated by Edgerton, Germeshausen, and Grier photographers, provided color and black-and-white and still and motion picture coverage. By using laboratory facilities established at the test site, personnel could process and classify the photographs for release to the press (18).

The airborne station, a C-47 from the Military Air Transport Service, left Indian Springs AFB at 0325 hours and arrived at the NTS at 0330 hours. The aircraft established an orbiting pattern at 10,000 feet about 25 kilometers south of ground zero at 0340 hours. It left the NTS at 0520 hours and landed at Indian Springs AFB at 0525 hours. The plane spent 40 minutes over the NTS after the detonation (3).

Based on standard photography procedures during the test series, cameramen probably spent one day photographing project setups before the detonation. The postshot photography was

done within a few days, after the areas were declared radiologically safe.

3.2 DEPARTMENT OF DEFENSE PARTICIPATION IN LASL AND UCRL TEST GROUP PROJECTS AT SHOT HOOD

The Los Alamos Scientific Laboratory Test Group performed five projects at Shot HOOD. Of these five projects, only Project 11.2, Radiochemistry Sampling, involved DOD participants, as indicated in table 3-2. The University of California Radiation Laboratory Test Group conducted eight projects at Shot HOOD, but DOD personnel took part only in Project 21.2, Radiochemistry Sampling. As shown in table 3-2, the same sampler pilots from AFSWC 4926th Test Squadron (Sampling) provided support concurrently for these projects. The two projects are discussed together under AFSWC participation at Shot HOOD, in section 3.5 of this chapter.

Table 3-2: LASL, UCRL, AND CETG PROJECTS WITH DOD PERSONNEL INVOLVEMENT, SHOT HOOD

Project	Title	Sponsor	Estimated Number DOD Personnel	DOD Agency	Capacity
11.2/ 21.2	Radiochemistry Sampling	LASL/ UCRL	16	4926th Test Squadron, AFSWC	Cloud Sampling
37.2/ 37.2a	Biophysical Aspects of Fallout/ Physical Aspects of Fallout	CETG	8	AFSWC	Radio Relay
39.1	Gamma and Neutron Radiation Measurements	CETG	22	USAF School of Aviation Medicine	*
39.5	Radiation Dosimetry for Human Exposure	CETG	3	USAF School of Aviation Medicine	Laboratory Analysis
39.9	Remote Radiological Monitoring	CETG	1	USAF School of Aviation Medicine	*

* Unknown

3.3 DEPARTMENT OF DEFENSE PARTICIPATION IN CIVIL EFFECTS TEST GROUP PROJECTS AT SHOT HOOD

The Civil Effects Test Group conducted ten projects at HOOD. DOD personnel took part in five of these projects, as shown in table 3-2. As at all shots in the PLUMBBOB series, Department of Defense participation in the Civil Effects Test Group projects was limited.

Projects 37.2, Biophysical Aspects of Fallout, and 37.2a, Physical Aspects of Fallout, required one C-47 aircraft, provided by AFSWC, for a radio relay. Other than eight AFSWC participants, DOD personnel were not involved in this project. The C-47 aircraft arrived at the NTS at 0240 hours and began an orbit 20 nautical miles southeast of ground zero at an altitude of 12,000 feet. It left the NTS after 0600 hours (3).

Project 39.1, Gamma and Neutron Radiation Measurements, engaged 22 DOD personnel. Some of these participants were from the Air Force School of Aviation Medicine. They experimented with film dosimetry techniques to measure gamma radiation from a nuclear detonation. Dosimeters were placed at 100-meter intervals 450 to 1,350 meters from ground zero (41). According to the Schedule of Events, three men were to enter the shot area eight hours after the detonation to recover the dosimeters (49).

Project 39.5, Radiation Dosimetry for Human Exposure, involved three DOD personnel from the Air Force School of Aviation Medicine. Other personnel included 18 civilians from the AEC Oak Ridge National Laboratory, three civilians from Edgerton, Germeshausen, and Grier, and one civilian from the General Electric Company. The objective of Project 39.5 was to determine the shielding afforded by light-frame houses and similar structures against fast neutrons and gamma rays. Project personnel placed an array of neutron and gamma ray detection devices southeast of ground zero at slant ranges of 1,140, 1,370,

and 1,600 meters. Shortly after the detonation, participants recovered the devices (12; 40).

Project 39.9, Remote Radiological Monitoring, involved one DOD participant from the Air Force School of Aviation Medicine. Participants recorded residual radiation data at four monitoring stations located 675, 900, 1,125, and 1,350 meters northeast of ground zero (40).

3.4 DEPARTMENT OF DEFENSE OPERATIONAL TRAINING PROJECTS AT SHOT HOOD

The Marine Corps conducted one operational training project at Shot HOOD, and the Air Force conducted three, as shown in table 3-3. The primary aims of these training projects were to test tactics and equipment and to instruct military personnel in the effects of nuclear detonations.

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

Project	Title	Sponsor	Type Aircraft	No. Aircraft	Staging Base	Estimated No. Personnel
52.3	Marine Fly-by Indoctrination	Marine Corps	R5D A4D	1 3	El Toro Marine Air Base Station, California	16 3
53.5	Aircrew Indoctrination	Air Defense Command	T-33	4	Nellis AFB, Nevada	8
53.7	Indirect Bomb Damage Assessment	Wright Air Development Command	F-89D	1	Indian Springs AFB, Nevada	2
53.9	Photographic Reconnaissance Training	Tactical Air Command	RF-84F	2	Luke AFB, California	2

Project 52.3, Marine Fly-by Indoctrination, was conducted by Marine Air Group 33 of the 3d Marine Air Wing. The project involved one R5D aircraft, probably manned by a crew of three and carrying 13 passengers, and three A4D aircraft, manned by one pilot each. A fourth A4D was supposed to participate, but technical problems forced it to abort its mission. The aircraft operated from the El Toro Marine Corps Air Base Station, Santa Ana, California. The three A4Ds flew at altitudes of 21,000 to 24,000 feet in an orbit 25 nautical miles long. The A4D aircraft entered the NTS and began their orbit at 0430 and left at 0500 hours. At shot-time, they were 16.5 nautical miles south-east of the HOOD detonation. The R5D began its orbit between Lathrop Wells and Camp Desert Rock at 11,000 feet at 0430 hours, and was ten nautical miles south of ground zero at shot-time. It left the area at 0500. The reporting point of all aircraft was Lathrop Wells (3).

Project 53.5, Aircrew Indoctrination, was conducted by the Air Defense Command to provide an opportunity for crew members and commanders to witness a nuclear detonation and penetrate the nuclear cloud. Four T-33 aircraft, each with a crew of two, took off from Nellis AFB at 0420. At 0435, they began orbiting at 34,000 feet, 30 nautical miles northeast of ground zero. They left their orbit and penetrated the cloud when ordered to do so by the sampler control aircraft discussed in section 3.5.1. The T-33s left the area by 0500 hours (3).

Project 53.7, Indirect Bomb Damage Assessment, conducted by the Wright Air Development Center, included one F-89D manned by a crew of two. The plane left Indian Springs AFB at 0355 and arrived at its shot-time position at 0410. It flew at an altitude of 35,000 feet in an orbit that placed it east of ground zero at shot-time. The plane left its orbit at 0441 and landed at Indian Springs AFB at 0504 (3).

Project 53.9, Photographic Reconnaissance Training, was conducted by an Air National Guard Tactical Reconnaissance Unit. The project involved two RF-84F aircraft, each probably manned by one pilot. The aircraft left Luke AFB at 0355 and arrived at the NTS at 0435, where they orbited between Lathrop Wells and Beatty, Nevada. The participants, who were from the Alabama National Guard, were assigned to photograph the ground zero area. At 0450 they flew toward ground zero at 10,000 feet. The planes left the area at 0515 (3).

3.5 AIR FORCE SPECIAL WEAPONS CENTER ACTIVITIES AT SHOT HOOD

Air Force Special Weapons Center support to the Test Manager and to test groups during Shot HOOD was provided by the 4950th Test Group (Nuclear), the 4926th Test Squadron (Sampling), and the 4935th Air Base Squadron, with support from the 4900th Air Base Group. AFSWC missions consisted of nuclear cloud sampling, cloud tracking, cloud penetration, terrain surveys, and courier missions. Cloud sampling was conducted for LASL Project 11.2 and UCRL Project 21.2. AFSWC personnel located in the air operations center at the Control Point at Yucca Pass exercised operational control of all aircraft participating at Shot HOOD. Table 3-4 indicates DOD participation in AFSWC projects, including the number and types of aircraft used.

3.5.1 Cloud Sampling

Ten aircraft collected samples of the Shot HOOD cloud for LASL Project 11.2, Radiochemistry Sampling, and UCRL Project 21.2, Radiochemistry Sampling. These ten sampler aircraft were flown by pilots of the 4926th Test Squadron (Sampling) and included four B-57Bs, each with one pilot and a radiation monitor, two F-84s with one pilot each, and four T-33s, each with a crew of two. A B-57B sampler control aircraft, which was flown by an AFSWC pilot accompanied by a scientific advisor from UCRL, also participated.

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

Program/Project	Mission	Type Aircraft	Number of Aircraft	Estimated Number of DOD Personnel
11.2/21.2	Cloud Sampling	B-57	1	2
	Sampler Control	F-84	2	2
	Sampler	B-57	4	8
	Sampler	T-33	4	8
	Courier Missions	C-47	3	15
37.2/37.2a	Radio-Relay	C-47	1	8
—	Cloud Tracking	B-25	1	6
—	Cloud Penetration	T-33	1	2
—	Security Sweeps	L-20	2	4
—	Survey Missions	H-21	6	24

The sampler control aircraft (serial number 504) left Indian Springs AFB at 0425 and reached its preshot position 50 nautical miles east of ground zero at an altitude of 30,000 feet at 0430. It left this orbit shortly after the detonation to view the cloud from all sides. The scientific advisor then directed the sampler aircraft to penetrate the cloud in order to collect the necessary samples. The sampler control aircraft left the NTS at about 0725 and landed at Indian Springs AFB around 0730. A spare B-57B sampler control aircraft stood by at Indian Springs AFB but was not needed.

