

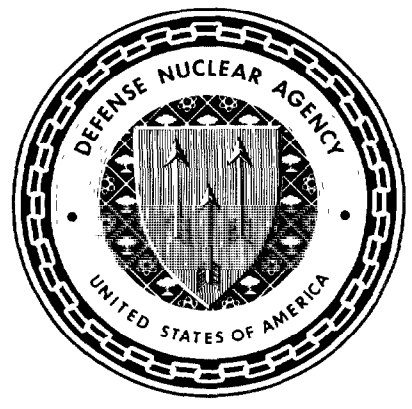
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# SHOT SIMON

## A Test of the UPSHOT-KNOTHOLE Series 25 APRIL 1953



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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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  This report describes the activities performed by DOD personnel, both civilian and military, at SHOT SIMON, the seventh nuclear test in the UPSHOT-KNOTHOLE atmospheric nuclear weapons testing series. SIMON had an expected yield of 35 kilotons, but its actual yield was 43 kilotons. The test was conducted on 25 April 1953 and involved participants from Exercise Desert Rock V, AFSWP, AFSWC, and the AEC test groups. The Tactical Troop Maneuver involved about 2,450 Army personnel. The Volunteer Observer Program had eight participants: seven from the Army and one from the Navy.		

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## PREFACE

Between 1945 and 1962, the United States Government, through the Manhattan Engineer District and its successor agency, the Atomic Energy Commission (AEC), conducted 235 atmospheric nuclear weapons tests at sites in the southwestern 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 were present at the atmospheric nuclear weapons tests conducted at the Nevada Proving Ground (NPG),\* northwest of Las Vegas, Nevada.

In 1977, 15 years after the last above-ground weapons test, the Center for Disease Control<sup>+</sup> noted a possible leukemia cluster among a small group of soldiers present at Shot SMOKY, one weapons-related test of Operation PLUMBBOB, the series of atmospheric nuclear weapons tests conducted in 1957. Since that initial report by the Center for Disease Control, the Veterans Administration has received a number of claims for medical benefits from former military personnel who believe their health may have been affected by their participation in the atmospheric nuclear weapons tests.

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

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

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\*Renamed the Nevada Test Site in 1955.

<sup>+</sup>The Center for Disease Control, an agency of the U.S. Department of Health, Education, and Welfare (now the U.S. Department of Health and Human Services).

- Determine the extent of the participants' exposure to ionizing radiation
- Provide public disclosure of information concerning participation by DOD personnel in the atmospheric nuclear weapons tests.

This report on Shot SIMON is based on the military and technical documents associated with the atmospheric nuclear weapons test event.

#### METHODS AND SOURCES USED TO PREPARE THIS VOLUME

Many of the documents pertaining specifically to DOD involvement during Shot SIMON, the seventh event of the UPSHOT-KNOTHOLE Series, were found in the Defense Nuclear Agency Technical Library, the Department of Energy Nevada Operations Office, the Los Alamos National Laboratory,\* and the Modern Military Branch of the National Archives.

In most cases, the surviving historical documentation of activities conducted at Shot SIMON addresses test specifications and technical information, rather than personnel data. The available historical documentation sometimes has inconsistencies in vital facts. Efforts have been made to resolve these inconsistencies wherever possible, or otherwise to bring them to the attention of the reader.

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 1-53." These sources detail the plans developed by DOD and AEC personnel prior to the UPSHOT-KNOTHOLE Series. It is not known if all of

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\*Formerly Los Alamos Scientific Laboratory (LASL)

the projects addressed in these planning documents were conducted exactly as planned. Although some of the after-action documents, such as the Armed Forces Special Weapons Project weapons test reports, summarize the projects performed during the UPSHOT-KNOTHOLE 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.

To facilitate use of references, this volume uses weapons test report titles for each project. All yield 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 tests, concerning fallout patterns, meteorological conditions, and 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.

#### ORGANIZATION AND CONTENT OF OPERATION UPSHOT-KNOTHOLE REPORTS

This volume details participation by DOD personnel in Shot SIMON, the seventh detonation of the Operation UPSHOT-KNOTHOLE atmospheric nuclear weapons testing series. Four other publications address DOD activities during the UPSHOT-KNOTHOLE Series:

- Series volume: Operation UPSHOT-KNOTHOLE, Atmospheric Nuclear Weapons Tests, 1953
- Shot volume: Shots ANNIE to RAY, the First Five UPSHOT-KNOTHOLE Tests
- Shot volume: Shot BADGER
- Shot volume: Shots ENCORE to CLIMAX, the Final Four UPSHOT-KNOTHOLE Tests.

The volumes addressing the test events of Operation UPSHOT-KNOTHOLE have been designed to complement one another. The

series volume describes those dimensions of Operation UPSHOT-KNOTHOLE that apply to the series as a whole, such as historical background, organizational relationships, and radiological safety procedures. In addition, that volume discusses the overall objectives of the operation, describes the geographic layout of the NPG, and contains a bibliography of works consulted in the preparation of all five Operation UPSHOT-KNOTHOLE reports.

The single-shot volumes describe DOD participation in Shots BADGER and SIMON, and the multi-shot volumes combine shot-specific descriptions of the other nuclear events of the UPSHOT-KNOTHOLE Series. The shot and multi-shot volumes list only the sources referenced in each text. Descriptions of activities concerning any particular shot in the UPSHOT-KNOTHOLE Series, whether the shot is addressed in a single-shot volume or in a multi-shot volume, should be supplemented by the general organizational and radiological safety information contained in the Operation UPSHOT-KNOTHOLE volume.

This volume is divided into four chapters: an introduction, two chapters on DOD activities, and a final chapter on radiation protection. It examines the activities of DOD personnel before, during, and after the SIMON event, focusing on their movements relative to the radiological environment. The procedures designed to ensure personnel safety, including exposure records indicating the effectiveness of those procedures, are discussed in chapter 4 whenever that information is available.

The information in this report is supplemented by the Reference Manual: Background Materials for the CONUS Volumes. The Reference Manual summarizes the basics of radiation physics, radiation health concepts, exposure criteria, and measurement techniques, as well as listing acronyms and terms used in the reports documenting the 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
BCT	Battalion Combat Team
BJY	BUSTER-JANGLE Y
DOD	Department of Defense
EG&G	Edgerton, Germeshausen, and Grier, Incorporated
FCDA	Federal Civil Defense Administration
HumRRO	Human Resources Research Office
IBDA	Indirect Bomb Damage Assessment
JTO	Joint Test Organization
LASL	Los Alamos Scientific Laboratory
NPG	Nevada Proving Ground
R/h	roentgens per hour
SAC	Strategic Air Command
UTM	Universal Transverse Mercator

SIMON

SHOT SYNOPSIS

AEC TEST SERIES: UPSHOT-KNOTHOLE  
DOD EXERCISE: DESERT ROCK V  
DATE/TIME: 25 April 1953, 0430 hours  
YIELD: 43 kilotons  
HEIGHT OF BURST: 300 feet (tower)

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

DOD Objective: To evaluate military equipment, tactics, and doctrine and to provide training for troops in a tactical maneuver involving a nuclear detonation.

Weather: At shot-time, the winds at surface level were north-northwest at five knots. At all levels above 10,000 feet, the wind was from the west. At 40,000 feet, it was at 48 knots. The surface temperature was 11.7°C, the relative humidity was 26 percent, and the pressure was 870 millibars.

Radiation Data: SIMON had a yield considerably greater than predicted. Onsite fallout occurred mostly to the east of ground zero. In other directions, intensities greater than 0.1 R/h (at the time of the initial survey completed at 0730 hours) were confined to an area extending two kilometers from ground zero. Intensities greater than 1.0 R/h were within a two-kilometer radius of ground zero.

Participants: Exercise Desert Rock V participants, including the Helicopter Atomic Test Unit from the 2d Marine Corps Provisional Atomic Exercise Brigade; Armed Forces Special Weapons Project; Los Alamos Scientific Laboratory, Air Force Special Weapons Center; contractors.

## CHAPTER 1

### INTRODUCTION

Shot SIMON was detonated at 0430 hours Pacific Standard Time on 25 April 1953 at the Nevada Proving Ground, the Atomic Energy Commission continental nuclear test site located northwest of Las Vegas. It was the seventh test of Operation UPGHOT-KNOTHOLE, a series of 11 atmospheric nuclear weapons tests conducted from 17 March to 4 June 1953. Shot SIMON was fired on a 300-foot steel tower in Area 1 of Yucca Flat, UTM coordinates 798009,\* nearly 50 kilometers<sup>+</sup> from Camp Mercury and Camp Desert Rock. Figure 1-1 shows the location of the SIMON detonation in relation to the other ten events of Operation UPGHOT-KNOTHOLE. The detonation had a yield equivalent to 43 kilotons of TNT, considerably greater than the predicted yield of 35 kilotons.

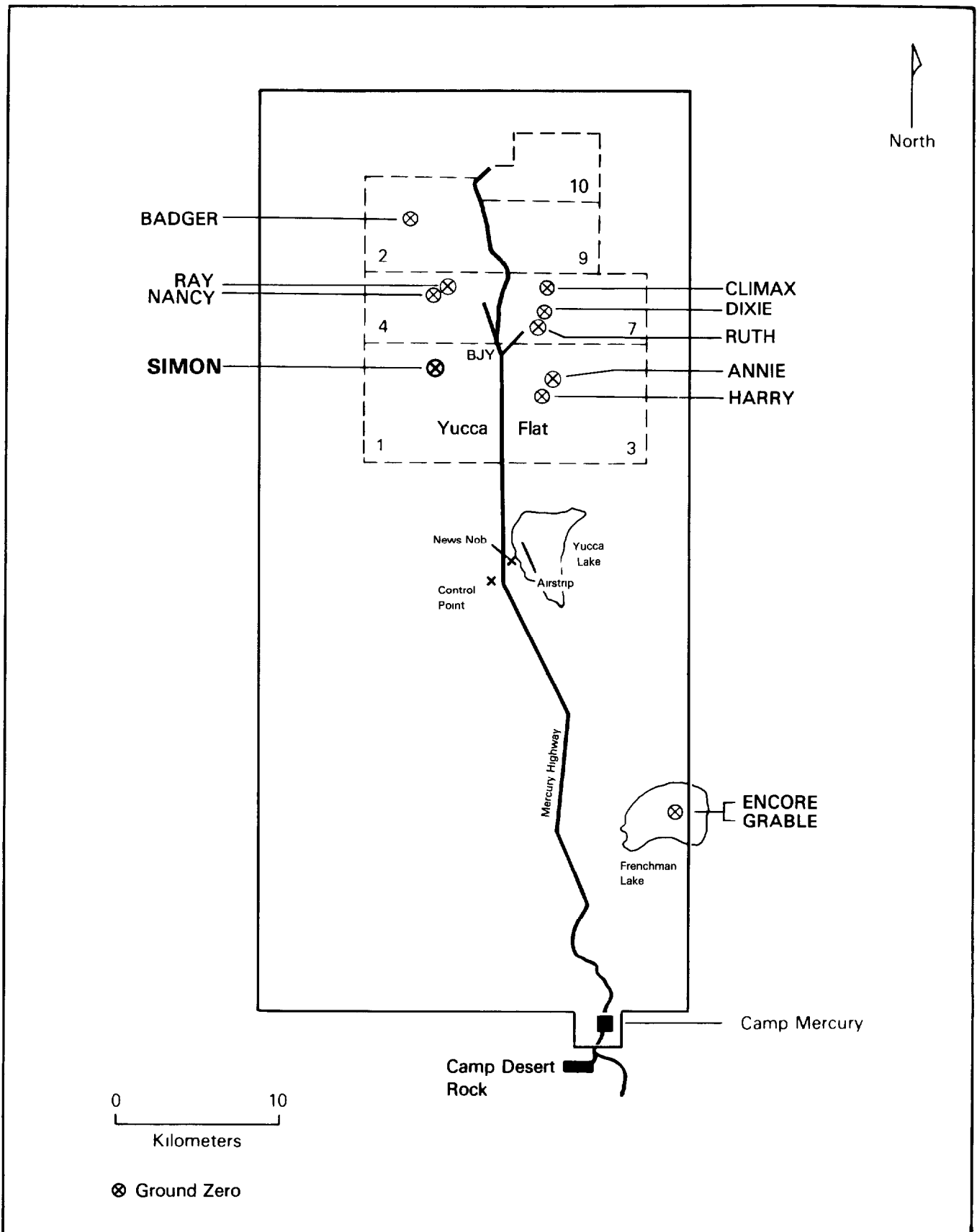
The top of the cloud resulting from Shot SIMON rose to an altitude of 44,000 feet.\*\* At 40,000 feet, the wind was from the west at 48 knots. Radioactive fallout occurred on the main access road and at several stations in Yucca Flat, which prevented early instrument-recovery operations. Offsite, fallout on U.S. 91 and 93 north of Glendale, Nevada, was such that the Test Director ordered roadblocks to be established on these highways. This was the first time any of the continental tests had required

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\*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.

<sup>+</sup>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 kilometer = 0.62 miles.

\*\*Altitudes are measured from mean sea level, while heights are measured from the ground. All vertical distances are given in feet.



**Figure 1-1: LOCATION OF SHOT SIMON IN THE NEVADA PROVING GROUND**

roadblocks off the NPG to monitor vehicles for radioactive contamination (12; 20; 24).\*

The SIMON device was developed for the Atomic Energy Commission by the Los Alamos Scientific Laboratory, one of two AEC nuclear weapons development laboratories. The device was experimental, and its detonation was designed to permit evaluation of the yield, blast, thermal, and radiological phenomena associated with it (12; 20; 24).

#### 1.1 DEPARTMENT OF DEFENSE PARTICIPATION AT SHOT SIMON

Department of Defense personnel took part in three types of activities at Shot SIMON, as at other shots in Operation UPSHOT-KNOTHOLE: scientific experiments, military technical and training projects, and support services. The Weapons Development Group, the Military Effects Group, and the Civil Effects Group conducted the scientific experiments. Various armed services personnel on temporary assignment from stations throughout the country conducted the military technical and training projects, known as Exercise Desert Rock V. Camp Desert Rock troops, elements of the Joint Test Organization (JTO), and Air Force Special Weapons Center (AFSWC) personnel provided support services.