The missions of the sampler aircraft, which all staged from Indian Springs AFB, are summarized in the following listing:

AIRCRAFT TYPE	SERIAL NUMBER	TAKEOFF TIME	TIME ENTERED CLOUD AREA	TIME LEFT CLOUD AREA	LANDING TIME
T-33	803	0416	0445	0600	0605
T-33	825	0416	0450	0600	0605
T-33	267	0420	0450	0610	0615
T-33	812	0420	0450	0610	0615
F-84G	054	0610	0615	0655	0700
F-84G	046	0620	0625	0705	0710
B-57B	495	0555	0600	0632	0640
B-57B	496	0600	0605	0645	0650
B-57B	500	0630	0635	0715	0720
B-57B	502	0640	0655	0725	0730

Two spare F-84G and one B-57B aircraft stood by at Indian Springs AFB during the cloud sampling mission but were not used (3).

Upon landing, sampler aircraft taxied to a designated area where Air Force ground personnel removed the samples and placed them in metal containers which were sent by courier to the laboratories. At the completion of this activity, the aircraft crew went through the decontamination procedures described in the PLUMBBOB series volume.

3.5.2 Courier Missions

It was planned that three C-47s would deliver cloud samples to UCRL and LASL. Five Air Force personnel probably manned each aircraft (3).

3.5.3 Cloud Tracking

Immediately after the HOOD detonation, four aircraft were scheduled to fly cloud-tracking missions over and beyond the Nevada Test Site. However, available documentation specifies only that one B-25, serial number 410, left Indian Springs AFB at 0500 and entered NTS airspace at 0510. The B-25 probably had a crew of six (3).

3.5.4 Cloud Penetration

Another AFSWC activity at Shot HOOD was part of an ongoing study to determine whether the Air Force should monitor the accumulation of radioactive contaminants on aircraft. A T-33, serial number 105, from the 4926th Test Squadron, piloted by an officer from Air Support Group Headquarters and carrying one observer, entered the Shot HOOD cloud. The pilot and the observer both wore lead vests instrumented with several film badges. Six additional film badges were taped to the ejection seats. The T-33 left Indian Springs AFB at 0550, began following the cloud at 0610, discontinued tracking at 0630, and landed at Indian Springs AFB at 0635 (2; 3).

3.5.5 Security Sweep Missions

Two L-20 aircraft, each carrying a security guard and a pilot, were scheduled to fly security checks over the test area on the day before and sometime after the detonation. The L-20 aircraft were based at the Yucca Lake airstrip (3).

3.5.6 Terrain Survey Missions

Six H-21 helicopters, staging from the helicopter pad near the Control Point, were available to fly radiation safety and terrain survey missions, as directed by the Test Manager and the Test Director. Each helicopter carried two Air Force crew members and two radiation safety monitors from Reynolds Electrical and Engineering Company. This survey mission is described with the other monitoring activities in chapter 4.

CHAPTER 4

RADIATION PROTECTION AT SHOT HOOD

To protect DOD participants at Shot HOOD from the radiation associated with a nuclear detonation, Exercise Desert Rock VII, the Nevada Test Organization, and the Air Force Special Weapons Center each developed its own criteria and procedures. These safety criteria and procedures, as well as the organizations developed to implement them, are detailed in chapter 5 of the PLUMBBOB series volume. The purpose of the radiation protection procedures developed for Operation PLUMBBOB was to ensure that individual exposure to ionizing radiation was as low as possible. At the same time, the procedures were designed so that participants could accomplish their missions.

Some of the procedures required that records be kept so that Exercise Desert Rock, the NTO, and AFSWC could evaluate the effectiveness of their radiation protection programs. Available information concerning radiation protection at Shot HOOD includes film badge readings for some of the participants in Desert Rock Project 52.1, Marine Brigade Exercise, and NTO data on radiation safety equipment, survey results and records, isointensity plots, and decontamination records.

4.1 RADIATION MONITORING AND FILM BADGE READINGS FOR PARTICIPANTS IN THE MARINE BRIGADE EXERCISE

The following discussion details radiation protection activities specifically related to the Marine Brigade Exercise, Project 52.1, at Shot HOOD.

Monitoring and Dosimetry

Monitors from seven major Marine Corps commands participated in special monitoring exercises while the 4th Marine Corps Provisional Atomic Exercise Brigade was at Camp Desert Rock. These 178 monitors were in addition to those monitors who belonged to the subordinate units of the 4th Brigade. At shot-time, 13 of the 16 monitoring teams were in the trenches, two were with the observers in the News Nob area, and one was in the vehicle assembly area. Fifteen minutes after the shot, the monitors began their activities. They monitored the equipment display area, accompanied Desert Rock monitors surveying towards the ground zero area, preceded Company E on its march towards ground zero, accompanied the motor convoy from the vehicle assembly area to the trenches and back to the assembly area, monitored Loading Zone One, and accompanied observers on buses and in sedans. The monitoring teams reassembled at the equipment display area upon completion of the exercise and monitored departing vehicles and personnel for contamination. The monitors returned to Camp Desert Rock at about 1800 hours (27; 55).

Sixteen monitors from 2d Battalion, 5th Marine Regiment, were deployed to Camp Desert Rock for special training by Army radiological safety teams at the NTS. These monitors, grouped into four teams, performed monitoring during the field exercise for Companies E, F, G, and H (55).

An attempt was made to establish an interim dosimetry capability for the Marine Corps. Field X-ray processing equipment was set up, and dental X-ray packets were issued to a representative group of participating personnel. After the troop exercise, the film was processed and interpreted. The results appeared to be in the reliability range of other photodosimetry systems (55). Results of the regular dosimetry program are reported in the next section.

Film Badge Results

Each Exercise Desert Rock participant was issued a film badge. Form LSD SCTF 10, the Lexington Signal Depot Film Badge Service Radiation Report, was used to record the individual's name, rank, serial number, organization, film badge number, and exposure. While the forms include much useful information, they do not always provide information specific to Shot HOOD. The LSD SCTF 10 forms cover periods of time ranging from two days to two months. In some cases, the participants could have gone to the forward area during another event. In addition, information on these forms was not always recorded accurately; names were misspelled and incorrect organization names were recorded.

In spite of these recordkeeping problems, film badge readings can be identified for about two-thirds of the DOD personnel at Shot HOOD. These are the records of the participants in Project 52.1, the Marine Brigade Exercise, which was performed only at Shot HOOD during the PLUMBBOB series. By separating the records of Project 52.1 participants from the other PLUMBBOB LSD SCTF 10 forms, it was possible to compile film badge readings specific to Shot HOOD.

Film badge readings are available for 639 persons assigned to Project 52.1. The only group not fully represented in these data is the 2d Battalion, 5th Marines: film badge readings are not available for the majority of enlisted men in this group. Research indicates that 51 of the 639 soldiers had film badges that were damaged or otherwise unreadable. Figure 4-1 presents the distribution of film badge readings for the 588 participants with readable badges. Although Project 52.1 consisted almost entirely of Marines, ten Navy medical personnel also participated. Only one of these ten men received an exposure greater than 1 roentgen; this exposure was 1.3 roentgens.