In the area of scientific experimentation, the two AEC weapons development laboratories, the Los Alamos Scientific Laboratory and the University of California Radiation Laboratory, collaborated to form the Weapons Development Group. This test group studied the characteristics of the various UPSHOT-KNOTHOLE detonations in an effort to develop more sophisticated nuclear

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\*All sources cited in the text are listed alphabetically and numbered in the Reference List at the end of this volume. The number given in the text is the number of the source document in the Reference List.

weapons. At Shot SIMON, the Weapons Development Group performed 23 experiments to study the effects of the detonation, all of which were conducted by LASL. DOD personnel assisted in five of these experiments. The Military Effects Group, sponsored by Field Command, Armed Forces Special Weapons Project (AFSWP), conducted 27 scientific experiments to determine specific applications of the nuclear devices against a variety of military targets. DOD personnel conducted all of these experiments. The Federal Civil Defense Administration (FCDA) Civil Effects Group conducted ten experiments that dealt with civil defense shelter durability and the effects of radiation on living organisms and drugs. DOD personnel assisted in two of these experiments. Participants in test group projects generally fielded data collection instruments at various distances around ground zero in the days and weeks before the scheduled detonation. They returned and recovered the equipment sometime after the detonation, when the Test Manager had determined that the radiological environment in the test area would permit limited access (12; 22).

Exercise Desert Rock V technical and training projects at Shot SIMON included an orientation and indoctrination program in which the participants witnessed the nuclear detonation from trenches and then viewed the effects of the detonation on military equipment. In addition, volunteer officer observers witnessed the detonation from trenches closer to ground zero than those used by the other observers. At Shot SIMON, Exercise Desert Rock V also included a troop maneuver in the shot area, as well as helicopter tests conducted by the Marine Corps (32; 34).

Exercise Desert Rock V programs generally accounted for the greatest number of DOD participants during UPSHOT-KNOTHOLE tests, and Shot SIMON was no exception. In contrast to the various scientific experiments, which involved an estimated 350 DOD personnel, the number of Exercise Desert Rock V participants at Shot SIMON is estimated at more than 3,000. Most of these



individuals participated in SIMON only, unlike members of the test groups who may have been active at the test site throughout Operation UPHOT-KNOTHOLE (12; 22; 32; 34).

A variety of support services were required by Desert Rock and test group personnel, as well as by the Test Manager, who was responsible for the execution of the tests. About 170 soldiers from the 9778th Radiological Safety Support Unit from Fort McClellan, Alabama, provided onsite radiological safety monitoring for the Test Manager. Approximately 2,000 soldiers from various Army units maintained and operated Camp Desert Rock, an installation of the U.S. Sixth Army. These personnel administered Exercise Desert Rock V activities and performed various services. Support troops worked in the forward areas of the NPG to construct observer trenches, lay communication lines, provide transportation and security, and assist in other preparations for Desert Rock activities. Soldiers of the 50th Chemical Service Platoon served as radiological safety monitors for Exercise Desert Rock participants during the nuclear tests (33).

JTO support elements included AEC construction contractors and radiological safety personnel. The construction contractors assisted test group personnel in building structures used in the projects. The radiological safety unit conducted an initial radiological survey of the project instrumentation areas immediately after the detonation, briefed personnel on the radiological environment, issued access permits to them, established checkpoints through which personnel entered the areas to recover experiments, provided extra monitors to recovery parties, and monitored and, if necessary, decontaminated personnel and vehicles as they left the forward area.

The Air Force Special Weapons Center also performed a number of support tasks. Based at Kirtland Air Force Base (AFB) in Albuquerque, New Mexico, AFSWC personnel performed cloud-sampling

and cloud-tracking missions, aerial surveys, and courier services for the Test Manager (21).

At Shot SIMON, as at all shots in Operation UPSHOT-KNOTHOLE, the Joint Test Organization coordinated all activities. Comprising personnel from the AEC, the DOD, and the FCDA, the JTO was supervised by the Test Manager, assisted by the Test Director. The UPSHOT-KNOTHOLE Series volume contains a detailed description of their duties and the functions of the Joint Test Organization.

## 1.2 RADIATION PROTECTION PROCEDURES DURING SHOT SIMON

In carrying out their tasks, DOD participants followed the radiation protection procedures established to minimize exposure to ionizing radiation while still allowing participants to accomplish their missions.

The AEC Division of Biology and Medicine established exposure limits for JTO participants, including test group and AFSWP personnel. Test group participants were to receive no more than 3.9 roentgens of radiation exposure during any 13-week period. To help implement this criterion, radiological safety personnel controlled access to radiation areas. In addition, radiological safety monitors accompanied project personnel recovering test instruments from highly radioactive areas. The monitors, who continuously monitored the radiation intensity in the recovery area, kept the participants informed of the radiological environment. The 9778th Radiological Safety Support Unit issued film badges for project personnel to wear at all times in the test area. These film badges were collected, developed, and evaluated at regular intervals, and any individual whose accumulated dose exceeded the established limits was barred from further participation in project activities in the forward area. Although evacuation was not required during UPSHOT-KNOTHOLE, emergency evacuation procedures were prepared for all test events (1; 14; 20; 34).

The radiation protection procedures authorized for AFSWC by the Test Manager included the same cumulative exposure limit of 3.9 roentgens of gamma radiation for air and ground crews as that established for the test group personnel. Complete decontamination, including showers and exchanges of clothing, was required of all aircrew members following each project mission, regardless of the exposure received on the flight. Aircraft were either decontaminated by washing or were isolated until radiation intensities decayed to predetermined levels (14; 20-21).

Radiation protection procedures for Exercise Desert Rock V participants, like those of the test groups and AFSWC, were designed to minimize potential exposure to ionizing radiation. Camp Desert Rock personnel and exercise participants, with the exception of the eight volunteer officer observers, were limited to no more than 6.0 roentgens of whole-body gamma radiation during any six-month period. The volunteer officer observers were limited to 10.0 roentgens per test, with no more than 25 roentgens for the entire operation. The Office, Chief of Army Field Forces, established these limits, subject to AEC approval (32; 50).

## CHAPTER 2

### EXERCISE DESERT ROCK V OPERATIONS AT SHOT SIMON

Department of Defense personnel participated in five Exercise Desert Rock V programs at Shot SIMON. In all, more than 3,000 soldiers took part in these Desert Rock activities. Table 2-1 lists the Desert Rock programs conducted at Shot SIMON and includes the estimated number of DOD personnel who took part in each program.

**Table 2-1: EXERCISE DESERT ROCK V ACTIVITIES AT SHOT SIMON**

Program	Participating Service	Estimated DOD Personnel
Troop Orientation and Indoctrination (Observers)	Army Navy Air Force Marine Corps	198 13 340 1
Volunteer Officer Observers	Army Navy	7 1
Tactical Troop Maneuvers	Army	2,450
Operational Helicopter Tests	Marine Corps	8
Damage Effects Evaluation	Army	*

\*Unknown

Personnel from Army Field Forces Human Research Unit No. 2 from the Human Resources Research Office (HumRRO) investigated the psychological reactions of these troops to Shot SIMON. These research personnel were present at all shots with provisional Battalion Combat Team (BCT) participation. The HumRRO unit administered a questionnaire to the troops before and after the shot. HumRRO investigators also interviewed the volunteer officer observers (32; 63).

## 2.1 CAMP DESERT ROCK PERSONNEL

Camp Desert Rock personnel provided support services to the exercise troops at Shot SIMON. Personnel were assigned to Camp Desert Rock from the following units to perform the tasks listed (32-33):

- Company C, 505th Military Police Battalion, provided direction and control of military vehicles.
- The 505th Signal Service Group (Composite Company) operated the public address system in the trench and parking areas and the mobile system, composed of four vehicles outfitted with speakers. They also were responsible for the radio system used by the radiological safety monitors and Control Group.
- The 371st Evacuation Hospital (-)\* established an aid station in Parking Area B (UTM coordinates 755031) before the shot. After the shot, they relocated to the trench area. They also provided an aid team for the observers.
- The 26th Transportation Truck Battalion (-) was responsible for transporting personnel between Camp Desert Rock and the trench area.
- The 50th Chemical Service Platoon was responsible for radiological safety operations.
- The 412th Engineer Construction Battalion constructed the display area, a wedge-shaped sector ranging 230 to 3,200 meters from ground zero.
- The 3623rd Ordnance Company placed the equipment in the display.

A medical technician and a veterinary officer were also present to lend support during the medical evaluation of test animals conducted as part of Exercise Desert Rock V.

The Control Group accompanied troops into the shot area to assist the BCT commanders in keeping all personnel together and ensuring that they followed safety and tactical instructions.

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\*Some subordinate units were not present.

The Control Group comprised officers and enlisted men from the Operations Section (G-3), as well as the Instructor Group, the Radiological Safety Section, and the Aviation Section. The Instructor Group presented orientation briefings when troops arrived at Camp Desert Rock, during the preshot rehearsal, at the trenches before the detonation, and in the display area after the detonation (32).

## 2.2 ORIENTATION AND INDOCTRINATION

As shown in table 2-1, 522 DOD personnel witnessed Shot SIMON. These observers were sent to Camp Desert Rock to become familiar with nuclear weapons and their effects. They observed the detonation and then inspected the damage to military equipment and vehicles (12; 32).

Observers began arriving at Camp Desert Rock on 21 April 1953. The Instructor Group presented the first orientation program on 22 April with only about half of the observers in attendance. On 23 April, observers and tactical troops took part in a full-scale rehearsal at the test site. Those present for the rehearsal were able to pass on instructions and assistance to later arrivals. The Instructor Group took the observers through the display area to provide a basis for assessing damage to display items. The instructors also explained that the anticipated radiation intensities from Shot SIMON might limit forward movement in the display area. After completing the tour, the observers were taken to the Shot BADGER display area to see the effects of that detonation. BADGER had been detonated five days earlier, on 18 April (32).

On 24 April, observers received the final four hours of orientation. Those not present for the 22 April orientation were instructed in the means of nuclear weapons delivery and the tactical employment of nuclear weapons. At 1930 hours on 24

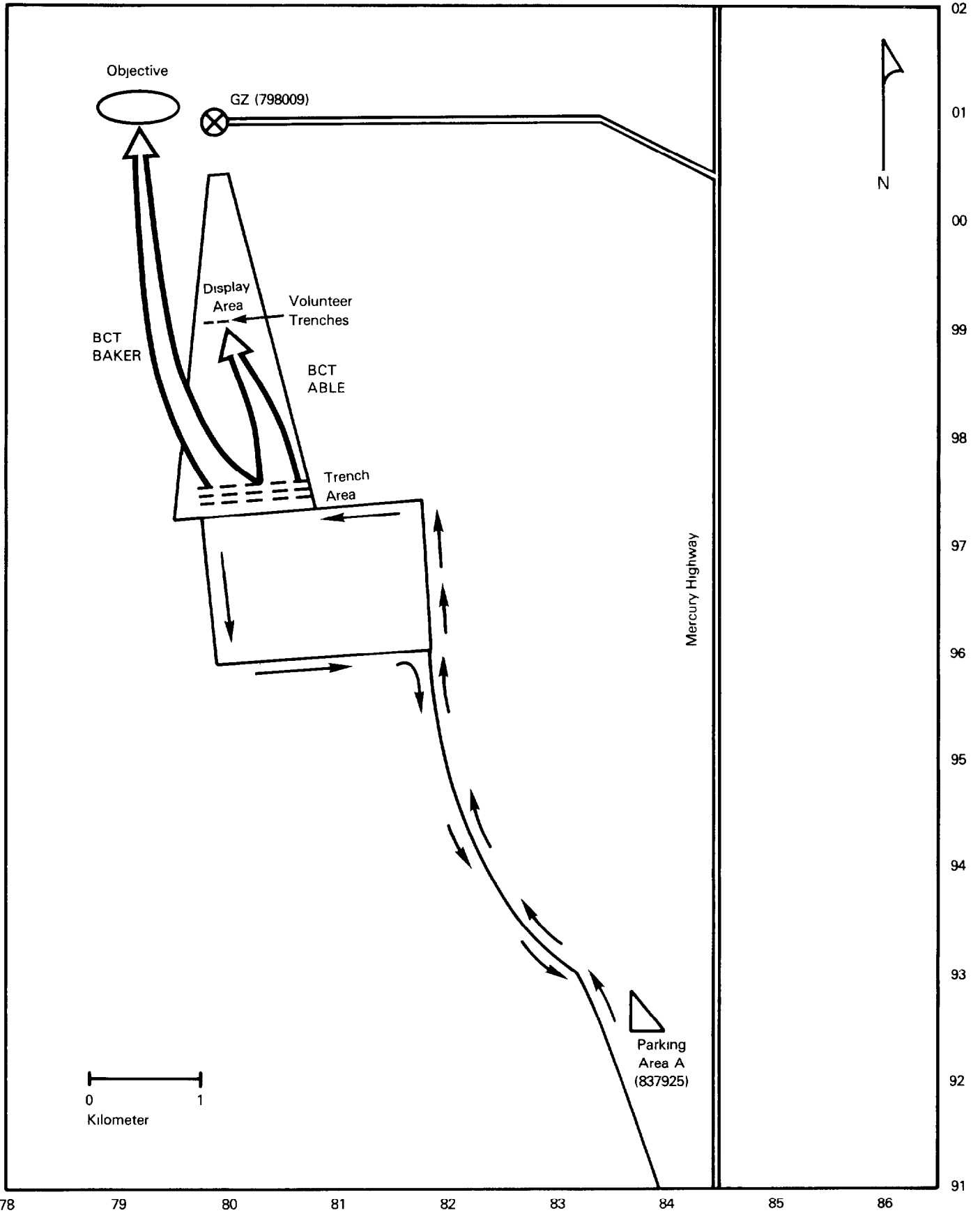
April, late arrivals received condensed briefings on the tactical concept of the exercise and on the general procedures to follow in the forward area (32).

According to the operation order, all observers were to depart for the forward area at 0145 hours on 25 April. They were scheduled to arrive at the main trench area, 3,660 meters from ground zero, at 0300 hours. The location of their trenches is shown in figure 2-1. This figure also shows the route the observers traveled to and from the trench area. A member of the Instructor Group conducted a preshot orientation in the trench area, from 0330 hours to 0420 hours. The instructor presented information on safety procedures, features of the terrain, and air participation. All observers entered the trenches 15 minutes before the shot, or at about 0415. Two minutes before the shot, they were instructed to crouch low, and a warning siren was sounded. Finally, an AEC spokesman took over the public address system and counted out the final seconds before the detonation (32; 34).

At shot-time, the scene was as follows:

A bright light, of approximately 3 seconds duration, was noted at the time of detonation. The ground shock was heavy and the earth appeared to roll for a moment. Noise accompanying the blast was deafening, loudest of this series of shots. Dust conditions following the blast and debris falling into the trenches obscured the vision of personnel in the trenches (32).