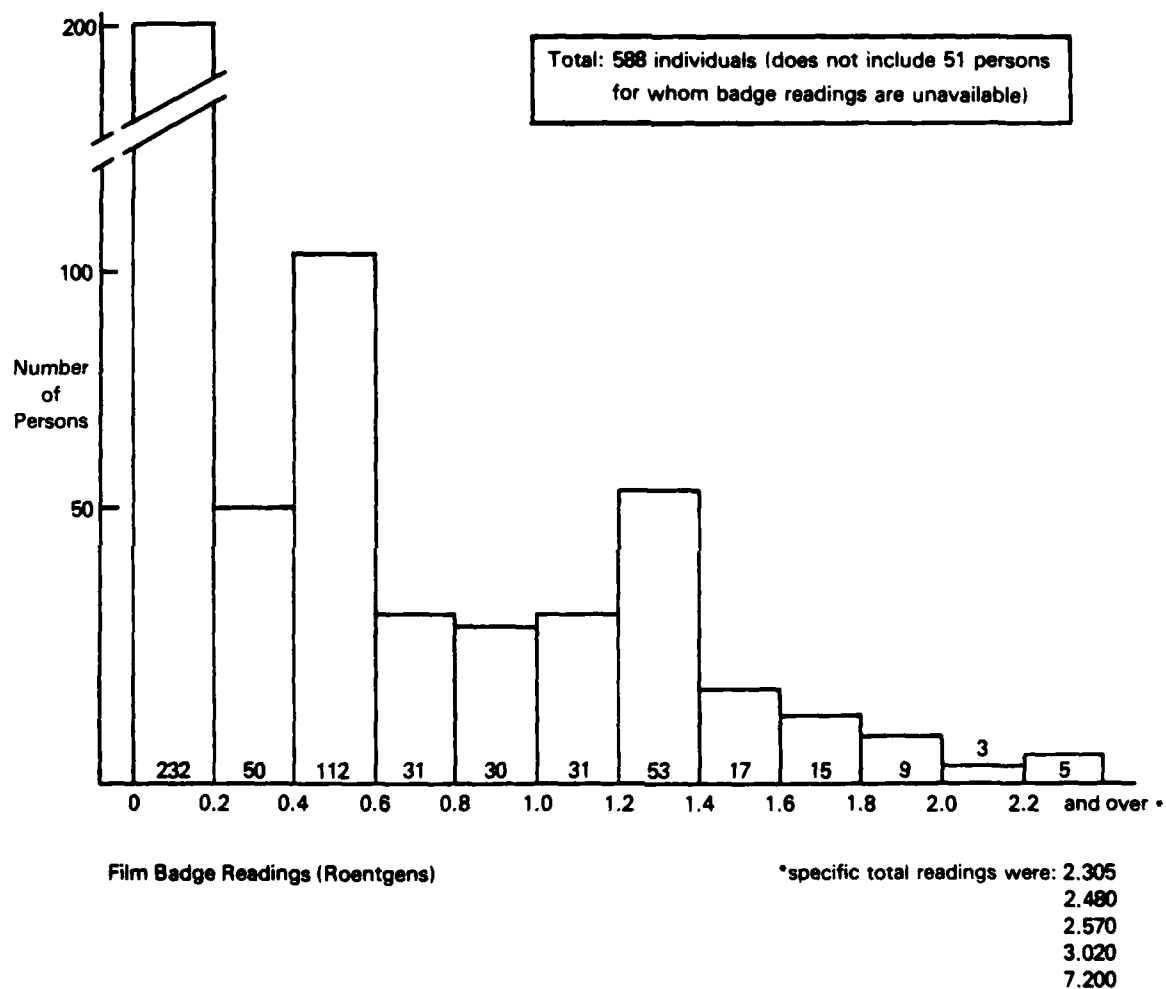


Figure 4-1: DISTRIBUTION OF TOTAL FILM BADGE READINGS, PROJECT 52.1, SHOT HOOD

The mean exposure reading for the 588 participants with readable badges was 0.6 roentgens. Seventy-five percent of the readings were below 1.6 roentgens, but eight of the 588 participants received 2 roentgens or more. The Equipment Display Officer, who returned to the display area several times in the days after the shot, received 7.2 roentgens. This is the only reading detected among Project 52.1 participants in excess of the Exercise Desert Rock limit of 5 roentgens. Aside from an equipment display assistant, all others with totals greater than 1.25 roentgens were members of the monitoring teams.

Most of the Project 52.1 participants were issued only one film badge. However, over one-third of those for whom dosimetry results are available received more than one badge, as shown below:

Persons issued one film badge:	369	(63%)
Persons issued two film badges:	42	(7%)
Persons issued three film badges*:	<u>177</u>	<u>(30%)</u>
TOTAL	588	(100%)

The men who received three badges were monitors. Half the monitors entered contaminated areas twice during training exercises, thus using two film badges. The other half used only one badge during training. The last badge received by both groups of monitors was used for Shots PRISCILLA and HOOD (55). Readings for the monitors are shown in figure 4-2. The mean reading for monitors was between 1.1 and 1.2 roentgens, approximately twice as high as the mean reading for all Project 52.1 participants.

*One person received four badges; the fourth may have been a replacement for a lost badge.

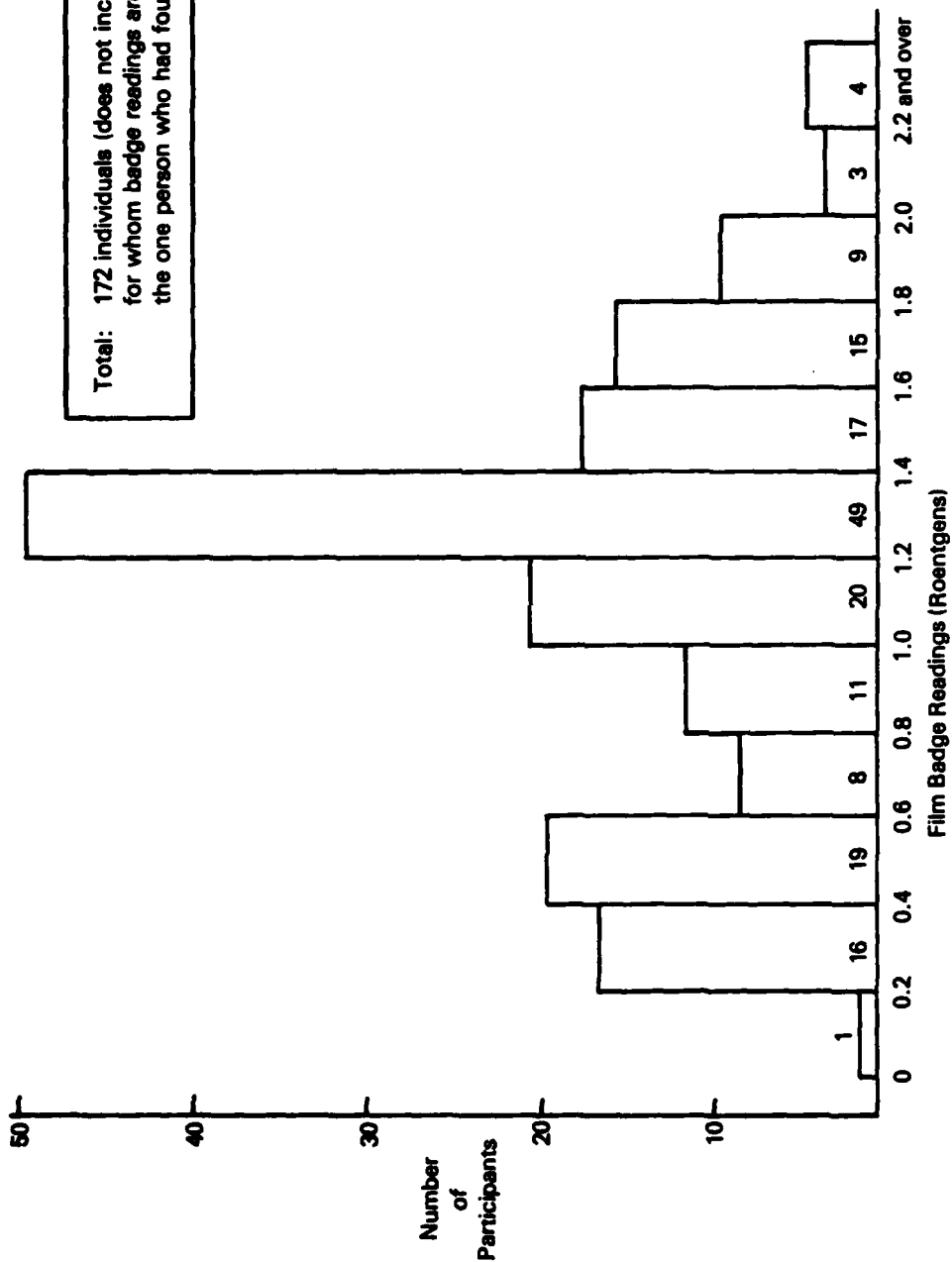


Figure 4-2: DISTRIBUTION OF TOTAL FILM BADGE READINGS, PROJECT 52.1, PARTICIPANTS WITH THREE FILM BADGES (MONITORS)

For all Desert Rock projects other than Project 52.1, participants were required to follow the standard procedures described in the PLUMBBOB series volume.

4.2 NEVADA TEST ORGANIZATION RADIATION PROTECTION ACTIVITIES

The following subsections describe the radiological protection activities of the Nevada Test Organization at Shot HOOD.

Dosimetry Records

From 4 July to 13 July 1957, a period that includes the 5 July detonation of HOOD, the Personnel Dosimetry Branch of the NTO issued 838 film badges and 405 pocket dosimeters.

Although the number of AFSWC participants who wore film badges is not known, data have been found that indicate the exposures received by ground crews during aircraft decontamination. For the decontamination of F-84 cloud samplers at Shots HOOD, PRISCILLA, DIABLO, DOPPLER, and OWENS, ground crew members received an average total exposure of 0.112 roentgens (1). No shot-specific exposure data are available.

Information on Radiation Safety Equipment

For Shot HOOD, the Logistics Branch issued 1,425 pieces of protective clothing and 370 respirators.

Monitoring Procedures and Support

Five minutes after the detonation, nine vehicles carrying a total of 12 monitors began the initial ground survey, which had a mid-time of 0536 hours. Resurveys were also made at a mid-time of 1052 hours on shot-day, and again on 6, 7, 8, 9, 10, 12, and 13 July.

Because heavy dust obscured ground points, the AFSWC aerial survey team, described in section 3.5.6 of this volume, could not perform its survey until about six hours after the detonation. The mid-time of this survey was 1043 hours. The aerial survey team also resurveyed the area around ground zero on 6 and 7 July. The maximum intensity encountered by the aerial survey team was 40 R/h, measured the day after Shot HOOD at 25 feet above ground zero (36; 46).

Plotting and Briefing

Using information from the initial surveys, the Plotting and Briefing Branch developed radiation isointensity contour maps. Figure 4-3 shows a copy of the initial map, with radiation intensities at a mid-time of 0536 hours. Figures 4-4 through 4-7 show copies of the contour maps generated from resurveys.

Information from the ground surveys allowed the Plotting and Briefing Branch to establish Full and Limited Radiological Exclusion (RADEX) areas. The Plotting and Briefing Branch also issued the access permits required for entry into these areas. During the period 5 July through 13 July, access permits were issued to a total of 619 individuals involved in 66 projects (36; 46).

Decontamination Activities

During the period 4 July through 13 July 1957, personnel of the Decontamination Section decontaminated 29 vehicles, 20 pressure gauges, and five electrical devices.

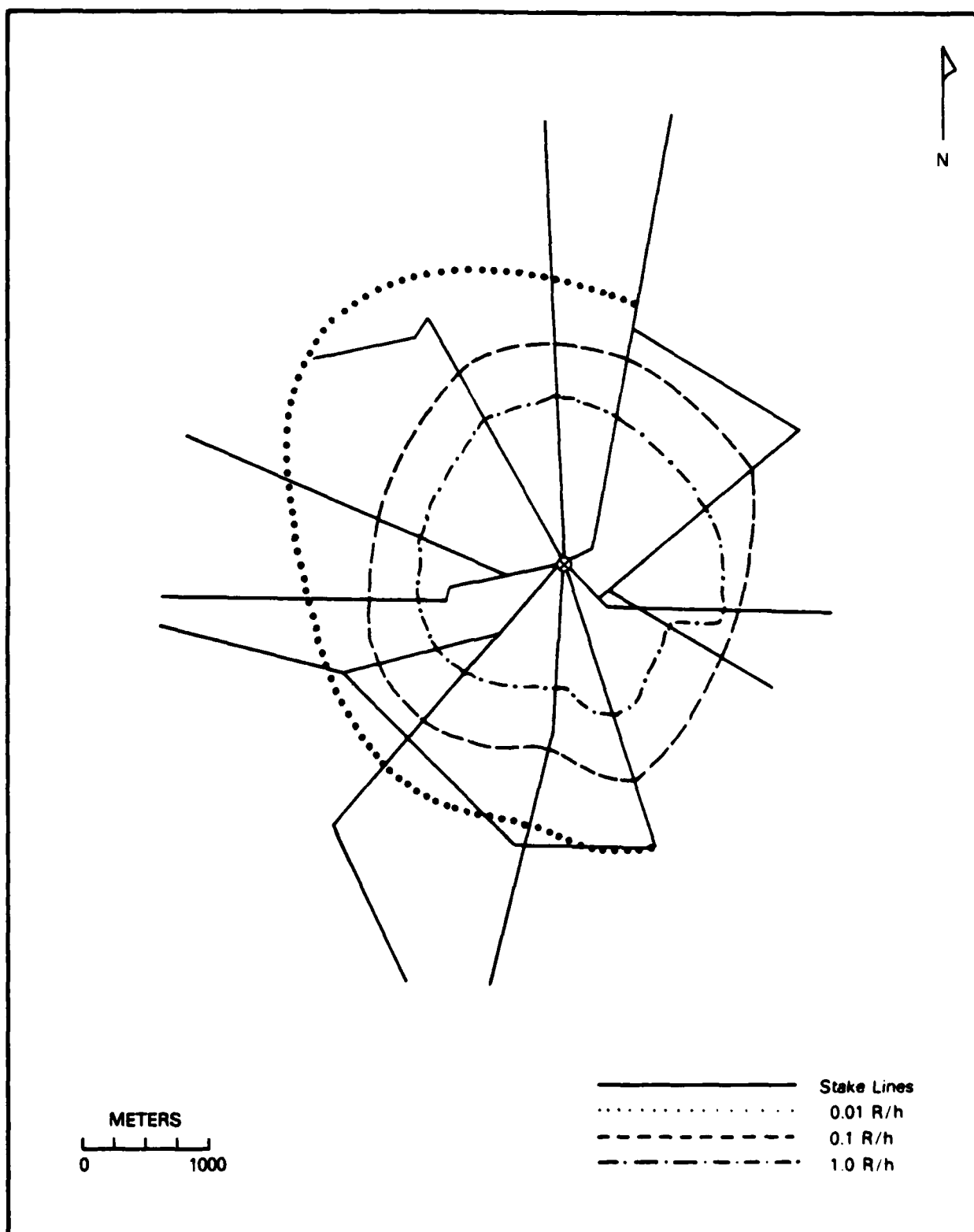


Figure 4-3: INITIAL SURVEY FOR SHOT HOOD, 5 JULY 1957, MID-TIME 0536

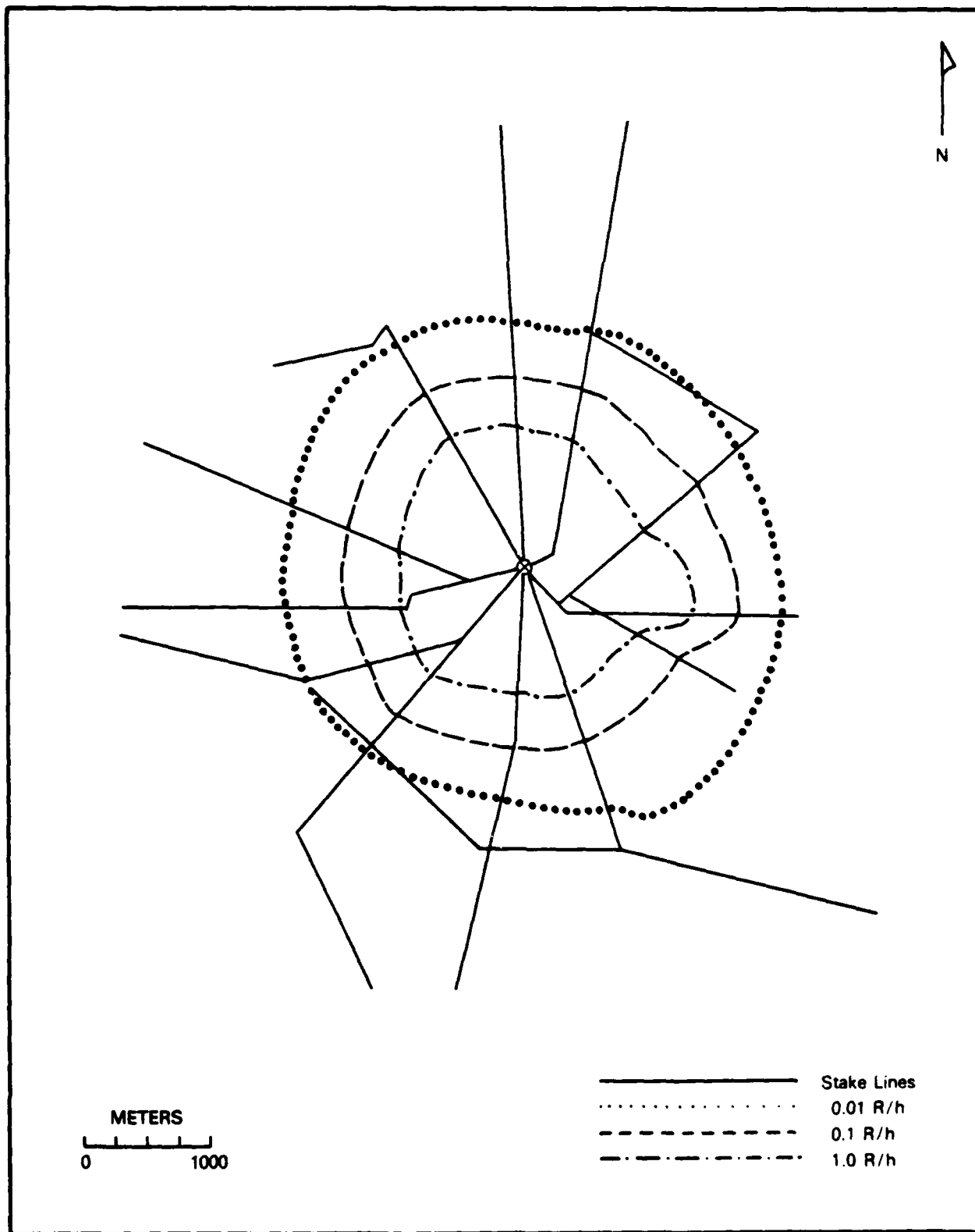


Figure 4-4: RESURVEY FOR SHOT HOOD, 5 JULY 1957, MID-TIME 1052

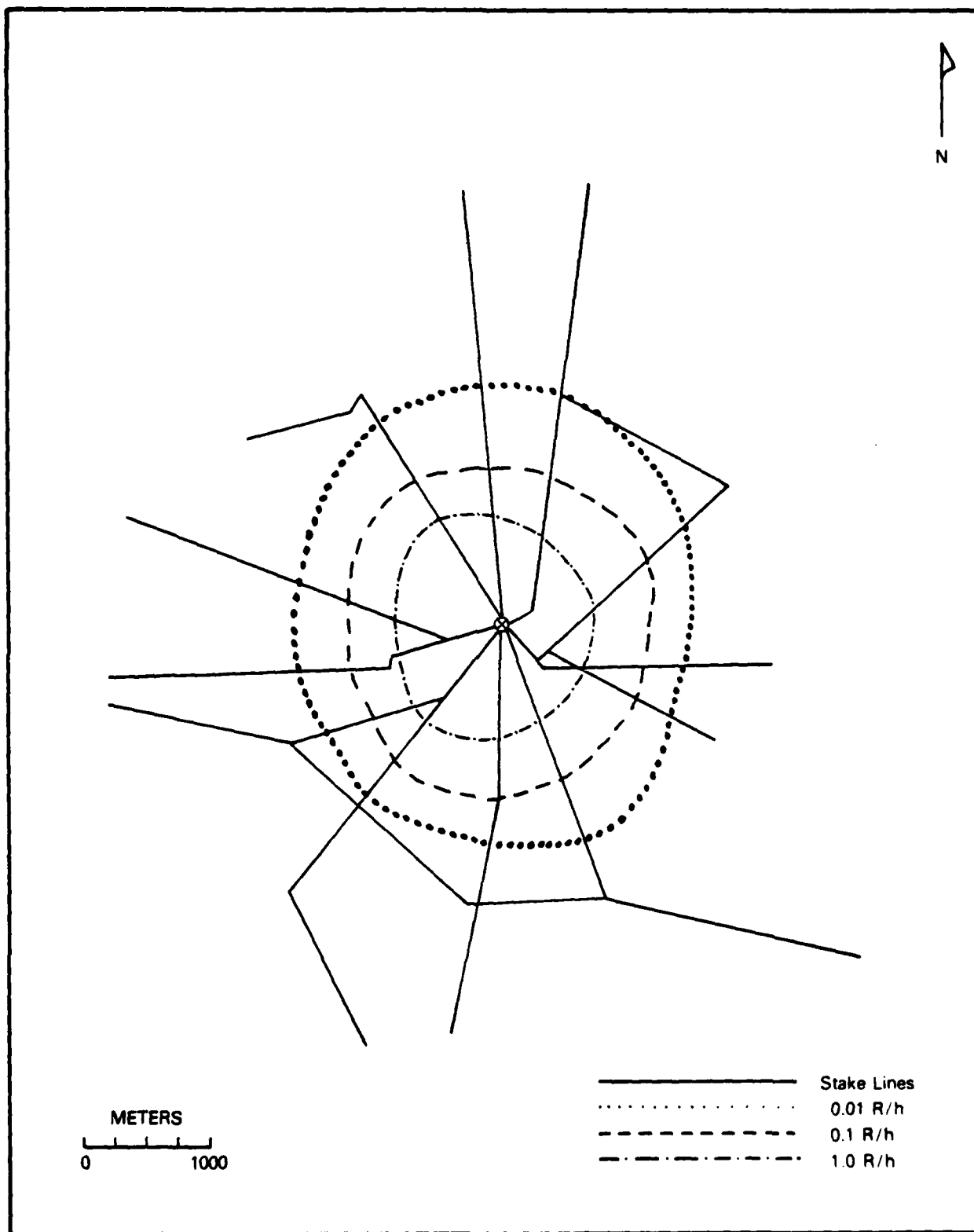
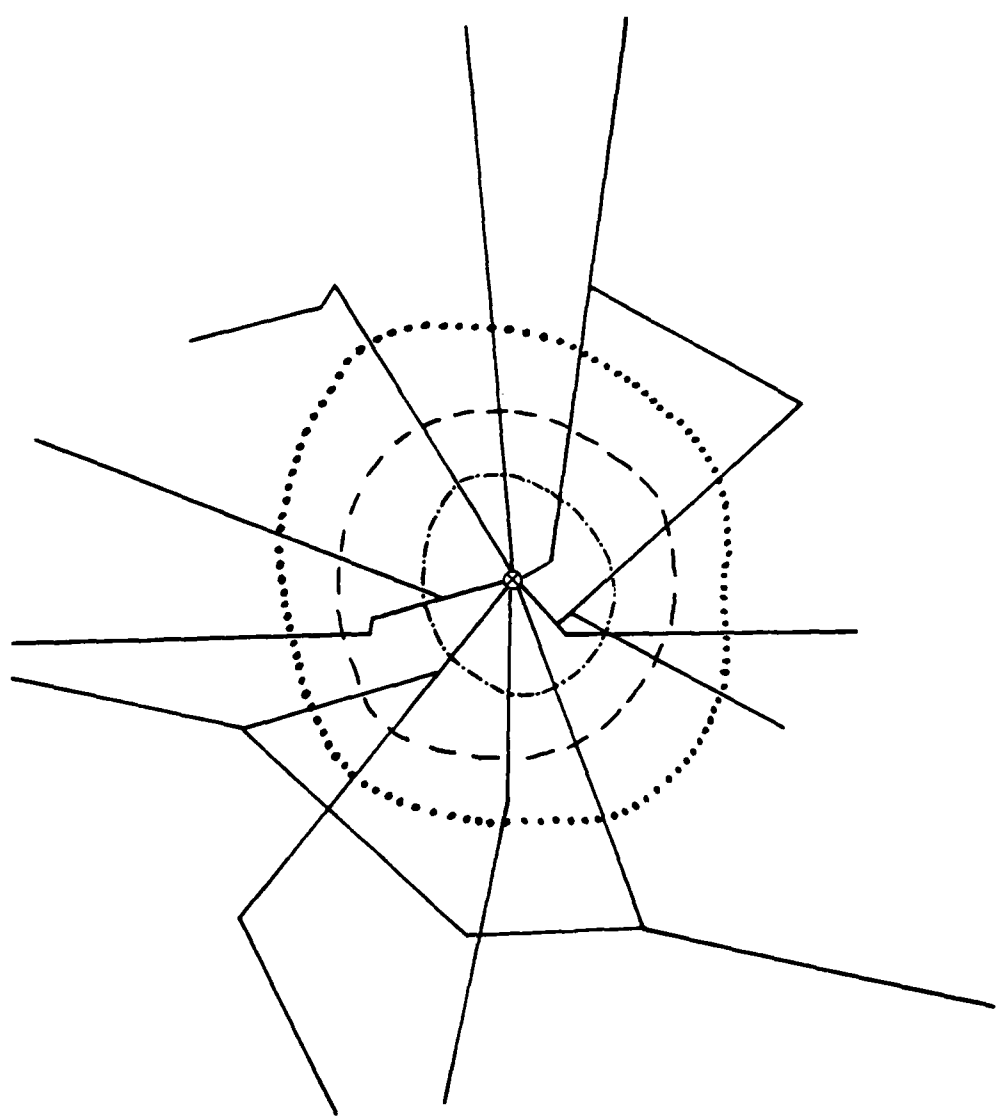


Figure 4-5: RESURVEY FOR SHOT HOOD, 6 JULY 1957, MID-TIME 0613



METERS
0 1000

———— Stake Lines
..... 0.01 R/h