Fifteen minutes after the shot, the radiological safety monitoring teams began their survey of the display area and marked the location of the 2.5 and 5.0 roentgen-per-hour (R/h) lines. At 0500 hours, 30 minutes after the detonation, the observers were scheduled to leave the main trench area for a walking tour of the display area. Members of the Instructor Group guided the observers through the area. The limit of forward movement was the display located 1,830 meters from ground zero, where the radiation intensity was about 2.5 R/h (14; 32; 34).



**Figure 2-1: LOCATIONS OF SIMON GROUND ZERO, TRENCHES, AND ROUTE OF MARCH**



After touring the display area, observers walked back to the main trench area. Because of low-level radiation in the vehicle loading area, personnel and vehicles were monitored and decontaminated at the decontamination station at Yucca Pass and at Parking Area A (25).

The scheduled departure time for return to camp was 0625 hours. Observers spent about 90 minutes moving from the trench area to the 1,830-meter line and back, as well as boarding trucks. The observers departed for Camp Desert Rock at 0630 hours. Because of the stop for decontamination, they probably arrived at about 0900, about an hour behind schedule (34).

### 2.3 VOLUNTEER OFFICER OBSERVERS

SIMON was the third and final shot in Operation UPSHOT-KNOTHOLE with volunteer officer observer participation. The principal difference between the volunteer observers and other observer groups was their position at the time of detonation. The location of the volunteer trenches in relation to the other trenches is shown in figure 2-1. Seven Army officers and one Navy officer, all knowledgeable in the effects of nuclear weapons, calculated a safe distance from which to view SIMON, based on its predicted yield. The volunteers chose to occupy two trenches 1,830 meters from ground zero. Both trenches were 1.8 meters (six feet) deep and about one meter (three feet) wide. One trench was revetted with timber, the other was unrevetted, and both had a sandbag parapet (32; 40).

The personal equipment issued to the volunteers consisted of standard Army field helmets and liners, protective masks, flashlights, canteens, and pocket dosimeters. Each volunteer also received three Desert Rock film badges, which were placed in the breast pocket, in a hip pocket, and inside the helmet (40).

The volunteers apparently left Camp Desert Rock with the other observers at 0145 hours on 25 April and arrived at the main trench area at 0300 hours. The volunteers presumably traveled by vehicle to their trenches 1,830 meters forward of the main trench area. There was a direct telephone line between the volunteer trenches and the control trench in the main trench area, and the Exercise Director's staff remained in constant contact with the volunteers before, during, and after the blast (32; 40).

At the time of detonation, the volunteers noted an intense light and a feeling of heat, even though they were crouching in the trenches. Sand and dirt were blown into the trenches by the air blast. Several volunteers also reported a ground shock similar to a mild earthquake. One observer who was holding a telephone received an electric shock that caused a tingling sensation around his neck. The operator holding the telephone in the control trench reported receiving a "shock equivalent to that received when holding a bare 110 volt electric wire." All volunteers generally reported reduced visibility during the first five minutes after the blast due to dust conditions (32; 40).

After the volunteers left their trenches, about one minute after the shot, they examined sheep and military equipment in the display area. They were met by a truck on the access road and returned to the main trench area (40).

Based on their experience at SIMON, the eight volunteers concluded that other personnel would gain very little by being entrenched closer to ground zero than the distance from which the other observers had witnessed the shot (3,660 meters). In fact, the more distant location offered a better view because there was less dust (32; 40).

## 2.4 TACTICAL TROOP MANEUVERS

At Shot SIMON, 2,450 Army personnel participated in a tactical exercise designed to provide realistic combat training under the conditions of a nuclear battlefield. For this shot, units from the Second, Fourth, Fifth, and Sixth Armies went to the Nevada Proving Ground to participate in the exercise. Table 2-2 lists the home stations of participants in this maneuver. These Army units arrived at Camp Desert Rock by 0700 hours on 22 April 1953. At that time, the troops were assembled into two provisional Battalion Combat Teams designated ABLE and BAKER. ABLE was composed of about 800 troops from the Second Army and about 400 troops from the Sixth Army. BAKER was composed of about 600 troops from the Fourth Army and about 600 troops from the Fifth Army (32; 34).

In preparation for Shot SIMON, the Instructor Group presented an orientation to BCT ABLE on the morning of 22 April and to BCT BAKER that afternoon.

On 23 April, two days before Shot SIMON, both combat teams participated in a full-scale rehearsal, using the trenches 3,660 meters from ground zero that would be used on shot-day (UTM coordinates 802973). All troops involved in the rehearsal left Camp Desert Rock at about 0700 hours and arrived at the trench area by 0945 hours, 45 minutes before the rehearsal shot-time. About 25 minutes later, a member of the Instructor Group conducted a terrain orientation for the participants and then instructed them in the procedures to follow in the trenches before the shot (32; 34).

The simulated assault began at 1035 hours, five minutes after the rehearsal shot-time. By 1110 hours, the combat teams had advanced 2,250 meters toward the intended ground zero to conclude the tactical phase of their rehearsal. The actual plan of attack called for troops to capture an objective about

Table 2-2: HOME STATIONS OF PERSONNEL  
PARTICIPATING IN THE TACTICAL  
MANEUVER AT SHOT SIMON

Battalion Combat Team ABLE

Second Army Area

Fort Meade, Maryland

Camp Pickett, Virginia

Sixth Army Area

Fort Ord, California

Fort MacArthur, California

Presidio of San Francisco,  
California

Battalion Combat Team BAKER

Fourth Army Area

Fort Hood, Texas

Fort Sam Houston, Texas

Camp Chaffee, Arkansas

Camp Polk, Louisiana

Fort Bliss, Texas

Fort Sill, Oklahoma

Fifth Army Area

Fort Riley, Kansas

Fort Leonard Wood, Missouri

Camp Atterbury, Indiana

Camp Carson, Colorado

3,800 meters north-northwest of their trenches, and about 750 meters west of ground zero (32; 34).

At the completion of the tactical phase of the rehearsal, the troops marched back through the display area. There, the instructors escorted each BCT through the displays to note the preshot condition of equipment. The instructor also told the group that if radiation intensities from fallout were as predicted, areas closer than the displays 1,370 to 1,830 meters from the tower might be inaccessible (32).

On shot-day, 25 April 1953, seven march units boarded vehicles that would take them from Camp Desert Rock to the trenches. The Control Group was the first, followed by the two BCTs in the next four march units, and the observers in the last two. The first march unit left Camp Desert Rock at 0030 hours and arrived at the trenches at 0155 hours. The last march unit was to depart Camp Desert Rock at 0224 hours and arrive at the trenches at 0315 hours. All personnel were in the trench area at 0322 hours. The 179 vehicles that had transported personnel to the trenches were moved to Parking Area A (UTM coordinates 837925), about ten kilometers from ground zero (32).

About 15 minutes before the detonation, the BCT participants prepared for the shot in the same manner as the observers did. With the shot came a blinding light that lasted only a few seconds. Dust resulting from the shock wave passage temporarily obscured the vision of the men in the trenches (32).

Five radiological monitoring teams assisted the maneuver troops. Five minutes after the detonation, a Chemical, Biological, and Radiological monitoring team left the trench area before the BCTs and positioned itself about 140 meters east of the foremost BCT element so as to be closer to ground zero than the troops during the maneuver. In addition, one monitoring team from the 50th Chemical Service Platoon accompanied each battalion (32).

At about the same time, two additional monitoring teams that were to survey the shot area left their position in the parking area, ten kilometers from ground zero. These two teams, also from the 50th Chemical Service Platoon, arrived at the display area about 15 minutes after the detonation (32).

Both BCTs began their attack at 0444 hours, 14 minutes after the detonation. Their objective was north-northwest of the trenches, at UTM coordinates 792010, as shown in figure 2-1. BCT ABLE, advancing on the east, moved to within about 1,830 meters of ground zero at 0600 hours. Radiological safety monitors halted the attack because the radiation intensity was 2.5 R/h in that area. BCT BAKER, advancing on the west, "encountered no areas having a high radiation intensity and advanced until the attack was halted," presumably upon reaching the objective (12; 32).

When the advance of both BCTs was halted, the Instructor Group escorted the troops through the display area. Because SIMON produced more widespread fallout than most of the previous shots, display areas forward of the 1,830-meter line were inaccessible due to intensities greater than the limit of 2.5 R/h (32). BCT BAKER would have skirted areas of higher radiation while moving from the objective back to the 1,830-meter line in the display. Both BCTs moved away from ground zero during their inspection of the display.

According to standard procedures, all personnel would have been swept with brooms and checked for contamination after returning to the trench area. However, because of the radiation levels in that area, field decontamination and monitoring were conducted at the decontamination station at Yucca Pass (32).

The troops were to have begun the return to camp at 0710 hours. Because of the stop for decontamination, the BCTs did not arrive at Camp Desert Rock until 1000 hours, about an hour later than planned. Troops had spent approximately five hours in the shot area, excluding travel time between the area and Camp Desert Rock (32).

## 2.5 OPERATIONAL HELICOPTER TESTS

At SIMON, Marine Corps personnel from the Helicopter Atomic Test Unit, 2d Marine Corps Provisional Atomic Exercise Brigade (2d MCPAEB), conducted operational tests with three Marine Corps HRS helicopters. Helicopters B and C had a pilot, co-pilot, and radiological monitor; the co-pilot in helicopter A also functioned as a monitor. The tests were designed to investigate factors that might affect the use of assault helicopters after a battlefield nuclear detonation. Before the detonation, helicopters A and B were hovering about 11 kilometers from ground zero, over the northwest corner of Yucca Lake, while helicopter C was over the south end of Yucca Lake, about 17 kilometers from ground zero (29).

Helicopter A was positioned with its left side exposed, and helicopter B was facing the blast. From one minute before the detonation until the passage of the blast wave, both helicopters hovered about ten feet above the ground. The pilots used the visors of their caps to shield their eyes from the flash. The co-pilots wore standard high-density goggles at shot-time, so that they would be prepared to assume control of the helicopter should the pilot be blinded by the flash. Neither pilot experienced flash blindness. As the blast wave passed, neither pilot lost control of the helicopter. The only damage was a window blown out of its molding into the passenger compartment of helicopter A (29; 32; 34).

After the blast wave passed, both helicopters proceeded to the shot area, as shown in figure 2-2. Helicopter A, in probing the SIMON shot area, encountered radiation intensities up to 50 R/h about one kilometer from the dust column before evasive action was completed. Helicopter B proceeded to a location 1,830 meters west of ground zero and landed. At this location, the radiological safety monitor left the aircraft and continued on foot to about 870 meters from ground zero where he measured radiation intensities up to 10.0 R/h, about 30 minutes after the shot. The monitor was not supposed to enter areas in which the radiation intensity exceeded 10.0 R/h (29; 34).

Helicopter C, unlike helicopters A and B, was flying toward ground zero from the south end of Yucca Lake at the time of the detonation. It continued flying while the blast wave passed, maintaining its 400-foot height and 60-knot airspeed. The pilot and co-pilot protected themselves from flash blindness in the same way as the crews of helicopters A and B. The pilot did not suffer flash blindness, and the passage of the blast wave did not affect his control of the helicopter. Helicopter C flew around the upwind side of the SIMON dust column to land about 2,000 meters northwest of ground zero, as shown in figure 2-2 (29; 34).

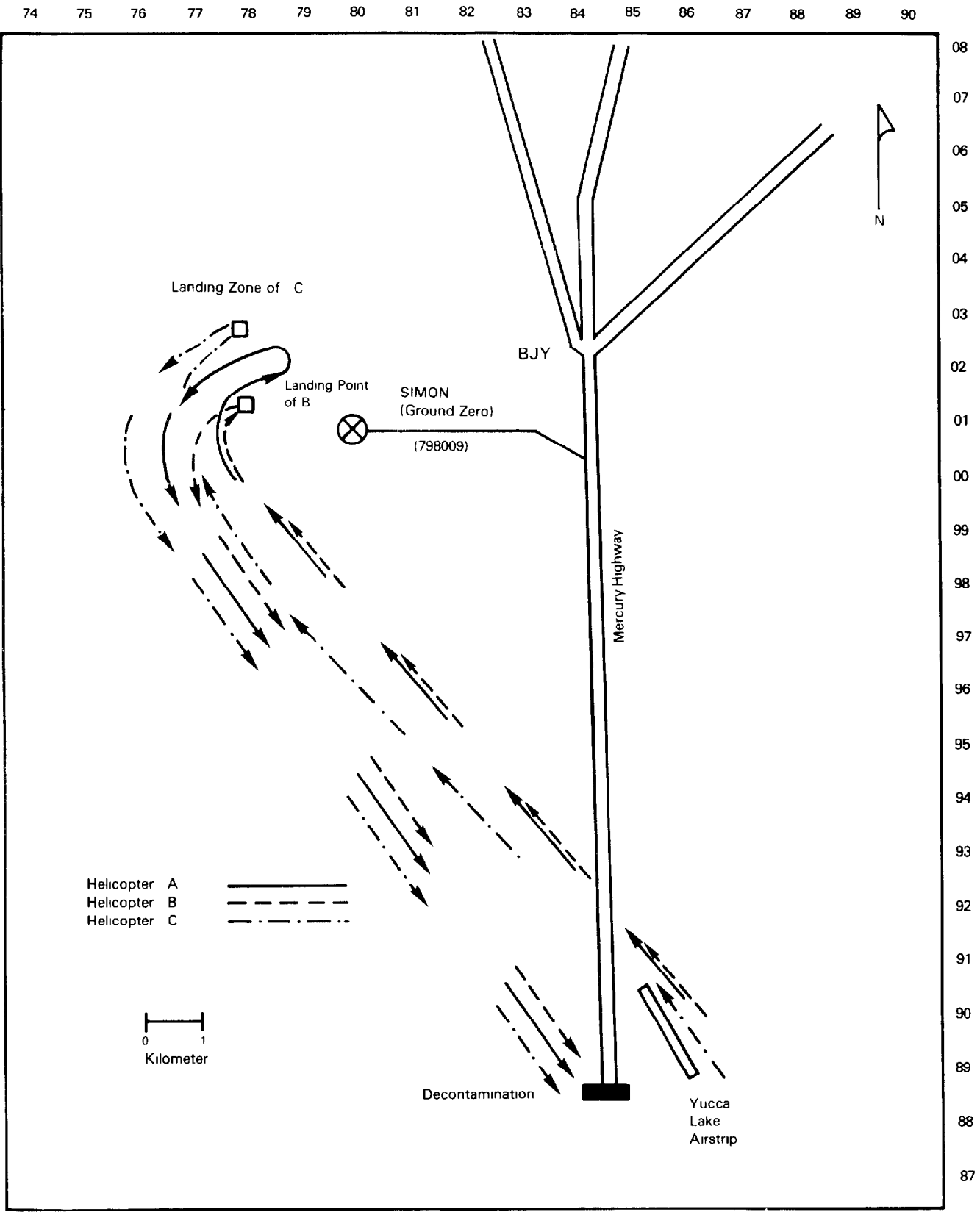
A fourth helicopter was scheduled to participate in Shot SIMON, performing tasks in tandem with helicopter C. However, no activities were reported for helicopter D (19; 21; 29).

After completing the test, the helicopters returned to Yucca Lake Airstrip where radiological monitors checked aircraft and crew for contamination. Upon receiving clearance from the monitors, the aircraft were to return to Camp Desert Rock (29).

## 2.6 DAMAGE EFFECTS EVALUATION

Before the SIMON detonation, Desert Rock personnel established a display area 230 to 3,200 meters south-southeast of





**Figure 2-2: OPERATIONAL HELICOPTER TESTS AT SHOT SIMON**

the shot-tower (figure 2-1). The display was designed primarily to add realism to the orientation and indoctrination of troops, who reviewed the display before and after the shot. Before the shot, the 412th Engineer Construction Battalion constructed such fortifications as bunkers, trenches, and foxholes at 460-meter intervals extending from ground zero. The 3623rd Ordnance Company placed equipment in the display, beginning with howitzers at about 230 meters, a truck at 370 meters, and a tank, truck, and artillery pieces at 460 meters. Thereafter, they placed equipment at 460-meter intervals, out to 3,200 meters. The equipment included more vehicles and artillery pieces, as well as communications gear (32).

After the detonation, one engineer team, including the commanding officer of the 412th Engineer Construction Battalion, was to evaluate the effects of the burst on the fortifications. In addition, one ordnance team and one signal team were to evaluate the effects of the burst on ordnance and signal equipment (32).

In conjunction with the damage effects evaluation, Desert Rock personnel also conducted medical and shielding evaluations. For the medical evaluation, 37 sheep were placed in the display area on the day before the shot. Some sheep were placed in each type of fortification, and others were tied to stakes in the open. None of the sheep were placed closer to ground zero than 460 meters. In addition, sheep were placed in two trenches located 1,370 and 1,600 meters from ground zero. After the SIMON detonation, a medical technician, accompanied by a radiological safety monitor, went to the display area by truck to observe the sheep. Later in the morning, a veterinary officer accompanied the loading party to aid in making a tentative evaluation of the detonation's effects on the sheep. When the sheep were returned to Camp Desert Rock, the veterinary officer completed the final evaluation (32).

Of unusual interest in the medical evaluation was the survival of one sheep placed in a bunker at 1,370 meters. The detonation caused the bunker to collapse, and it was assumed that the sheep was dead. On 13 May, however, when a work party removed the top portion of the bunker, the trapped sheep leaped from the emplacement. Even though the animal had been without food and water for 19 days, it appeared to be in good condition and was able to walk. The animal recovered completely and was used in a display at a subsequent shot (32).

To evaluate the shielding offered by the fortifications, a chemical team took radiation measurements by placing film badges on stakes in the open and in the trenches, foxholes, and other dugouts. After the shot, the chemical team retrieved the badges to record their readings (32).

## CHAPTER 3

### JOINT TEST ORGANIZATION OPERATIONS AT SHOT SIMON

At Shot SIMON, Department of Defense personnel performed a variety of activities for the Joint Test Organization. DOD personnel conducted experiments for the three test groups: the Military Effects Group, the Weapons Development Group, and the Civil Effects Group. These activities required DOD personnel to enter the forward area before, during, and after the shot. In addition, the Air Force Special Weapons Center provided air support to the Test Manager and the test groups.

Detailed descriptions of project objectives and general project activities are contained in the UPSHOT-KNOTHOLE Series volume. The information in this chapter addresses only those operations performed at Shot SIMON.

#### 3.1 MILITARY EFFECTS GROUP PROJECTS

The Military Effects Group of AFSWP Field Command conducted 27 projects at Shot SIMON. Table 3-1 lists the projects and the participating groups.

The Test Manager declared the area open for recovery operations at 1230 hours, eight hours after the detonation.

In the following descriptions of project activities, information on the number of participants, as well as the time of the activities, has been obtained from the Test Director's Schedule of Events for SIMON (4). That source contains only planned numbers of personnel and planned times of activities. The Schedule of Events was used because, in most cases, final reports did not provide the necessary personnel information.

**Table 3-1: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT SIMON**

Project	Title	Participants
<b>Military Effects Group</b>		
1 1c-1	Air Shock Pressure-time versus Distance for a Tower Shot	Sandia Corporation, Ballistic Research Laboratories, Naval Ordnance Laboratory
1 1c-2	Air Shock Pressures as Affected by Hills and Dales	Sandia Corporation
2 2a	Gamma Radiation Spectrum of Residual Contamination	Signal Corps Engineering Laboratories
2 2b	Residual Ionizing Radiation Depth Dose Measurements in Unit-density Material	Naval Medical Research Institute
3 30	Air Blast Gauge Studies	Ballistic Research Laboratories
4 5	Ocular Effects of Thermal Radiation from Atomic Detonation	Air Force School of Aviation Medicine
4 7	Beta-gamma Skin Hazard in the Postshot Contaminated Area	Walter Reed Army Medical Center
5 1	Atomic Weapon Effects on AD Type Aircraft In Flight	Navy Bureau of Aeronautics
6 2	Indirect Bomb Damage Assessment (IBDA) Phenomena and Techniques	Wright Air Development Center; Vitro Corporation
6 3	Interim IBDA Capabilities of Strategic Air Command	Strategic Air Command
6 4	Evaluation of Chemical Dosimeters	Chemical and Radiological Laboratories
6 7	Measurements and Analysis of Electromagnetic Radiation from Nuclear Detonations	Signal Corps Engineering Laboratories
6 8	Evaluation of Military Radiac Equipment	Signal Corps Engineering Laboratories, Bureau of Ships
6 8a	Initial Gamma Exposure versus Distance	Signal Corps Engineering Laboratories
6 9	Evaluation of Naval Airborne Radiac Equipment	Navy Bureau of Aeronautics
6 10	Evaluation of Rapid Aerial Radiological Survey Techniques	Signal Corps Engineering Laboratories
6 12	Determination of Height of Burst and Ground Zero	Signal Corps Engineering Laboratories; Army Field Forces Board #1
6 13	Effectiveness of Fast Scan Radar for Fireball Studies and Weapons Tracking	Naval Electronics Laboratory
7 1	Electromagnetic Effects from Nuclear Explosions	Headquarters, Air Force *
7 3	Detection of Airborne Low Frequency Sound from Nuclear Explosions	Headquarters, Air Force *
7 4	Seismic Measurements	Headquarters, Air Force
7 5	Calibration and Analysis of Close-in A-Bomb Debris	Headquarters, Air Force; Air Force Special Weapons Center

\* Other participating agencies are listed in the text

**Table 3-1: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT SIMON (Continued)**

Project	Title	Participants
<b>Military Effects Group (Continued)</b>		
8 1a	Effects of Thermal and Blast Forces from Nuclear Detonations on Basic Aircraft Structures and Components	Wright Air Development Center; Division of Research, University of Dayton
8.1b	Additional Data on the Vulnerability of Parked Aircraft to Atomic Bombs	Wright Air Development Center
8.2	Measurement of Thermal Radiation with a Vacuum Microphone	Air Force Cambridge Research Center
8.12a	Sound Velocities near the Ground in the Vicinity of an Atomic Explosion	Naval Electronics Laboratory
9.1	Technical Photography	EG&G; Signal Corps Pictorial Center, Air Force Lookout Mountain Laboratory
<b>Weapons Development Group</b>		
13.1	Radiochemistry Sampling	Air Force Special Weapons Center
18.1	Total Thermal and Air Attenuation	Naval Research Laboratory
18.2	Power versus Time	Naval Research Laboratory
18.3	Spectroscopy	Naval Research Laboratory
18 6	Surface-brightness Investigations	Naval Research Laboratory
<b>Civil Effects Group</b>		
27.1	Distribution and Characteristics of Fallout at Distances Greater than Ten Miles, March and April 1953	School of Medicine, UCLA; Navy
29 1	Comparison and Evaluation of Dosimetry Methods Applicable to Gamma Radiation	Atomic Energy Project, UCLA *

\* Other participating agencies are listed in the text

Project 1.1c-1, Air Shock Pressure-time versus Distance for a Tower Shot, was designed to check the expected asymmetry of blast effects. Personnel placed gauges about 500 and 700 meters from ground zero along each of three lines running north, north-east, and east of ground zero (57).

Project 1.1c-2, Air Shock Pressures as Affected by Hills and Dales, was designed to study the behavior of a shock wave as it passed over a ridge. A ridge between Yucca Flat and Tippipah Spring, about five kilometers west of ground zero, was chosen as the site for project stations. Fifteen measurement stations were selected on the front and back slopes of the ridge and at outlying positions in front of and behind the ridge. At each station, personnel installed ten pressure gauges flush with the ground surface (48).

Forty-five minutes after personnel were permitted to re-enter the test area, four personnel accompanied by a monitor were scheduled to go to a station about six kilometers from ground zero to recover data. The recovery took one hour (4).

Project 2.2a, Gamma Radiation Spectrum of Residual Contamination, was to characterize the residual gamma radiation resulting from the shot. After the shot, three project personnel and a monitor made measurements with radiac meters at locations 4,830 and 4,760 meters from ground zero, where the radiation intensities were 0.195 and 0.11 R/h, respectively. Personnel took measurements the next day at a location 4,030 meters from ground zero, where the radiation intensity was 0.348 R/h. Personnel also made gamma ray spectral measurements four, five, and ten days after the shot between 3,200 and 4,000 meters east of ground zero. Radiation intensities at all of these locations were about 0.3 R/h (4-5).

Project 2.2b, Residual Ionizing Depth Dose Measurements in Unit-density Material, was conducted to evaluate the biological effects of residual beta and gamma radiation fields. After the shot, six participants and a monitor placed radiation detectors inside lucite and masonite phantoms, which simulated the density of human tissue. On shot-day, personnel placed the phantoms in 15 R/h and 3.5 R/h locations five to six kilometers from ground zero near Mercury Highway. They returned to retrieve them several hours later. Personnel conducted similar operations two days after the shot at the same location (4; 10).

Project 3.30, Air Blast Gauge Studies, was designed to test a new self-contained recording gauge for the measurement of pressure-time phenomena resulting from an atomic blast. For SIMON, the primary objectives were to compare Ballistic Research Laboratories and Sandia Corporation gauges, to check the asymmetry of the blast wave, and to test further the nylon and carbon paper thermal initiation device. Project personnel instrumented six stations located about 500 and 700 meters north, northeast, and east of ground zero. They installed the gauges in the ground so that the top of the gauge was flush with the ground surface (4; 45).

Project 4.5, Ocular Effects of Thermal Radiation from Atomic Detonation, was conducted to determine to what degree the flash of a nuclear detonation temporarily impairs vision and how it affects night vision. In the first part of the project, 11 Air Force personnel from Nellis AFB were in a darkened trailer 13 kilometers from ground zero. They viewed the flash through a shutter that protected their eyes from much of the visible and infrared portion of the spectrum. After viewing the shot through the shutter, they performed a number of visual tasks. In the second part of the experiment, 130 rabbits were used to determine the ranges at which retinal burns could be produced. Three three-man parties placed the rabbits in ten locations from five



to 40 kilometers from ground zero the night before the detonation. At recovery hour, three teams, each of three project personnel and a monitor, retrieved the rabbits (2; 4; 8).

Project 4.7, Beta-gamma Skin Hazard in the Postshot Contaminated Area, measured beta (and low-energy gamma) radiation exposure potential to human skin and determined the extent to which this exposure exceeded the gamma radiation exposure routinely reported in radiological safety monitoring. Measurements were taken using ion chambers with walls about the thickness of human skin. The ion chambers were placed on different parts of masonite phantoms, which simulated the attenuation scattering of beta and gamma radiation by the human body (7).

Before the shot, personnel loaded equipment into two vehicles and assembled at the Radiological Safety Operations Office. Three hours after the detonation, the initial survey results were available, and the general outline of the fallout pattern was discernible. A study of the road network and the isointensity lines dictated the choice of likely spots for investigation. One hour after recovery hour, the party proceeded to the radiation area and set up desks and "offices" at the 0.01 R/h line. Personnel then looked for locations in the radiation area where a gamma survey meter would read about 0.8 R/h. At SIMON, these spots were approximately 130 meters upwind and 1,830 and 1,920 meters crosswind of ground zero. After the locations were chosen, ion chambers were readied at the desks near each location and transported to the 0.8 R/h area for the exposure. Readings could be obtained fairly quickly (five to 30 minutes per exposure) in the 0.8 R/h area. By withdrawing to the 0.01 R/h line after placing the ion chambers, project personnel kept their gamma exposures below the authorized maximum, 3.9 roentgens in 13 weeks (7).

Project 5.1, Atomic Weapons Effects on AD Type Aircraft in Flight, was designed to study the structural response of aircraft in level flight attitude, tail toward the blast (55). Figure 3-1 shows a practice run for this project.

One unmanned and five manned aircraft participated, flying in formation over the test site. The AD-2 drone was used to simulate the escape position of a delivery aircraft. During takeoff, the drone was under the control of a pilot at a ground station located beside the runway at Indian Springs AFB. Once the drone was airborne, control was turned over to a Navy F8F control aircraft. Using information from the Aircraft Participation Unit, the control pilot flew the drone to its predetermined position relative to the burst at shot-time. The other aircraft, a backup F8F control aircraft and three AD-4 aircraft that simulated fighter support, flew for one hour and 15 minutes over the test location (21; 55).

At shot-time, the drone was at a slant range of 1,900 meters from the burst. Because Shot SIMON exceeded the predicted yield by about 20 percent and the drone was positioned for near-critical weapons effects, the higher thermal radiation severely weakened all of the blue-painted skin on the underside of the wing. As a result of the weakened skin, combined with the over-pressure and gust effects, wing panels were torn off at the time of shock arrival, and the drone crashed. Much valuable information on thermal damage was obtained from the panels retrieved from the drone (2; 55).

According to the Schedule of Events for Shot SIMON, three hours before the detonation, 23 Project 5.1 personnel were to travel to station 5.1b, about one kilometer east of Yucca Pass at UTM coordinates 861877. They were to remain there through shot-time (4).