----- 0.1 R/h
- . - . - . 1.0 R/h

Figure 4-6: RESURVEY FOR SHOT HOOD, 7 JULY 1957, MID-TIME 0818

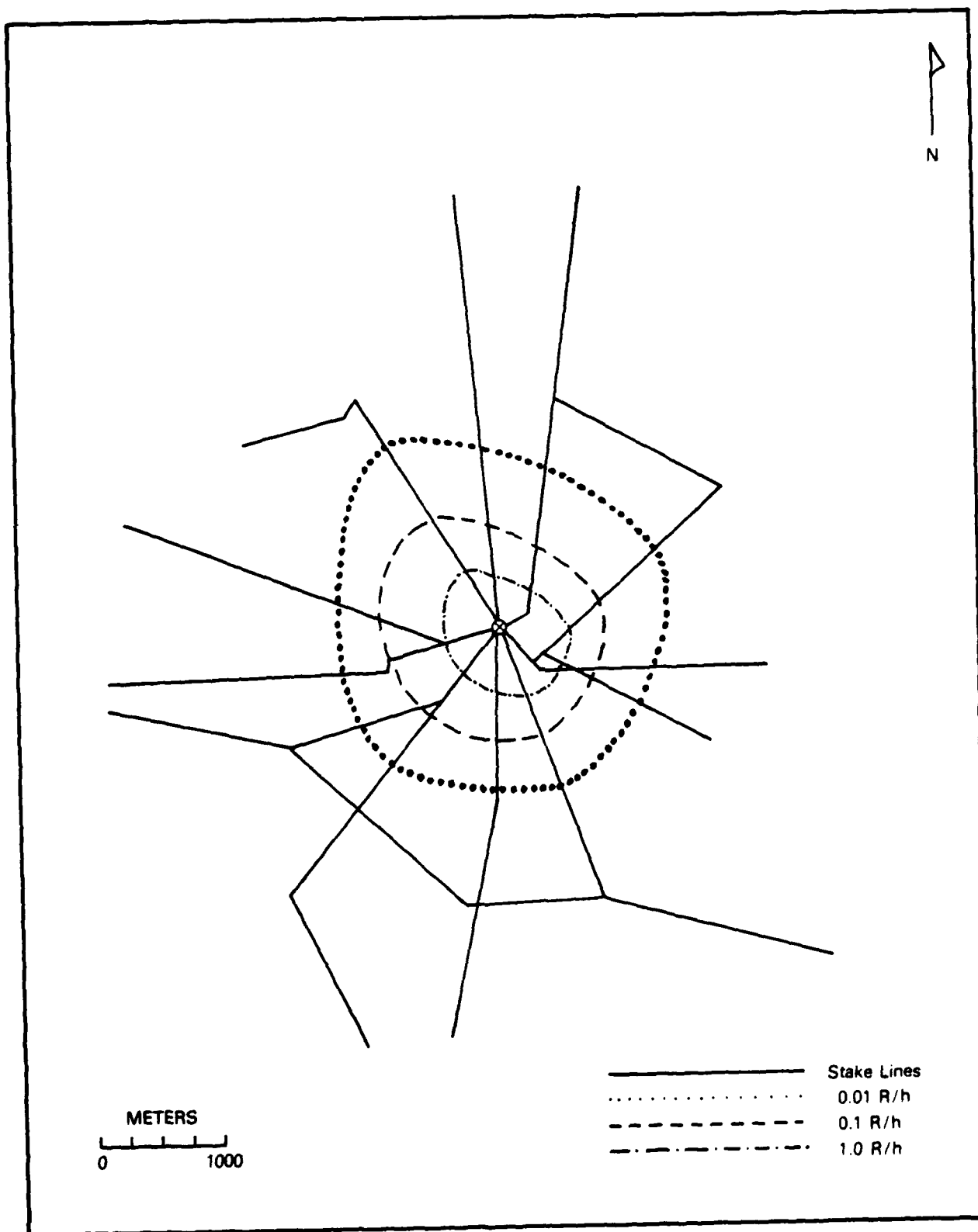


Figure 4-7: RESURVEY FOR SHOT HOOD, 8 JULY 1957, MID-TIME 0658

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AVAILABILITY INFORMATION

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

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Salt Lake City, UT
ATTN: Director