**Figure 3-1: NAVY DRONE ELEMENT ON A PRACTICE RUN FOR PROJECT 5.1 AT SIMON**

Project 6.2, Indirect Bomb Damage Assessment (IBDA) Phenomena and Techniques, was performed to confirm indications that a radar return could be obtained from a nuclear explosion and that it could be used in determining ground zero and predicting height of burst and yield (35). Three B-29 aircraft equipped with IBDA systems took off from Kirtland AFB at 0005 hours on shot-day, entering the test area at about 0240 hours. One of the aircraft developed engine problems, forcing it to land at Nellis AFB. The other two aircraft maintained holding patterns throughout the detonation, one eight kilometers south of ground zero, and the other 11 kilometers east of ground zero. Both aircraft left the area around 0455 hours and landed at Kirtland AFB around 0700 hours (2; 21; 41; 49).

Project 6.2 also investigated whether the fireball significantly changes the direction of a radar beam. For this part of the project, radar transmitter and receiver stations were placed around ground zero. According to the Schedule of Events, "approved manned stations" were at UTM coordinates 830880, 870894, and 880895 (4; 49).

At 2200 hours on the day before the detonation, two two-man teams traveled to the receiver stations to turn on the generators that powered the equipment. They remained at the stations through shot-time. A third team traveled to the transmitter station to turn on the power generator and left the station for the Control Point about four hours before shot-time. Two hours after recovery hour, two project personnel, including a monitor, returned to the transmitter station to turn off the generator (4).

Project 6.3, Interim Indirect Bomb Damage Assessment (IBDA) Capabilities of Strategic Air Command, was a corollary to Project 6.2. An interim IBDA system, installed in operational Strategic Air Command (SAC) aircraft, was evaluated in connection with simulated strike missions (43).

Current IBDA capabilities were determined in tests under field conditions using SAC aircraft equipped with the latest available IBDA systems. While flying simulated strike and support formations over a target, these aircraft recorded data essential for determination of the three IBDA parameters: yield, burst height, and ground zero (43).

Eight B-50 aircraft of the 2nd Medium Bomber Wing from Hunter AFB, Georgia, and seven B-47 aircraft of the 305th Medium Bomber Wing from McDill AFB, Florida, reached the test area around 0330 hours at altitudes of 25,000 and 37,000 feet, respectively. The aircraft flew in formation over the test site to simulate strike and support activities and left the area soon after shot-time. While over the test site, the crews tested the IBDA equipment and familiarized themselves with operations pertaining to nuclear warfare. A total of 106 personnel participated, including personnel who operated the weather reconnaissance aircraft that preceded the IBDA aircraft (20-21; 43).

Project 6.4, Evaluation of Chemical Dosimeters, was fielded by the Army Chemical Center and its Chemical and Radiological Laboratories. The objective was to test the E-1 tactical dosimeter and other instruments under development for use as personnel dosimeters. The dosimeters would be used to measure gamma radiation exposure (11).

Project personnel fastened dosimeters to exposure plates with masking tape and then covered them with thermal and shock shields. The plates were affixed to frames at eight stations. Because of the radiation levels, recovery operations did not take place until 30 hours after the detonation (11).

Project 6.7, Measurements and Analysis of Electromagnetic Radiation from Nuclear Detonations, was conducted by the Signal Corps Engineering Laboratories. The project consisted of two

parts. Part I measured the physical characteristics of the pulse of the electromagnetic radiation. Part II detected and recorded electromagnetic signals emitted by nuclear devices before the detonation. Part II was performed at the request of AFSWP and the Office of Naval Research (15).

Before the shot, three project personnel and a monitor in two vehicles traveled 2,750 meters south of ground zero to turn on equipment. They then drove to a station 1.6 kilometers north of the Control Point, at UTM coordinates 830900, where they remained through shot-time. Several days later, three men and a monitor spent about one hour in the test area recovering film (3-4; 15).

Project 6.8, Evaluation of Military Radiac Equipment, and Project 6.8a, Initial Gamma Exposure versus Distance, were fielded together by the Signal Corps Engineering Laboratories, assisted by Air Force students and Navy personnel. This project was designed to test radiac instruments in initial and residual radiation fields produced by a nuclear detonation (42; 46).

Experimental dosimeters were placed at 16 stations located about 1,070 to 2,710 meters from ground zero. These portable stations were designed with aluminum thermal and blast shields. Three parties of six men and one monitor each traveled in vehicles to recover the film and dosimeters 45 minutes after recovery hour. This mission took about three hours. After recovery, the experimental dosimeters were compared to the standard dosimeters exposed in National Bureau of Standards holders at the same locations (4; 42; 46).

One minute after the detonation, two men accompanied by one monitor left the Control Point and traveled to the 5.0 R/h area to collect air samples with portable samplers. Two hours after recovery hour, four parties, each of six men and a monitor,

conducted simulated initial radiological safety surveys with experimental radiac instruments. This activity took about three hours (4; 42).

Project 6.9, Evaluation of Naval Airborne Radiac Equipment, evaluated aerial ground survey equipment, automatic recording dosimeters, and gamma dosimeters. The accuracy of the equipment at high altitudes was compared to its accuracy at ground level. The equipment was designed for use by special carrier-based aircraft to warn assault troops that they might be entering contaminated areas (61).

A P2V aircraft, with a crew of three, left Kirtland AFB at 0130, three hours before the shot. When it was 20 kilometers southwest of ground zero, the aircraft established a holding pattern at an altitude of 12,000 feet. Radiac equipment in the aircraft was turned on before shot-time to allow for a one-hour warm-up period before the aircraft entered the shot area.

After the detonation, the aircraft approached the shot area and established a holding pattern while waiting for the cloud to dissipate. When the aircraft was cleared to enter the shot area by the Aircraft Participation Unit, it began runs over the radiation area in a cloverleaf pattern. The patterns were flown at an initial height of some 6,000 feet above the terrain, with subsequent patterns flown at heights decreasing by 500 feet each run. The lowest run was approximately 1,000 feet above the ground. The aircraft was over the area for three hours and landed at Indian Springs AFB at 0846 hours. The P2V took off from Indian Springs AFB at 0734 hours the day after the detonation to repeat the evaluation of the radiac equipment (21-22; 61).

Project 6.10, Evaluation of Rapid Aerial Radiological Survey Techniques, was fielded by the Signal Corps Engineering Laboratories. It was intended to improve the aerial radiological

survey procedures used during Operations BUSTER-JANGLE and TUMBLER-SNAPPER and to determine the effect of the aircraft on radiac instrument readings taken inside the aircraft. Film badges were placed at various locations opposite one another on the interior and exterior of the aircraft (53).

One HRS-2 helicopter, probably with a crew of four, staged from Yucca Airstrip. The helicopter took off at 1305 hours on shot-day and reached the test area at 1310 hours. It entered the radiation area, flying about 500 feet above the ground, and circled ground zero at a radius of about one kilometer. The crew then selected a landmark at or near ground zero as a reference point and determined the direction of maximum fallout. From this information, the crew determined approximate radiation levels and decided on the altitude of operation (21; 53).

The helicopter then flew a cloverleaf pattern centered over the reference point at three different altitudes. The first leg of the cloverleaf pattern passed over the reference point in the direction of maximum fallout. Airspeed, direction, and altitude were kept constant on each leg of the pattern. Monitors in the helicopter obtained data by using a mechanical recording system and by writing intensity readings on a data sheet every five seconds. The aircraft was in the area about two hours and landed by 1500 hours (21; 53).

Project 6.12, Determination of Height of Burst and Ground Zero, was fielded by the Army Field Forces Board Number 1 and the Signal Corps Engineering Laboratories. The objective was to evaluate equipment and techniques for locating ground zero and determining the height of burst (62).

Sound-ranging stations were located up to 60 kilometers from ground zero, to the south, southeast, and southwest of Camp Desert Rock. The system consisted of three separate microphone



arrays several kilometers apart along a line perpendicular to the line from the center of the array to the burst point. Seismic monitors and flash-ranging cameras were placed about 13 to 16 kilometers from ground zero (62).

Three hours before the shot, nine men traveled to station 6.12b, in the southeast corner of Yucca Lake at UTM coordinates 885875, where they remained through shot-time. The station was within 1.6 kilometers of the seismic monitors and flash-ranging cameras (4; 62).

Project 6.13, Effectiveness of Fast Scan Radar for Fireball Studies and Weapons Tracking, evaluated the effectiveness of a new developmental fast-scan X-band radar for studies of the phenomena produced by nuclear detonations. The radar was mounted on a van. Three hours before the shot, six project personnel traveled to station 6.13a, UTM coordinates 840892, and remained there through shot-time (4; 44).

Project 7.1, Electromagnetic Effects from Nuclear Explosions, was a continuation of studies conducted during Operations BUSTER-JANGLE and TUMBLER-SNAPPER. The project was designed to obtain additional information on the electromagnetic radiation produced by a nuclear detonation. The project was conducted by Headquarters, Air Force, with assistance from the National Bureau of Standards, the Air Force Security Service, the Air Force Cambridge Research Center, and the Air Weather Service. In conducting the study, project personnel manned monitoring stations at one location onsite and at 11 locations offsite. Thirteen project personnel traveled to the onsite station, 18 kilometers southeast of ground zero at UTM coordinates 895857, four hours before the shot to operate the station through shot-time (4; 51).

Project 7.3, Detection of Airborne Low Frequency Sound from Nuclear Explosions, was designed to compare low frequency sounds produced by nuclear detonations at various remote field stations. These stations were located across the United States and around the world. The Signal Corps Engineering Laboratories operated stations in Alaska, Hawaii, Greenland, Japan, and Germany. The Navy Electronics Laboratory, the Signal Corps Engineering Laboratories, and the National Bureau of Standards manned the nine stations in the continental United States (52).

Project 7.4, Seismic Measurements, recorded the seismic waves produced by the shot for comparison with those produced by other shots of Operation UPSHOT-KNOTHOLE and previous operations. Project personnel operated stations in Alabama, Alaska, Arizona, Montana, South Dakota, Wyoming, and Nevada. At 1430 hours, two hours after recovery hour, two project members and a monitor traveled to a seismic station in Yucca Flat, almost ten kilometers northeast of ground zero, to turn off equipment and recover records. This activity took about one hour (4; 16).

Project 7.5, Calibration and Analysis of Close-in A-Bomb Debris, analyzed samples of the Shot SIMON cloud to evaluate various parameters of the nuclear device. An aircraft with only a pilot onboard took gaseous and particulate samples of the cloud. These activities are detailed in section 3.4, which discusses Air Force Special Weapons Center support missions at SIMON (58).

Project 8.1a, Effects of Thermal and Blast Forces from Nuclear Detonations on Basic Aircraft Structures and Components, investigated the capabilities of weapons-delivery aircraft to withstand thermal and blast forces. This information was used to establish design criteria for future weapons-delivery aircraft. Four project personnel placed B-36 components 160, 210, 320, and 460 meters from ground zero. No shot-day recovery operations or inspections were necessary (56).

Project 8.1b, Additional Data on the Vulnerability of Parked Aircraft to Atomic Bombs, supplemented existing data concerning the effects of nuclear weapons on parked aircraft. Two hours after recovery hour, seven project members and a monitor inspected a B-29 aircraft, which was parked 1,890 meters from ground zero during the shot. This activity took one hour (2; 4; 22-23).

Project 8.2, Measurement of Thermal Radiation with a Vacuum Microphone, was conducted by the Air Force Cambridge Research Center. The objective was to evaluate a device used to measure thermal radiation produced by a nuclear detonation. Project personnel placed microphones 2,420 meters from ground zero several days before the detonation. Signals from the microphones were electrically transmitted to recording equipment located in two vans, about 1,610 meters north of the Control Point (UTM coordinates 826902). Four hours before the detonation, six project personnel traveled to these vans to man equipment through shot-time (4; 6).

Project 8.12a, Sound Velocities near the Ground in the Vicinity of an Atomic Explosion, was conducted by the Navy Electronics Laboratory. The objective was to determine the velocity of sound just above the ground before the arrival of the shock wave. At SIMON, the purpose was primarily to check equipment that would be used for the project at Shots ENCORE and GRABLE. Before the shot, project personnel placed particle velocity meters 1,370 meters from ground zero. Two hours after recovery hour, four personnel and a monitor traveled to this location to inspect the meters (4; 47).

Project 9.1, Technical Photography, was conducted by Edgerton, Germeshausen, and Grier, Incorporated (EG&G), and by personnel from the Signal Corps Pictorial Center and the Air Force Lookout Mountain Laboratory. Twenty-three Signal Corps

officers and five Air Force enlisted personnel were assigned to work directly with EG&G. The objective was to take both still photographs and motion pictures of the preshot and postshot stages of various projects (27).

In addition to Project 9.1 technical photography, the Air Force Lookout Mountain Laboratory provided documentary photography support. Ten personnel photographed the SIMON burst from the five camera stations listed below (4a; 4b):

<u>Station</u>	<u>Location (UTM)</u>	<u>Number of Personnel</u>	<u>Distance from Ground Zero (kilometers)</u>
#1	894982	2	10
#2	900928	2	13
#3	829900	2	11
#4	788939	2	7
#5*	843878	2	14

These personnel entered the forward areas of the test site about two hours before the burst to set up camera equipment. They remained in the area until after shot-time, photographing the burst and subsequent cloud development (4).

Besides their ground mission, Lookout Mountain Laboratory photographers took aerial photographs from a C-47 aircraft. The C-47 left Indian Springs AFB at 0326 hours, with as many as eight people on board. The C-47 entered the SIMON test area and established a holding pattern. The aircraft was 16 kilometers south of ground zero at an altitude of 10,000 feet when the photographers filmed the burst. At 0433 hours, the C-47 aircraft left the test area to return to Indian Springs AFB, where it landed at 0453 hours (4; 21).

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\*Station 5 was at the Control Point.

### 3.2 WEAPONS DEVELOPMENT GROUP PROJECTS

The Weapons Development Group conducted 23 projects at Shot SIMON. Of these, only five involved DOD personnel. Table 3-1 lists DOD participation in the Weapons Development Group projects, which were all sponsored by the Los Alamos Scientific Laboratory.

Project 13.1, Radiochemistry Sampling, was supported by cloud-sampling pilots from the 4926th Test Squadron (Sampling). This activity is discussed in section 3.4, under AFSWC participation at Shot SIMON.

The Naval Research Laboratory of Washington, D.C., conducted Projects 18.1, 18.2, 18.3, and 18.6 for the Weapons Development Group at Shot SIMON. However, detailed information is available only for Project 18.3, Spectroscopy. The objective of this project was to obtain information on spectral characteristics of light emitted from nuclear detonations. Spectrometers were used to record on film the variation with time of the wavelength of light from the detonation. Two spectrometers were in Building 400, located near the Control Point at Yucca Pass. Personnel manned this station on shot-day in order to operate the instruments. The distance between the SIMON ground zero and Building 400 was about 14 kilometers (4; 9; 17).

### 3.3 CIVIL EFFECTS GROUP PROJECTS

The Civil Effects Group conducted ten projects at SIMON, but only two involved DOD participants, as listed in table 3-1.

Project 27.1, Distribution and Characteristics of Fallout at Distances Greater than Ten Miles from Ground Zero, involved 31 Navy enlisted men. The objective was to determine radioactivity, particle size, and other parameters associated with fallout (54).

The participants organized into 13 teams. According to the operation plan, they were to set up stations consisting of various experiments along roads and trails selected on the basis of the predicted fallout patterns. The participants remained at previously assigned rendezvous points until after a weather prediction was made at 2300 hours the night before the shot. The teams then established 31 sampling stations in a pattern extending 30 degrees on each side of the estimated midline of the fallout. They spent four hours completing this task and then returned to their respective rendezvous points before the shot. Approximately 24 hours after the detonation, the teams collected samples, dismantled the stations, and returned to Camp Mercury. They stayed a minimum of 16 kilometers from ground zero during their field activities (54).

Project 29.1, Comparison and Evaluation of Dosimetry Methods Applicable to Gamma Radiation, involved 26 participants from the Evans Signal Laboratory, part of the Signal Corps Engineering Laboratories. Personnel from the Army Chemical Corps, the Naval Radiological Defense Laboratory, and the Naval Medical Research Institute also assisted. The objective was to evaluate the performance of various radiation detection instruments in radiation areas with gamma intensities up to 10.0 R/h. Participants placed film packs on 16 posts before shot-day and recovered the packs 54 hours after the detonation (59).

#### 3.4 AIR FORCE SPECIAL WEAPONS CENTER ACTIVITIES

At Shot SIMON, AFSWC had operational control of all aircraft, cloud sampling and cloud tracking, aerial surveys, sample courier missions, and a radio relay. AFSWC conducted cloud-sampling missions for LASL Project 13.1, Radiochemistry Sampling, and for AFSWP Project 7.5, Calibration and Analysis of Close-in A-Bomb Debris. Table 3-2 details DOD participation in AFSWC-supported projects, showing the numbers and types of aircraft used.

**Table 3-2: AFSWC AIR MISSION SUPPORT, SHOT SIMON**

Mission	Type of Aircraft	Number of Aircraft	Estimated DOD Personnel
Cloud Sampling			
Snooper	F-84G	1	1
Sampler Control	B-50	1	9
Sampler	F-84G	10	10
Sample Courier			
	C-47	1	4
	B-25	10	50
Cloud Tracking			
	B-29	2	20
	B-25	1	5
Radiation Terrain Survey/Radio-Relay			
	C-47	1	4
	H-18	1	3
	L-20	2	16

### 3.4.1 Cloud Sampling

Nine F-84G aircraft collected particulate samples of the SIMON cloud for LASL Project 13.1. In addition, a B-29 was scheduled to collect gaseous and particulate samples for Project 7.5. Due to equipment problems, the B-29 aircraft was replaced by an F-84G. A B-50 sampler control aircraft manned by an AFSWC crew of nine, including a scientific advisor from LASL, and another F-84G aircraft acted as "snooper" aircraft, surveying the cloud before the actual sampling sorties. The first cloud penetration took place at 0711 hours, two hours and 41 minutes after the detonation. The following listing summarizes the activities of each sampler aircraft (21):

AIRCRAFT (F-84G)	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (seconds)	TOTAL TIME IN CLOUD AREA (minutes)
Red 1	4	693	75
Red 3	2	-	124
Red 4	2	695	77
White 2	2	1850	103
White 3	2	1675	75
White 4	3	55	119
Blue 1	2	755	103
Blue 2	2	620	74
Blue 4	3	-	105
Catnip 1 (Project 7.5)	1	65	152

The highest intensity encountered during the sampling missions was 7.0 R/h, and the highest sampler pilot exposure was 2.7 roentgens (21).

After the sampling missions were completed, the aircraft landed at Indian Springs AFB and parked in designated areas. Engines were shut down, and the canopies remained closed and sealed until the samples were removed from the aircraft. The pilots remained on full oxygen while they waited. The 4926th sample-removal team and radiological safety monitors removed the samples from each aircraft and placed them in shielded containers (21).

After the samples from each aircraft were removed and stored, the pilots shut down their oxygen and opened the canopies. They stepped onto platforms held by forklifts, so they would not touch the exterior of the aircraft, then moved to a pickup truck. They were taken to the decontamination station,



where they were monitored and decontaminated as necessary (13; 21; 60).

#### 3.4.2 Sample Courier Missions

After Shot SIMON, 11 aircraft transported scientific data to laboratories throughout the United States for analysis. Ten B-25 aircraft and one C-47 flew the courier missions (22).

#### 3.4.3 Cloud Tracking

After the detonation, two B-29s, each with a crew of ten, left Kirtland AFB to track the cloud at 22,000 and 18,000 feet. One of the B-29s, however, aborted its mission due to mechanical failure. The remaining B-29 tracked the cloud at 22,000 feet for five hours. A B-25 from Indian Springs AFB, with a crew of five, tracked the cloud at 12,000 feet for four hours (14; 21).

#### 3.4.4 Aerial Surveys of Terrain

As requested by the Test Director, one AFSWC H-18 helicopter, two L-20 aircraft, and one C-47 made radiological surveys of the terrain after the SIMON detonation to measure radiation intensities. The H-18 helicopter began the close-in survey ten minutes after the detonation and continued the survey for three hours at 25 to 30 feet above the ground. The two L-20 aircraft flew surveys at 500 feet above the ground, covering both onsite and offsite terrain. The C-47 conducted a survey up to 320 kilometers offsite. This mission took three hours and was conducted at heights ranging from 400 to 2,400 feet above the ground (14; 21).

## CHAPTER 4

### RADIATION PROTECTION AT SHOT SIMON

Exercise Desert Rock V, the Joint Test Organization, and the Air Force Special Weapons Center each developed its own procedures to protect participants in Shot SIMON from the radiation resulting from the nuclear detonation. JTO and AFSWC based their procedures on criteria developed by the AEC Division of Biology and Medicine. The Office, Chief of Army Field Forces, established the radiological safety procedures and criteria for Desert Rock participants. The purpose of these radiation protection procedures was to ensure that individual exposure to ionizing radiation was within safe limits. The safety criteria and procedures used by Exercise Desert Rock, JTO, and AFSWC, as well as the organizations developed to implement the procedures, are described in chapter 5 of the UPHOT-KNOTHOLE Series volume.

Reports describing the results of radiation protection programs at Shot SIMON have been located for the Exercise Desert Rock volunteer observers and some test group members. Dosimetry data are available for the eight volunteer officer observers at SIMON. No film badge readings are available for Desert Rock troops. The results of the JTO procedures at Shot SIMON are available from two sources: the radiological safety report and the final dose report. The radiological safety report summarizes the activities that took place at each shot in the UPHOT-KNOTHOLE Series. The final dose report contains a listing of total exposures for all DOD personnel and civilians who received film badges issued by the AFSWP Radiological Safety Support Unit to the test groups. This report contains individual names, units, and total doses. Only doses received at SIMON in excess of the established limits are discussed below (1a; 1b; 14).

#### 4.1 DESERT ROCK RADIATION PROTECTION PROCEDURES

SIMON was characterized by a higher-than-predicted yield that resulted in a more widespread area of onsite radioactive fallout than expected. Specific details of the radiological protection activities at Shot SIMON are presented in this section. Chapter 5 of the UPSHOT-KNOTHOLE Series volume describes the standard procedures at the operation.

##### 4.1.1 Radiation Protection for the Tactical Troop Maneuver and the Observers

At shot-time, observers and members of both BCTs were in trenches 3,660 meters from ground zero. A monitor noted an initial gamma radiation exposure not exceeding 0.025 roentgens in these trenches (32).

At 0444 hours, 14 minutes after the shot, both BCTs began their attack. Radiation monitors at the head of BCT ABLE, on the east, halted the attack at 0600 hours at about 1,830 meters southwest of ground zero. At that point, the radiation intensity was 2.5 R/h. BCT BAKER, on the west, encountered no areas of high radiation intensity and presumably reached the objective (12; 32).

When the tactical phase of the maneuver was over, the observers and troops moved to the display area. There, members of the Instructor Group escorted them on a tour of the equipment and field fortifications. Due to radiation levels in the display area, forward movement was not permitted past the display at 1,830 meters from ground zero (also the site of the volunteer officer observer trenches) where the radiation intensity was about 2.5 R/h (32).

Although standard procedures called for personnel to undergo field decontamination and monitoring before they boarded vehicles

in the trench area for the return to camp, light fallout in the trench area precluded this operation. At the direction of the Radiological Safety Officer, troops and vehicles moved to the decontamination station at Yucca Pass for field decontamination and monitoring. SIMON was the only shot in the UPSHOT-KNOTHOLE series requiring the use of an alternate field decontamination post because of contamination in the planned location (32).

No film badge readings are available either for soldiers participating in the tactical troop maneuver or for the regular observers. Readings from pocket dosimeters issued to some of the maneuver troops indicated an estimated average exposure of 3.0 roentgens, with a high of 7.0 roentgens (exceeding the limit of 6.0 roentgens) (35). Dose reconstruction indicates an average gamma dose for observers of about 0.5 roentgens (25).

#### 4.1.2 Radiation Protection for the Volunteer Officer Observers

At Shot SIMON, eight officers knowledgeable in the effects of nuclear weapons calculated a safe distance for viewing a device predicted to yield 35 kilotons. By consensus, the volunteers agreed that trenches located 1,830 meters from ground zero would provide adequate protection from a nuclear device of that yield (32; 40). SIMON, however, had an actual yield of 43 kilotons.

Immediately after the burst, one volunteer officer noted a reading of 100 R/h on his IM-71/PD radiac meter. Within the next ten seconds, this reading dropped to 50 R/h, gradually decreasing within the next minute to about 20 to 25 R/h. At this time, the group leader directed the volunteers to leave their two trenches. As they left the trenches and examined the equipment in the area, radiac meter readings increased again to 40 R/h. Meter readings steadily decreased as the group walked away from ground zero. Whenever the group stopped to examine anything, such as the sheep

in the display area, meter readings began increasing again, indicating that fallout was being deposited in that area (32; 40).

The group walked about 400 meters away from ground zero, and boarded trucks to the main trench area. At the point where they met the trucks, the radiation intensity was 10.0 R/h. This intensity decreased rapidly as they drove away from ground zero. By the time the volunteers had reached the main trenches, the radiation intensity was less than 1.0 R/h (32; 40).

Each volunteer carried a pocket dosimeter and three Desert Rock film badges. The dosimeters registered an average of 10.4 roentgens of whole body exposure. One film badge was placed in each of the following places: breast pocket, hip pocket, inside the helmet. Readings ranged from 9.5 to 19.54 roentgens for the volunteers. The breast pocket film badges, which correspond to the single film badge worn by other test participants, had readings of 9.5 to 17.5 roentgens, with an average of 12.7 roentgens. Seven of the eight volunteer officers exceeded the established limit of 10.0 roentgens for one test (40; 64).

The eight volunteer officer observers at Shot SIMON were within the range of initial neutron radiation and they received neutron exposures in addition to gamma exposures. The film badges and pocket dosimeters these individuals carried, however, were not designed to measure neutron exposures. Dose reconstruction for the volunteer observers indicates an average neutron dose of about 28 roentgens (25).

#### 4.1.3 Radiation Protection for the Operational Helicopter Test

During the helicopter test mission, pilots were instructed to avoid areas where the radiation intensity was greater than 10.0 R/h. One of the helicopters at Shot SIMON encountered

intensities of up to 50 R/h before it could take evasive action. Radiological safety monitors were aboard the three helicopters, but information is not available on the radiation levels measured by these monitors (29). Film badge data for the helicopter personnel have not been found.

#### 4.2 JOINT TEST ORGANIZATION RADIATION PROTECTION PROCEDURES

Military personnel who were members of the 9778th Radiological Safety Support Unit performed all radiation protection activities onsite. In addition, civilian and military personnel were involved in offsite monitoring operations.

##### 4.2.1 Dosimetry

During the period from 24 April until 2 May, members of the Dosimetry and Records Section processed 1,880 film badges. On shot-day and the day after, 39 individuals had received cumulative gamma exposures exceeding the established 3.9 roentgen limit. A comparison of film badge to pocket dosimeter readings on these two days showed that film badges generally read twice as high as pocket dosimeters. Since individuals used their pocket dosimeters to monitor their exposure in the shot-area, this discrepancy could have accounted for the overexposures at SIMON (12; 14).

Eight men from the Wright Air Development Center received exposures between 5.0 and 8.9 roentgens. These men were probably responsible for decontaminating aircraft from the 4925th Test Group that participated in Shot SIMON (21). An individual from the 4920th Medical Group at Kirtland AFB also participated in the aircraft decontamination and had an exposure of 5.1 roentgens. Six personnel from Fort McClellan, Alabama, who were assigned to the Radiological Safety Support Unit received total exposures ranging from 4.0 to 8.4 roentgens as a result of monitoring

activities. In addition, six Air Force personnel from Lowry AFB, Colorado, participated in activities that resulted in overexposures ranging from 4.4 to 6.9 roentgens. Also, two employees of Evans Signal Laboratory received total exposures of 16.1 and 16.9 roentgens at SIMON (1a; 1b).