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

Veterans Administration - RO
Roanoke, VA
ATTN: Director

Veterans Administration - RO
Cheyenne, WY
ATTN: Director

Veterans Administration - RO
San Diego, CA
ATTN: Director

Veterans Administration - RO
Boise, ID
ATTN: Director

Veterans Administration - RO
Detroit, MI
ATTN: Director

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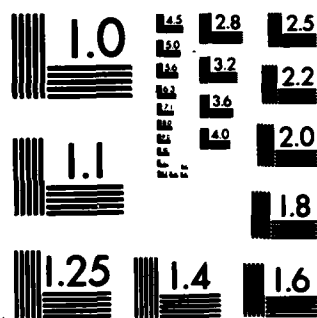
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OTHER GOVERNMENT AGENCIES (Continued)

Veterans administration - RO
Nashville, TN
ATTN: Director

The White House
ATTN: Domestic Policy Staff

DEPARTMENT OF DEFENSE CONTRACTORS

Advanced Research & Applications Corp
ATTN: H. Lee

JAYCOR
ATTN: A. Nelson
10 cy ATTN: Health & Environment Div

Kaman Tempo
6 cy ATTN: E. Martin
ATTN: DASAC

Kaman Tempo
ATTN: R. Miller

Kaman Tempo
10 cy ATTN: C. Jones

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ATTN: C. Robinette
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ATTN: National Materials Advisory Board

Pacific-Sierra Research Corp
ATTN: H. Brode, Chairman SAGE

R & D Associates
ATTN: P. Haas

Science Applications, Inc
ATTN: Tech Library

Science Applications, Inc
10 cy ATTN: L. Novotney

OTHER

Adams State College
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Akron Public Library
ATTN: Govt Publication Librarian

Alabama St Dept of Archives & History
ATTN: Military Records Division

University of Alabama
ATTN: Reference Dept/Documents

University of Alaska
ATTN: Director of Libraries

University of Alaska
ATTN: Govt Publication Librarian

OTHER (Continued)

Albany Public Library
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Alexander City State Jr College
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Allegheny College
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Allen County Public Library
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Altoona Area Public Library
ATTN: Librarian

American Statistics Index
ATTN: Cathy Jarvey

Anaheim Public Library
ATTN: Librarian

Andrews Library, College of Wooster
ATTN: Government Documents

Angelo State University Library
ATTN: Librarian

Angelo Jacoboni Pub Lib
ATTN: Librarian

Anoka County Library
ATTN: Librarian

Appalachian State University
ATTN: Library Documents

Arizona State University Library
ATTN: Librarian

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

Arkansas College Library
ATTN: Library

Arkansas Library Comm
ATTN: Library

Arkansas State University
ATTN: Library

University of Arkansas
ATTN: Government Documents Div

Austin College
Arthur Hopkins Library
ATTN: Librarian

Atlanta Public Library
ATTN: Ivan Allen Dept

Atlanta University Center
ATTN: Librarian

OTHER (Continued)

Auburn Univ at Montgomery Lib
ATTN: Librarian

B. Davis Schwartz Mem Lib
ATTN: Librarian

Bangor Public Library
ATTN: Librarian

Bates College Library
ATTN: Librarian

Baylor University Library
ATTN: Docs Dept

Beloit College Libraries
ATTN: Serials Docs Dept

Bemidji State College
ATTN: Library

Benjamin F. Feinberg Library
State University College
ATTN: Government Documents

Bierce Library, Akron University
ATTN: Government Documents

Boston Public Library
ATTN: Documents Department

Bowdoin College
ATTN: Librarian

Bowling Green State Univ
ATTN: Govt Docs Services

Bradley University
ATTN: Govt Publication Librarian

Brandeis University Lib
ATTN: Documents Section

Brigham Young University
ATTN: Librarian

Brigham Young University
ATTN: Documents Collection

Brookhaven National Laboratory
ATTN: Technical Library

Brooklyn College
ATTN: Documents Division

Broward County Library Sys
ATTN: Librarian

Brown University
ATTN: Librarian

Bucknell University
ATTN: Reference Dept

OTHER (Continued)

Buffalo & Erie Co Pub Lib
ATTN: Librarian

Burlington Library
ATTN: Librarian

California at Fresno State Univ Lib
ATTN: Library

California at San Diego University
ATTN: Documents Department

California at Stanislaus St Clg Lib
ATTN: Library

California St Polytechnic Univ Lib
ATTN: Librarian

California St Univ at Northridge
ATTN: Gov Doc

California State Library
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California State Univ at Long Beach Lib
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California State University
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California State University
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California Univ Library
ATTN: Govt Publications Dept

California Univ Library
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California University Library
ATTN: Govt Documents Dept

California University Library
ATTN: Documents Sec

California University
ATTN: Government Documents Dept

Calvin College Library
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Calvin T. Ryan Library
Kearney State College
ATTN: Govt Documents Dept

Carleton College Library
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Carnegie Library of Pittsburgh
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Carnegie Mellon University
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OTHER (Continued)

Carson Regional Library
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Case Western Reserve University
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University of Central Florida
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Central Michigan University
ATTN: Library Documents Section

Central Missouri State Univ
ATTN: Government Documents

Central State University
ATTN: Library Documents Dept

Central Washington University
ATTN: Library Docs Section

Central Wyoming College Library
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Charleston County Library
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Charlotte & Mecklenburg County Pub Lib
ATTN: E. Correll

Chattanooga Hamilton Co
ATTN: Librarian

Chesapeake Pub Lib System
ATTN: Librarian

Chicago Public Library
ATTN: Governments Publications Dept

State University of Chicago
ATTN: Librarian

Chicago University Library
ATTN: Director of Libraries
ATTN: Documents Processing

Cincinnati University Library
ATTN: Librarian

Claremont Colleges Libs
ATTN: Doc Collection

Clemson University
ATTN: Director of Libraries

Cleveland Public Library
ATTN: Documents Collection

Cleveland State Univ Lib
ATTN: Librarian

Coe Library
ATTN: Documents Division

OTHER (Continued)

Colgate Univ Library
ATTN: Reference Library

Colorado State Univ Libs
ATTN: Librarian

Colorado University Libraries
ATTN: Director of Libraries

Columbia University Library
ATTN: Documents Service Center

Columbus & Franklin Cty Public Lib
ATTN: Gen Rec Div

Compton Library
ATTN: Librarian

Connecticut State Library
ATTN: Librarian

University of Connecticut
ATTN: Govt of Connecticut

Connecticut University
ATTN: Director of Libraries

Cornell University Lib
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Corpus Christi State University Lib
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CSIA Library
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Culver City Library
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Curry College Library
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Dallas County Public Library
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Dallas Public Library
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Dalton Jr College Library
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Dartmouth College
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Davenport Public Library
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Davidson College
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Dayton & Montgomery City Pub Lib
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University of Dayton
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OTHER (Continued)

Decatur Public Library
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Dekalb Comm Coll So Cpus
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Delaware Pauw University
ATTN: Librarian

University of Delaware
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Delta College Library
ATTN: Librarian

Delta State University
ATTN: Librarian

Denison Univ Library
ATTN: Librarian

Denver Public Library
ATTN: Documents Div

Dept of Lib & Archives
ATTN: Librarian

Detroit Public Library
ATTN: Librarian

Dickinson State College
ATTN: Librarian

Drake Memorial Learning Resource Ctr
ATTN: Librarian

Drake University
ATTN: Cowles Library

Drew University
ATTN: Librarian

Duke University
ATTN: Public Docs Dept

Duluth Public Library
ATTN: Documents Section

Earlham College
ATTN: Librarian

East Carolina University
ATTN: Library Docs Dept

East Central University
ATTN: Librarian

East Islip Public Library
ATTN: Librarian

East Orange Public Lib
ATTN: Librarian

East Tennessee State Univ Sherrod Lib
ATTN: Documents Dept

OTHER (Continued)

East Texas State University
ATTN: Library

Eastern Branch
ATTN: Librarian

Eastern Illinois University
ATTN: Librarian

Eastern Kentucky University
ATTN: Librarian

Eastern Michigan University Lib
ATTN: Documents Libn

Eastern Montana College Library
ATTN: Documents Dept

Eastern New Mexico Univ
ATTN: Librarian

Eastern Oregon College Library
ATTN: Librarian

Eastern Washington Univ
ATTN: Librarian

El Paso Public Library
ATTN: Documents & Genealogy Dept

Elko County Library
ATTN: Librarian

Elmira College
ATTN: Librarian

Elon College Library
ATTN: Librarian

Enoch Pratt Free Library
ATTN: Documents Office

Emory University
ATTN: Librarian

Evansville & Vanderburgh County Pub Lib
ATTN: Librarian

Everett Public Library
ATTN: Librarian

Fairleigh Dickinson Univ
ATTN: Depository Dept

Florida A & M Univ
ATTN: Librarian

Florida Atlantic Univ Lib
ATTN: Div of Public Documents

Florida Institute of Tech Lib
ATTN: Federal Documents Dept

Florida Intl Univ Library
ATTN: Docs Section

OTHER (Continued)

Florida State Library
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Florida State University
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Fond Du Lac Public Lib
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Fort Hays State University
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Fort Worth Public Library
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Free Pub Lib of Elizabeth
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Free Public Library
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Freeport Public Library
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Fresno County Free Library
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Gadsden Public Library
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Garden Public Library
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Gardner Webb College
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Gary Public Library
ATTN: Librarian

Georgetown Univ Library
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Georgia Inst of Tech
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Georgia Southern College
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Georgia Southwestern College
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Georgia State Univ Lib
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University of Georgia
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Glassboro State College
ATTN: Librarian

Gleeson Library
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OTHER (Continued)

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ATTN: Director of Libraries

Graceland College
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Grand Forks Public City-County Library
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Grand Rapids Public Library
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Greenville County Library
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Guam RFK Memorial University Lib
ATTN: Fed Depository Collection

University of Guam
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Gustavus Adolphus College
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Hardin-Simmons University Library
ATTN: Librarian

Hartford Public Library
ATTN: Librarian

Harvard College Library
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University of Hawaii
ATTN: Government Docs Collection

Hawaii State Library
ATTN: Federal Documents Unit

University of Hawaii at Monoa
ATTN: Director of Libraries

University of Hawaii
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Haydon Burns Library
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Henry Ford Comm College Lib
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Herbert H. Lehman College
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Hofstra Univ Library
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Hoover Institution
ATTN: J. Bingham

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University of Houston, Library
ATTN: Documents Div

Houston Public Library
ATTN: Librarian

Hoyt Public Library
ATTN: Librarian

Humboldt State College Library
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Huntington Park Library
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Hutchinson Public Library
ATTN: Librarian

Idaho Public Lib & Info Center
ATTN: Librarian

Idaho State Library
ATTN: Librarian

Idaho State University Library
ATTN: Documents Dept

University of Idaho
ATTN: Documents Sect
ATTN: Dir of Libraries

University of Illinois, Library
ATTN: Documents Section

Illinois State Library
ATTN: Government Documents Branch

Illinois Univ at Urbana Champaign
ATTN: P. Watson, Documents Library

Illinois Valley Comm Coll
ATTN: Library

Indiana State Library
ATTN: Serial Section

Indiana State University
ATTN: Documents Libraries

Indiana University Library
ATTN: Documents Department

Indianapolis Marion Cty Pub Library
ATTN: Social Science Div

Iowa State University Library
ATTN: Govt Documents Dept

Iowa University Library
ATTN: Government Documents Dept

OTHER (Continued)

Butler University, Irwin Library
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Isaac Delchdo College
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James Madison University
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Jefferson County Public Lib
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Jersey City State College
ATTN: Librarian

Johns Hopkins University
ATTN: Documents Library

John J. Wright Library, La Roche College
ATTN: Librarian

Johnson Free Public Lib
ATTN: Librarian

Kahului Library
ATTN: Librarian

Kalamazoo Public Library
ATTN: Librarian

Kansas City Public Library
ATTN: Documents Div

Kansas State Library
ATTN: Librarian

Kansas State Univ Library
ATTN: Documents Dept

University of Kansas
ATTN: Director of Libraries

Kent State University Library
ATTN: Documents Div

Kentucky Dept of Library & Archives
ATTN: Documents Section

University of Kentucky
ATTN: Governments Publication Dept
ATTN: Director of Libraries

Kenyon College Library
ATTN: Librarian

Lake Forest College
ATTN: Librarian

Lake Sumter Comm Coll Lib
ATTN: Librarian

Lakeland Public Library
ATTN: Librarian

OTHER (Continued)

Lancaster Regional Library
ATTN: Librarian

Lawrence University
ATTN: Documents Dept

Lee Library, Brigham Young University
ATTN: Documents & Map Section

Library & Statutory Distribution & Svc
2 cy ATTN: Librarian

Little Rock Public Library
ATTN: Librarian

Long Beach Publ Library
ATTN: Librarian

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

Louisiana State University
ATTN: Government Doc Dept
ATTN: Director of Libraries

Louisville Free Pub Lib
ATTN: Librarian

Louisville Univ Library
ATTN: Librarian

Lyndon B. Johnson Sch of Pub Affairs Lib
ATTN: Librarian

Maine Maritime Academy
ATTN: Librarian

Maine University at Orono
ATTN: Librarian

University of Maine
ATTN: Librarian

Manchester City Library
ATTN: Librarian

Mankato State College
ATTN: Govt Publications

Mantor Library
Univ of Maine at Farmington
ATTN: Director of Libraries

Marathon County Public Library
ATTN: Librarian

Marshall Brooks Library
ATTN: Librarian

University of Maryland
ATTN: McKeldin Libr Docs Div

University of Maryland
ATTN: Librarian

OTHER (Continued)

University of Massachusetts
ATTN: Government Docs College

McNeese State Univ
ATTN: Librarian

Memphis Shelby County Pub Lib & Info Ctr
ATTN: Librarian

Memphis State University
ATTN: Librarian

Mercer University
ATTN: Librarian

Mesa County Public Library
ATTN: Librarian

University of Miami, Library
ATTN: Government Publications

Miami Public Library
ATTN: Documents Division

Miami Univ Library
ATTN: Documents Dept

Michel Orradre Library
University of Santa Clara
ATTN: Documents Div

Michigan State Library
ATTN: Librarian

Michigan State University Library
ATTN: Librarian

Michigan Tech University
ATTN: Library Documents Dept

University of Michigan
ATTN: Acq Sec Documents Unit

Middlebury College Library
ATTN: Librarian

Millersville State Coll
ATTN: Librarian

Milne Library
State University of New York
ATTN: Docs Librn

Milwaukee Pub Lib
ATTN: Librarian

Minneapolis Public Lib
ATTN: Librarian

Minnesota Div of Emergency Svcs
ATTN: Librarian

Minot State College
ATTN: Librarian

Mississippi State University
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OTHER (Continued)

University of Mississippi
ATTN: Director of Libraries

Missouri Univ at Kansas City Gen
ATTN: Librarian

Missouri University Library
ATTN: Government Documents

M.I.T. Libraries
ATTN: Librarian

Mobile Public Library
ATTN: Governmental Info Division

Moffett Library
ATTN: Librarian

Montana State Library
ATTN: Librarian

Montana State University, Library
ATTN: Librarian

University of Montana
ATTN: Documents Div

Moorhead State College
ATTN: Library

Mt Prospect Public Lib
ATTN: Librarian

Murray State Univ Lib
ATTN: Library

Nassau Library System
ATTN: Librarian

Natrona County Public Library
ATTN: Librarian

Nebraska Library Comm
ATTN: Librarian

Univ of Nebraska at Omaha
ATTN: Librarian

Nebraska Western College Library
ATTN: Librarian

Univ of Nebraska at Lincoln
ATTN: Director of Libraries

Univ of Nevada at Reno
ATTN: Governments Pub Dept

Univ of Nevada at Las Vegas
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New Hampshire University Lib
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New Hanover County Public Library
ATTN: Librarian

Nebraska University
ATTN: Director of Libraries

OTHER (Continued)

New Mexico State Library
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New Mexico State University
ATTN: Lib Documents Div

University of New Mexico
ATTN: Director of Libraries

University of New Orleans Library
ATTN: Govt Documents Div

New Orleans Public Lib
ATTN: Library

New York Public Library
ATTN: Librarian

New York State Library
ATTN: Doc Control, Cultural Ed Ctr

New York State Univ at Stony Brook
ATTN: Main Lib Doc Sect

New York State Univ Col at Cortland
ATTN: Librarian

State Univ of New York
ATTN: Library Documents Sec

State Univ of New York
ATTN: Librarian

New York State University
ATTN: Documents Center

State University of New York
ATTN: Documents Dept

New York University Library
ATTN: Documents Dept

Newark Free Library
ATTN: Librarian

Newark Public Library
ATTN: Librarian

Niagara Falls Pub Lib
ATTN: Librarian

Nicholls State Univ Library
ATTN: Docs Div

Nieves M. Flores Memorial Lib
ATTN: Librarian

Norfolk Public Library
ATTN: R. Parker

North Carolina Agri & Tech State Univ
ATTN: Librarian

Univ of North Carolina at Charlotte
ATTN: Atkins Library Documents Dept

Univ of North Carolina at Greensboro, Library
ATTN: Librarian

OTHER (Continued)

North Carolina Central University
ATTN: Librarian

North Carolina State University
ATTN: Librarian

North Carolina University at Wilmington
ATTN: Librarian

University of North Carolina
ATTN: BA SS Division Documents

North Dakota State University Lib
ATTN: Docs Librarian

University of North Dakota
ATTN: Librarian

North Georgia College
ATTN: Librarian

North Texas State University Library
ATTN: Librarian

Northeast Missouri State University
ATTN: Librarian

Northeastern Illinois University
ATTN: Library

Northeastern Oklahoma State Univ
ATTN: Librarian

Northeastern University
ATTN: Dodge Library

Northern Arizona University Lib
ATTN: Government Documents Dept

Northern Illinois University
ATTN: Librarian

Northern Iowa University
ATTN: Library

Northern Michigan Univ
ATTN: Documents

Northern Montana College Library
ATTN: Librarian

Northwestern Michigan College
ATTN: Librarian

Northwestern State Univ
ATTN: Librarian

Northwestern State Univ Library
ATTN: Librarian

Northwestern University Library
ATTN: Govt Publications Dept

Normal Public Library
ATTN: Librarian

OTHER (Continued)

University of Notre Dame
ATTN: Document Center

Oakland Comm College
ATTN: Librarian

Oakland Public Library
ATTN: Librarian

Oberlin College Library
ATTN: Librarian

Ocean County College
ATTN: Librarian

Ohio State University
ATTN: Libraries Documents Division

Ohio University Library
ATTN: Docs Dept

Oklahoma City University Library
ATTN: Librarian

Oklahoma City University Library
ATTN: Librarian

Oklahoma Dept of Libraries
ATTN: U.S. Govt Documents

University Library, Oklahoma
ATTN: Government Documents Collection

Old Dominion University
ATTN: Doc Dept Univ Library

Olivet College Library
ATTN: Librarian

Omaha Pub Lib Clark Branch
ATTN: Librarian

Oregon State Library
ATTN: Librarian

University of Oregon
ATTN: Documents Section

Quachita Baptist University
ATTN: Librarian

Pan American University Library
ATTN: Librarian

Passaic Public Library
ATTN: Librarian

Paul Klapper Library
ATTN: Documents Dept

Pennsylvania State Library
ATTN: Government Publications Section

OTHER (Continued)