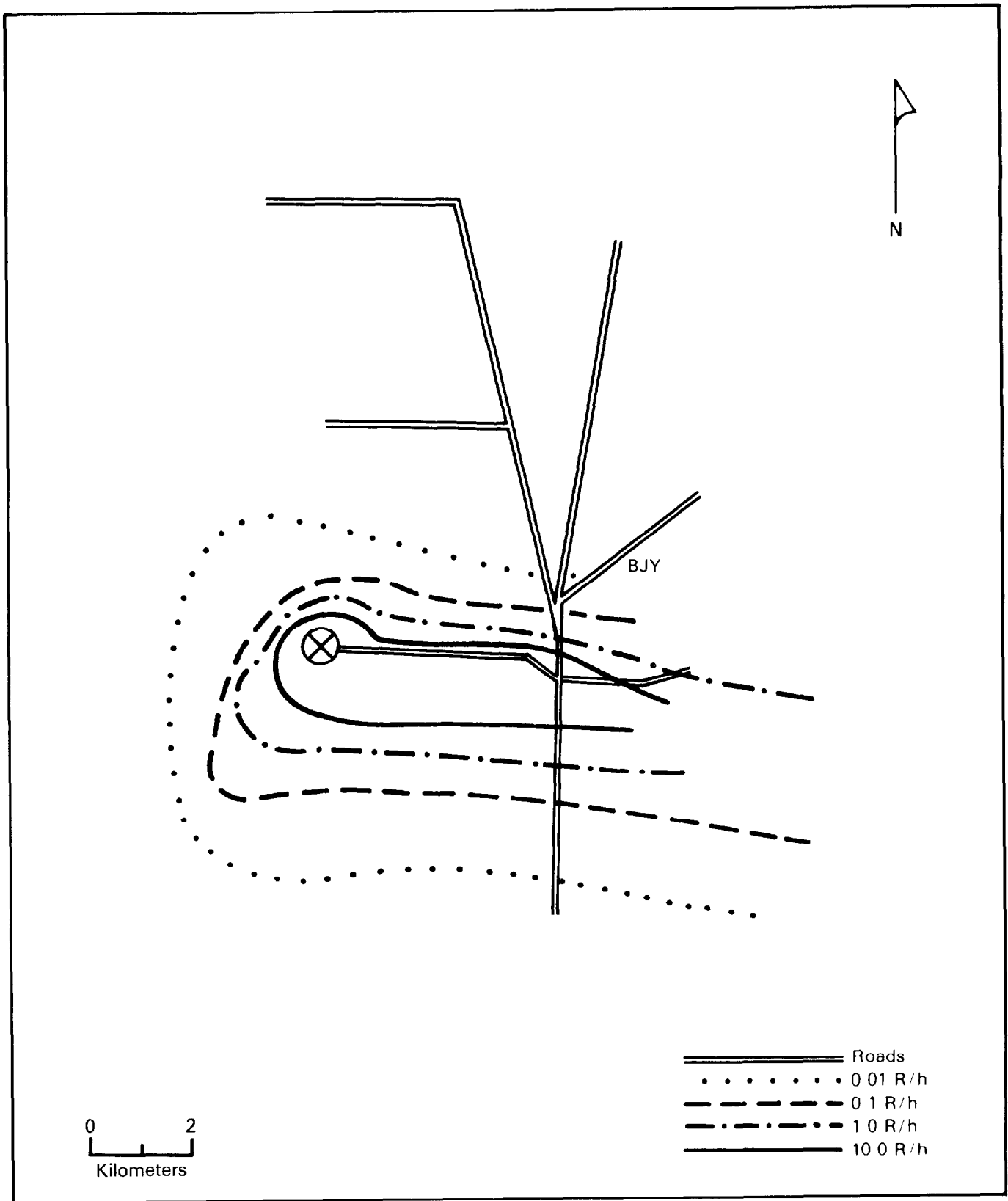
Film badge records indicate that nine other JTO participants at SIMON received exposures greater than 3.9 roentgens. These individuals had exposures that ranged from 4.2 to 9.2 roentgens. One individual was from each of the following organizations: Bureau of Ships; Naval Medical Research Institute; Wichita Municipal Airport; Naval Hospital in San Diego; Naval Training Center in San Diego; Naval Amphibious Base in Coronado, California; and Naval Ordnance Test Center in Inyokern, California. In addition, one individual was attached to Commander, Amphibious Group 3, and another was from the Navy Bureau of Medicine and Surgery (1a; 1b).

#### 4.2.2 Logistics

During the period of 24 April to 2 May, the Supply Section issued 316 protective caps, 359 pairs of shoe covers, 283 respirators, 327 pairs of gloves, and 218 pairs of goggles. The Instrument Supply and Repair Section issued 124 radiation survey instruments (14).

#### 4.2.3 Monitoring

The initial onsite survey party of four two-man teams left the Radiological Safety Building at the Control Point five minutes after detonation. At 0450, 20 minutes after detonation, the survey party began reporting gamma readings. Extensive fallout on access roads slowed the completion of the survey which continued until 0730 hours. A copy of this initial survey plot is shown in figure 4-1. Due to extensive contamination in the



**Figure 4-1: INITIAL SURVEY FOR SHOT SIMON,  
25 APRIL 1953, 0730 HOURS**



onsite area, the Test Director did not declare recovery hour until 1230 hours, eight hours after the detonation. Monitors also resurveyed the shot-area that day, beginning at 1500 hours. Data from this resurvey were used to make the isointensity plot shown in figure 4-2 (12; 14).

A shift in the wind direction at shot-time caused the cloud from Shot SIMON to drift to the east of the Nevada Proving Ground. Offsite monitors patrolling this area encountered significant gamma radiation (0.2 R/h) due to fallout on Highways 91 and 93 north of Glendale, Nevada. These results were transmitted to the Test Director who ordered that roadblocks, manned by Offsite Monitoring personnel, be established at North Las Vegas and Alamo, Nevada, and at St. George, Utah. This was the first time any of the continental nuclear tests had required roadblocks off the Nevada Proving Ground to monitor vehicles for radioactive contamination (12; 14).

An H-18 helicopter performed the close-in aerial survey, taking off from the Control Point ten minutes after the detonation. The highest intensity encountered was 10.0 R/h (12). Two L-20s and a C-47 performed the extended terrain survey, up to 320 kilometers offsite. The C-47 also resurveyed the area the next day. The maximum radiation intensity on the ground detected by the C-47 on shot-day was 0.11 R/h. The L-20s conducted surveys on shot-day only, encountering maximum intensities of 0.8 R/h (14).

#### 4.2.4 Plotting and Briefing

From 24 April to 2 May, a total of 789 people in 262 parties received briefing for entry into controlled areas. Ten parties were permitted to enter the shot area before recovery hour (14).

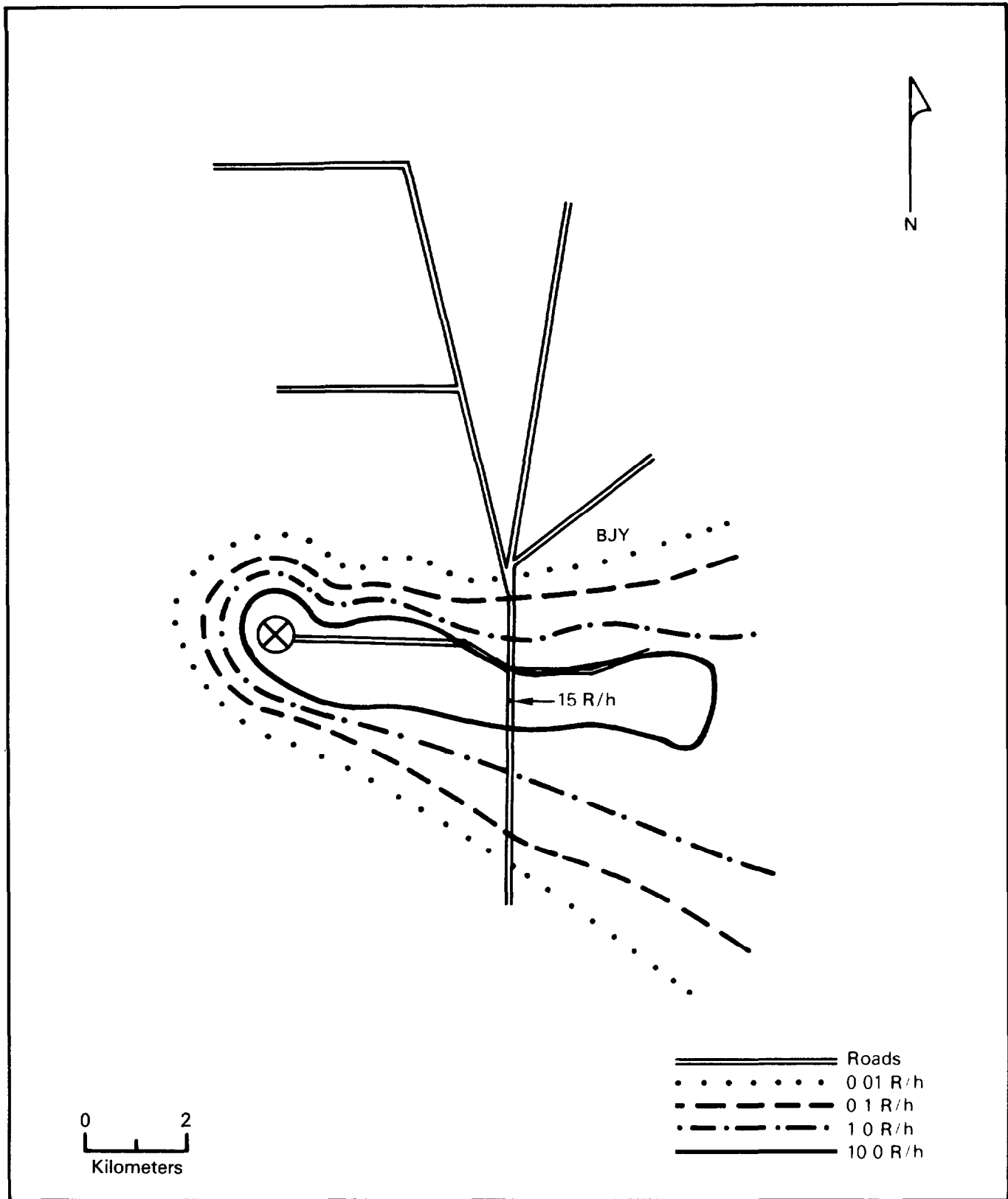


Figure 4-2: RESURVEY FOR SHOT SIMON,  
 25 APRIL 1953, 1500 HOURS

Members of the Plotting and Briefing Section also prepared the two radiation isointensity plots of the SIMON shot area shown in figures 4-1 and 4-2 (14).

#### 4.2.5 Decontamination

Members of the Vehicle Decontamination Section decontaminated 102 JTO vehicles onsite during the period covering Shot SIMON (14).

In addition, due to heavy fallout on Highways 91 and 93, decontamination stations were established at the three roadblocks to monitor and decontaminate public vehicles that passed through the contaminated area. The roadblocks and decontamination stations at St. George and at North Las Vegas each had one DOD monitor. Alamo had no DOD monitor (14).



## SHOT SIMON REFERENCE LIST

The following list of references represents only those documents cited in the SIMON volume. When a DNA-WT document is followed by an EX, the latest version has been cited. A complete list of documents reviewed during the preparation of the Operation UPSHOT-KNOTHOLE volumes is contained in the Operation UPSHOT-KNOTHOLE volume Bibliography.

## AVAILABILITY INFORMATION

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

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

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P.O. Box 14100  
Las Vegas, Nevada 89114

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(Sales Office)

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

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\*\*\*\*Requests subject to Privacy Act restrictions.

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Central Michigan University  
ATTN: Library Docs Sec

Central Missouri State Univ  
ATTN: Gov Docs

Central State University  
ATTN: Lib Docs Dept

Central Washington University  
ATTN: Lib Docs Sec

Central Wyoming College Library  
ATTN: Librn

Charleston County Library  
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Charlotte & Mecklenburg County Public Library  
ATTN: E. Correll

Chattanooga Hamilton County, Bicentennial Library  
ATTN: Librn

Chesapeake Public Library System  
ATTN: Librn

Chicago Public Library  
ATTN: Gov Pubs Dept

State University of Chicago  
ATTN: Librn

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

Cincinnati University Library  
ATTN: Librn

Claremont Colleges Libraries  
ATTN: Doc Collection

Clemson University  
ATTN: Dir of Libraries

OTHER (Continued)

Cleveland Public Library  
ATTN: Docs Collection

Cleveland State University Library  
ATTN: Librn

Coe Library  
ATTN: Docs Div

Colgate University Library  
ATTN: Ref Lib

Colorado State University Libraries  
ATTN: Librn

University of Colorado Libraries  
ATTN: Dir of Libraries

Columbia University Library  
ATTN: Docs Svc Ctr

Columbus & Franklin Cty Public Library  
ATTN: Gen Rec Div

Compton Library  
ATTN: Librn

Connecticut State Library (Reg)  
ATTN: Librn

University of Connecticut  
ATTN: Gov't of Connecticut

University of Connecticut  
ATTN: Dir of Libraries

Cornell University Library  
ATTN: Librn

Corpus Christi State University Library  
ATTN: Librn

Culver City Library  
ATTN: Librn

Curry College Library  
ATTN: Librn

University of North Carolina at Asheville  
ATTN: Librn

Dallas County Public Library  
ATTN: Librn

Dallas Public Library  
ATTN: Librn

Dalton Junior College Library  
ATTN: Librn

Dartmouth College  
ATTN: Librn

Davenport Public Library  
ATTN: Librn

Davidson College  
ATTN: Librn

OTHER (Continued)

Dayton & Montgomery City Public Library  
ATTN: Librn

University of Dayton  
ATTN: Librn

Decatur Public Library  
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Dekalb Community College So Cpus  
ATTN: Librn

Delaware Pauw University  
ATTN: Librn

University of Delaware  
ATTN: Librn

Delta College Library  
ATTN: Librn

Delta State University  
ATTN: Librn

Denison University Library  
ATTN: Librn

Denver Public Library (Reg)  
ATTN: Docs Div

Dept of Library & Archives (Reg)  
ATTN: Librn

Detroit Public Library  
ATTN: Librn

Burlington Library  
ATTN: Librn

Dickinson State College  
ATTN: Librn

Alabama Agricultural Mechanical University & Coll  
ATTN: Librn

Drake University  
ATTN: Cowles Library

Drew University  
ATTN: Librn

Duke University  
ATTN: Pub Docs Dept

Duluth Public Library  
ATTN: Docs Sec

East Carolina University  
ATTN: Lib Docs Dept

East Central University  
ATTN: Librn

East Islip Public Library  
ATTN: Librn

OTHER (Continued)

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

East Tennessee State University Sherrod Library  
ATTN: Docs Dept

East Texas State University  
ATTN: Library

Monmouth County Library Eastern Branch  
ATTN: Librn

Eastern Illinois University  
ATTN: Librn

Eastern Kentucky University  
ATTN: Librn

Eastern Michigan University Library  
ATTN: Library

Eastern Montana College Library  
ATTN: Docs Dept

Eastern New Mexico University  
ATTN: Librn

Eastern Oregon College Library  
ATTN: Librn

Eastern Washington University  
ATTN: Librn

El Paso Public Library  
ATTN: Docs & Geneology Dept

Elko County Library  
ATTN: Librn

Elmira College  
ATTN: Librn

Elon College Library  
ATTN: Librn

Enoch Pratt Free Library  
ATTN: Docs Ofc

Emory University  
ATTN: Librn

Evansville & Vanderburgh Cty Public Library  
ATTN: Librn

Everett Public Library  
ATTN: Librn

Fairleigh Dickinson University  
ATTN: Depository Dept

Florida A & M University  
ATTN: Librn

Florida Atlantic University Library  
ATTN: Div of Pub Docs

OTHER (Continued)