Pennsylvania State University
ATTN: Library Document Sec

University of Pennsylvania
ATTN: Director of Libraries

Penrose Library
University of Denver
ATTN: Penrose Library

Peoria Public Library
ATTN: Business, Science & Tech Dept

Free Library of Philadelphia
ATTN: Govt Publications Dept

Philipsburg Free Public Library
ATTN: Library

Phoenix Public Library
ATTN: Librarian

University of Pittsburg
ATTN: Documents Office G 8

Plainfield Public Library
ATTN: Librarian

Popular Creek Public Lib District
ATTN: Librarian

Association of Portland Lib
ATTN: Librarian

Portland Public Library
ATTN: Librarian

Portland State University Library
ATTN: Librarian

Prescott Memorial Lib
Louisiana Tech Univ
ATTN: Librarian

Princeton University Library
ATTN: Documents Division

Providence College
ATTN: Librarian

Providence Public Library
ATTN: Librarian

Cincinnati & Hamilton County Public Library
ATTN: Librarian

Public Library of Nashville and Davidson County
ATTN: Library

University of Puerto Rico
ATTN: Doc & Maps Room

Purdue University Library
ATTN: Librarian

OTHER (Continued)

Quinebaug Valley Community Col
ATTN: Librarian

Ralph Brown Draughon Lib
Auburn University
ATTN: Microforms & Documents Dept

Rapid City Public Library
ATTN: Librarian

Reading Public Library
ATTN: Librarian

Reed College Library
ATTN: Librarian

Reese Library
Augusta College
ATTN: Librarian

University of Rhode Island Library
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University of Rhode Island
ATTN: Director of Libraries

Rice University
ATTN: Director of Libraries

Richard W. Norton Mem Lib
Louisiana College
ATTN: Librarian

Richland County Pub Lib
ATTN: Librarian

University of Richmond
ATTN: Library

Riverside Public Library
ATTN: Librarian

University of Rochester Library
ATTN: Documents Section

Rutgers University, Camden Library
ATTN: Librarian

Rutgers State University
ATTN: Librarian

Rutgers University
ATTN: Director of Libraries

Rutgers University Law Library
ATTN: Federal Documents Dept

Salem College Library
ATTN: Librarian

Samford University
ATTN: Librarian

San Antonio Public Library
ATTN: Bus Science & Tech Dept

OTHER (Continued)

San Diego County Library
ATTN: C. Jones, Acquisitions

San Diego Public Library
ATTN: Librarian

San Diego State University Library
ATTN: Govt Pubs Dept

San Francisco Public Library
ATTN: Govt Documents Dept

San Francisco State College
ATTN: Govt Pub Collection

San Jose State College Library
ATTN: Documents Dept

San Luis Obispo City-County Library
ATTN: Librarian

Savannah Pub & Effingham Libty Reg Lib
ATTN: Librarian

Scottsbluff Public Library
ATTN: Librarian

Scranton Public Library
ATTN: Librarian

Seattle Public Library
ATTN: Ref Doc Asst

Selby Public Library
ATTN: Librarian

Shawnee Library System
ATTN: Librarian

Shreve Memorial Library
ATTN: Librarian

Silas Bronson Public Library
ATTN: Librarian

Simon Schwob Mem Lib
Columbus College
ATTN: Librarian

Sioux City Public Library
ATTN: Librarian

Skidmore College
ATTN: Librarian

Slippery Rock State College Library
ATTN: Librarian

South Carolina State Library
ATTN: Librarian

University of South Carolina
ATTN: Librarian

OTHER (Continued)

University of South Carolina
ATTN: Government Documents

South Dakota Sch of Mines & Tech
ATTN: Librarian

South Dakota State Library
ATTN: Federal Documents Department

University of South Dakota
ATTN: Documents Librarian

South Florida University Library
ATTN: Librarian

Southdale-Hennepin Area Library
ATTN: Government Documents

Southeast Missouri State University
ATTN: Librarian

Southeastern Massachusetts University Library
ATTN: Documents Sec

University of Southern Alabama
ATTN: Librarian

Southern California University Library
ATTN: Documents Dept

Southern Connecticut State College
ATTN: Library

Southern Illinois University
ATTN: Librarian

Southern Illinois University
ATTN: Documents Ctr

Southern Methodist University
ATTN: Librarian

University of Southern Mississippi
ATTN: Library

Southern Oregon College
ATTN: Library

Southern University in New Orleans, Library
ATTN: Librarian

Southern Utah State College Library
ATTN: Documents Department

Southwest Missouri State College
ATTN: Library

Southwestern University of Louisiana, Libraries
ATTN: Librarian

Southwestern University School of Law Library
ATTN: Librarian

OTHER (Continued)

Spokane Public Library
ATTN: Reference Dept

Springfield City Library
ATTN: Documents Section

St. Bonaventure University
ATTN: Librarian

St. Joseph Public Library
ATTN: Librarian

St. Lawrence University
ATTN: Librarian

St. Louis Public Library
ATTN: Librarian

St. Paul Public Library
ATTN: Librarian

Stanford University Library
ATTN: Govt Documents Dept

State Historical Soc Lib
ATTN: Docs Serials Section

State Library of Massachusetts
ATTN: Librarian

State University of New York
ATTN: Librarian

Stetson Univ
ATTN: Librarian

University of Steubenville
ATTN: Librarian

Stockton & San Joaquin Public Lib
ATTN: Librarian

Stockton State College Library
ATTN: Librarian

Superior Public Library
ATTN: Librarian

Swarthmore College Lib
ATTN: Reference Dept

Syracuse University Library
ATTN: Documents Div

Tacoma Public Library
ATTN: Librarian

Tampa, Hillsborough County Public Lib
ATTN: Librarian

Temple University
ATTN: Librarian

Tennessee Technological University
ATTN: Librarian

OTHER (Continued)

University of Tennessee
ATTN: Dir of Libraries

Terteling Library
College of Idaho
ATTN: Librarian

Texas A & M University Library
ATTN: Librarian

University of Texas at Arlington
ATTN: Library Documents

University of Texas at San Antonio
ATTN: Library

Texas Christian University
ATTN: Librarian

Texas State Library
ATTN: U.S. Documents Sect

Texas Tech University Library
ATTN: Govt Docs Dept

Texas University at Austin
ATTN: Documents Coll

Texas University at El Paso
ATTN: Documents and Maps Lib

University of Toledo Library
ATTN: Librarian

Toledo Public Library
ATTN: Social Science Dept

Torrance Civic Center Library
ATTN: Librarian

Traverse City Public Library
ATTN: Librarian

Trenton Free Public Library
ATTN: Librarian

Trinity College Library
ATTN: Librarian

Trinity University Library
ATTN: Documents Collection

Tufts University Library
ATTN: Documents Dept

Tulane University
ATTN: Documents Dept

University of Tulsa
ATTN: Librarian

UCLA Research Library
ATTN: Public Affairs Svc/US Docs

State Library of Ohio
ATTN: Librarian

OTHER (Continued)

Uniformed Svcs Univ of the Hlth Sci
ATTN: LRC Library

University Libraries
ATTN: Dir of Libraries

Upper Iowa College
ATTN: Documents Collection

Utah State University
ATTN: Librarian

University of Utah
ATTN: Special Collections

University of Utah
ATTN: Dept of Pharmacology
ATTN: Director of Libraries

Valencia Library
ATTN: Librarian

Vanderbilt University Library
ATTN: Govt Docs Sect

University of Vermont
ATTN: Director of Libraries

Virginia Commonwealth University
ATTN: Librarian

Virginia Military Institute
ATTN: Librarian

Virginia Polytechnic Inst Lib
ATTN: Docs Dept

Virginia State Library
ATTN: Serials Section

University of Virginia
ATTN: Public Documents

Volusia County Public Libraries
ATTN: Librarian

Washington State Library
ATTN: Documents Section

Washington State University
ATTN: Lib Documents Section

Washington University Libraries
ATTN: Dir of Libraries

University of Washington
ATTN: Documents Div

Wayne State University Library
ATTN: Librarian

Wayne State University Law Library
ATTN: Documents Dept

Weber State College Library
ATTN: Librarian

Wagner College
ATTN: Librarian

OTHER (Continued)

Wesleyan University
ATTN: Documents Librarian

West Chester State Coll
ATTN: Documents Dept

West Covina Library
ATTN: Librarian

University of West Florida
ATTN: Librarian

West Hills Community Coll
ATTN: Library

West Texas State University
ATTN: Library

West Virginia Coll of Grad Studies Lib
ATTN: Librarian

University of West Virginia
ATTN: Dir of Libraries

Westerly Public Library
ATTN: Librarian

Western Carolina University
ATTN: Librarian

Western Illinois University Lib
ATTN: Librarian

Western Washington Univ
ATTN: Librarian

Western Wyoming Community College Lib
ATTN: Librarian

Westmoreland Cty Comm Coll
ATTN: Learning Resource Ctr

Whitman College
ATTN: Librarian

Wichita State Univ Library
ATTN: Librarian

William & Mary College
ATTN: Docs Dept

William Allen White Library
Emporia Kansas State College
ATTN: Govt Documents Div

William College Library
ATTN: Librarian

Willimantic Public Library
ATTN: Librarian

Winthrop College
ATTN: Documents Dept

University of Wisconsin at Whitewater
ATTN: Governments Documents Library

OTHER (Continued)

Wisconsin Milwaukee University
ATTN: Librarian

Wisconsin Oshkosh University
ATTN: Librarian

Wisconsin Platteville University
ATTN: Librarian

Wisconsin University at Stevens Point
ATTN: Docs Section

University of Wisconsin
ATTN: Govt Pubs Dept

University of Wisconsin
ATTN: Acquisitions Dept

Worcester Public Library
ATTN: Librarian

OTHER (Continued)

Yale University
ATTN: Director of Libraries

Yeshiva University
ATTN: Librarian

Yuma City County Library
ATTN: Librarian

Wright State Univ Library
ATTN: Govts Documents Dept

Wyoming State Library
ATTN: Librarian

University of Wyoming
ATTN: Documents Div