Florida Institute of Technology  
ATTN: Library

Florida International University Library  
ATTN: Docs Sec

Florida State Library  
ATTN: Docs Sec

Florida State University  
ATTN: Librn

University of Florida  
ATTN: Docs Dept

Fond Du Lac Public Library  
ATTN: Librn

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

Ft Worth Public Library  
ATTN: Librn

Free Public Library of Elizabeth  
ATTN: Librn

Free Public Library  
ATTN: Librn

Freeport Public Library  
ATTN: Librn

Fresno Cty Free Library  
ATTN: Librn

Gadsden Public Library  
ATTN: Librn

Garden Public Library  
ATTN: Librn

Gardner Webb College  
ATTN: Docs Library

Gary Public Library  
ATTN: Librn

Geauga Cty Public Library  
ATTN: Librn

Georgetown University Library  
ATTN: Gov Docs Room

Georgia Institute of Technology  
ATTN: Librn

Georgia Southern College  
ATTN: Librn

Georgia Southwestern College  
ATTN: Dir of Libraries

Georgia State University Library  
ATTN: Librn

OTHER (Continued)

University of Georgia  
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Glassboro State College  
ATTN: Librn

Gleeson Library  
ATTN: Librn

Graceland College  
ATTN: Librn

Grand Forks Public City-County Library  
ATTN: Librn

Grand Rapids Public Library  
ATTN: Dir of Lib

Greenville County Library  
ATTN: Librn

Guam RFK Memorial University Library  
ATTN: Fed Depository Coll

University of Guam  
ATTN: Librn

Gustavus Adolphus College  
ATTN: Librn

South Dakota University  
ATTN: Librn

Hardin-Simmons University Library  
ATTN: Librn

Hartford Public Library  
ATTN: Librn

Harvard College Library  
ATTN: Dir of Lib

Harvard College Library  
ATTN: Serials Rec Div

University of Hawaii Library  
ATTN: Gov Docs Coll

Hawaii State Library  
ATTN: Fed Docs Unit

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

University of Hawaii  
Hilo Campus Library  
ATTN: Librn

Haydon Burns Library  
ATTN: Librn

Hennepin County Library  
ATTN: Gov Docs

Henry Ford Community College Library  
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OTHER (Continued)

Herbert H. Lehman College  
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Hofstra University Library  
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Hollins College  
ATTN: Librn

Hopkinsville Community College  
ATTN: Librn

Wagner College  
ATTN: Librn

University of Houston Library  
ATTN: Docs Div

Houston Public Library  
ATTN: Librn

Tulane University  
ATTN: Docs Dept

Hoyt Public Library  
ATTN: Librn

Humboldt State College Library  
ATTN: Docs Dept

Huntington Park Library  
ATTN: Librn

Hutchinson Public Library  
ATTN: Librn

Idaho Public Library & Information Center  
ATTN: Librn

Idaho State Library  
ATTN: Librn

Idaho State University Library  
ATTN: Docs Dept

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

University of Illinois Library  
ATTN: Docs Sec

Illinois State Library (Reg)  
ATTN: Gov Docs Br

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

Illinois Valley Community College  
ATTN: Library

Illinois State University  
ATTN: Librn

Indiana State Library (Reg)  
ATTN: Serial Sec

Indiana State University  
ATTN: Docs Library

OTHER (Continued)

Indiana University Library  
ATTN: Docs Dept

Indianapolis Marion County Public Library  
ATTN: Social Science Div

Iowa State University Library  
ATTN: Gov Docs Dept

Iowa University Library  
ATTN: Gov Docs Dept

Butler University  
ATTN: Librn

Isaac Delchdo College  
ATTN: Librn

James Madison University  
ATTN: Librn

Jefferson County Public Library  
Lakewood Regional Library  
ATTN: Librn

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

Johns Hopkins University  
ATTN: Docs Library

La Roche College  
ATTN: Librn

Johnson Free Public Library  
ATTN: Librn

Kalamazoo Public Library  
ATTN: Librn

Kansas City Public Library  
ATTN: Docs Div

Kansas State Library  
ATTN: Librn

Kansas State University Library  
ATTN: Docs Dept

University of Kansas  
ATTN: Dir of Library (Reg)

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

Maine Maritime Academy  
ATTN: Librn

University of Maine  
ATTN: Librn

OTHER (Continued)

Kent State University Library  
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Kentucky Dept of Library & Archives  
ATTN: Docs Sec

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

Kenyon College Library  
ATTN: Librn

Lake Forest College  
ATTN: Librn

Lake Sumter Community College Library  
ATTN: Librn

Lakeland Public Library  
ATTN: Librn

Lancaster Regional Library  
ATTN: Librn

Lawrence University  
ATTN: Docs Dept

Brigham Young University  
ATTN: Docs & Map Sec

Lewis University Library  
ATTN: Librn

Library and Statutory Dist & Svc  
2 cy ATTN: Librn

Earlham College  
ATTN: Librn

Little Rock Public Library  
ATTN: Librn

Long Beach Public Library  
ATTN: Librn

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

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

Louisville Free Public Library  
ATTN: Librn

Louisville University Library  
ATTN: Librn

Hoover Institution  
ATTN: J. Bingham



OTHER (Continued)

Manchester City Library  
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Mankato State College  
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University of Maine at Farmington  
ATTN: Dir of Libraries

Marathon County Public Library  
ATTN: Librn

Principia College  
ATTN: Librn

University of Maryland  
ATTN: McKeidin Library Docs Div

University of Maryland  
ATTN: Librn

University of Massachusetts  
ATTN: Gov Docs Coll

Mauı Public Library  
Kahului Branch  
ATTN: Librn

McNeese State University  
ATTN: Librn

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

Memphis State University  
ATTN: Librn

Mercer University  
ATTN: Librn

Mesa County Public Library  
ATTN: Librn

Miami Dade Community College  
ATTN: Librn

University of Miami Library  
ATTN: Gov Pubs

Miami Public Library  
ATTN: Docs Div

Miami University Library  
ATTN: Docs Dept

University of Santa Clara  
ATTN: Docs Div

Michigan State Library  
ATTN: Librn

Michigan State University Library  
ATTN: Librn

Murray State University Library  
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OTHER (Continued)

Michigan Tech University  
ATTN: Lib Docs Dept

University of Michigan  
ATTN: Acq Sec Docs Unit

Middlebury College Library  
ATTN: Librn

Millersville State College  
ATTN: Librn

State University of New York  
ATTN: Docs Librn

Milwaukee Public Library  
ATTN: Librn

Minneapolis Public Library  
ATTN: Librn

University of Minnesota  
ATTN: Dir of Libraries (Reg)

Minot State College  
ATTN: Librn

Mississippi State University  
ATTN: Librn

University of Mississippi  
ATTN: Dir of Libraries

Missouri University at Kansas City General  
ATTN: Librn

University of Missouri Library  
ATTN: Gov Docs

M.I.T. Libraries  
ATTN: Librn

Mobile Public Library  
ATTN: Gov Info Div

Midwestern University  
ATTN: Librn

Montana State Library  
ATTN: Librn

Montana State University Library  
ATTN: Librn

University of Montana  
ATTN: Dir of Libraries (Reg)

Montebello Library  
ATTN: Librn

Moorhead State College  
ATTN: Library

Mt Prospect Public Library  
ATTN: Gov't Info Ctr

OTHER (Continued)

Nassau Library System  
ATTN: Librn

Natrona County Public Library  
ATTN: Librn

Nebraska Library Community  
Nebraska Public Clearinghouse  
ATTN: Librn

University of Nebraska at Omaha  
ATTN: Univ Lib Docs

Nebraska Western College Library  
ATTN: Librn

University of Nebraska  
ATTN: Dir of Libraries (Reg)

University of Nebraska Library  
ATTN: Acquisitions Dept

University of Nevada Library  
ATTN: Gov Pubs Dept

University of Nevada at Las Vegas  
ATTN: Dir of Libraries

New Hampshire University Library  
ATTN: Librn

New Hanover County Public Library  
ATTN: Librn

New Mexico State Library  
ATTN: Librn

New Mexico State University  
ATTN: Lib Docs Div

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

University of New Orleans Library  
ATTN: Gov Docs Div

New Orleans Public Library  
ATTN: Librn

New York Public Library  
ATTN: Librn

New York State Library  
ATTN: Docs Control Cultural Ed Ctr

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

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

State University of New York  
ATTN: Lib Docs Sec

North Texas State University Library  
ATTN: Librn

OTHER (Continued)

State University of New York  
ATTN: Librn

New York State University  
ATTN: Docs Ctr

State University of New York  
ATTN: Docs Dept

New York University Library  
ATTN: Docs Dept

Newark Free Library  
ATTN: Librn

Newark Public Library  
ATTN: Librn

Niagara Falls Public Library  
ATTN: Librn

Nicholls State University Library  
ATTN: Docs Div

Nieves M. Flores Memorial Library  
ATTN: Librn

Norfolk Public Library  
ATTN: R. Parker

North Carolina Agricultural & Tech State  
University  
ATTN: Librn

University of North Carolina at Charlotte  
ATTN: Atkins Lib Doc Dept

University Library of North Carolina at Greensboro  
ATTN: Librn

University of North Carolina at Wilmington  
ATTN: Librn

North Carolina Central University  
ATTN: Librn

North Carolina State University  
ATTN: Librn

University of North Carolina  
ATTN: BA SS Div Docs

North Dakota State University Library  
ATTN: Docs Librn

University of North Dakota  
ATTN: Librn

North Georgia College  
ATTN: Librn

Minnesota Div of Emergency Svcs  
ATTN: Librn

OTHER (Continued)

Northeast Missouri State University  
ATTN: Librn

Northeastern Oklahoma State University  
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Northeastern University  
ATTN: Dodge Library

Northern Arizona University Library  
ATTN: Gov Docs Dept

Northern Illinois University  
ATTN: Librn

Northern Michigan University  
ATTN: Docs

Northern Montana College Library  
ATTN: Librn

Northwestern Michigan College  
ATTN: Librn

Northwestern State University  
ATTN: Librn

Northwestern State University Library  
ATTN: Librn

Northwestern University Library  
ATTN: Gov Pubs Dept

Norwalk Public Library  
ATTN: Librn

Northeastern Illinois University  
ATTN: Library

University of Notre Dame  
ATTN: Doc Ctr

Oakland Community College  
ATTN: Librn

Oakland Public Library  
ATTN: Librn

Oberlin College Library  
ATTN: Librn

Ocean County College  
ATTN: Librn

Ohio State Library  
ATTN: Librn

Ohio State University  
ATTN: Lib Docs Div

Ohio University Library  
ATTN: Docs Dept

Oklahoma City University Library  
ATTN: Librn

Oklahoma City University Library  
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OTHER (Continued)

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

University of Oklahoma  
ATTN: Docs Div

Old Dominion University  
ATTN: Doc Dept Univ Lib

Olivet College Library  
ATTN: Librn

Omaha Public Library Clark Branch  
ATTN: Librn

Onondaga County Public Library  
ATTN: Gov Docs Sec

Oregon State Library  
ATTN: Librn

University of Oregon  
ATTN: Docs Sec

Quachita Baptist University  
ATTN: Librn

Pan American University Library  
ATTN: Librn

Passaic Public Library  
ATTN: Librn

Queens College  
ATTN: Docs Dept

Pennsylvania State Library  
ATTN: Gov Pubs Sec

Pennsylvania State University  
ATTN: Lib Doc Sec

University of Pennsylvania  
ATTN: Dir of Libraries

University of Denver  
ATTN: Penrose Library

Peoria Public Library  
ATTN: Business, Science & Tech Dept

Free Library of Philadelphia  
ATTN: Gov Pubs Dept

Philipsburg Free Public Library  
ATTN: Library

Phoenix Public Library  
ATTN: Librn

University of Pittsburgh  
ATTN: Docs Office, G8

Plainfield Public Library  
ATTN: Librn

OTHER (Continued)

Popular Creek Public Library District  
ATTN: Librn

Association of Portland Library  
ATTN: Librn

Portland Public Library  
ATTN: Librn

Portland State University Library  
ATTN: Librn

Pratt Institute Library  
ATTN: Librn

Louisiana Tech University  
ATTN: Librn

Princeton University Library  
ATTN: Docs Div

Providence College  
ATTN: Librn

Providence Public Library  
ATTN: Librn

Public Library Cincinnati & Hamilton County  
ATTN: Librn

Public Library of Nashville and Davidson County  
ATTN: Librn

University of Puerto Rico  
ATTN: Doc & Maps Room

Purdue University Library  
ATTN: Librn

Quinebaug Valley Community College  
ATTN: Librn

Auburn University  
ATTN: Microforms & Docs Dept

Rapid City Public Library  
ATTN: Librn

Reading Public Library  
ATTN: Librn

Reed College Library  
ATTN: Librn

Augusta College  
ATTN: Librn

University of Rhode Island Library  
ATTN: Gov Pubs Ofc

University of Rhode Island  
ATTN: Dir of Libraries

Rice University  
ATTN: Dir of Libraries

Louisiana College  
ATTN: Librn

OTHER (Continued)

Richland County Public Library  
ATTN: Librn

Riverside Public Library  
ATTN: Librn

University of Rochester Library  
ATTN: Docs Sec

University of Rutgers Camden Library  
ATTN: Librn

State University of Rutgers  
ATTN: Librn

Rutgers University  
ATTN: Dir of Libraries (Reg)

Rutgers University Law Library  
ATTN: Fed Docs Dept

Salem College Library  
ATTN: Librn

Samford University  
ATTN: Librn

San Antonio Public Library  
ATTN: Bus Science & Tech Dept

San Diego County Library  
ATTN: C. Jones, Acquisitions

San Diego Public Library  
ATTN: Librn

San Diego State University Library  
ATTN: Gov Pubs Dept

San Francisco Public Library  
ATTN: Gov Docs Dept

San Francisco State College  
ATTN: Gov Pubs Coll

San Jose State College Library  
ATTN: Docs Dept

San Luis Obispo City-County Library  
ATTN: Librn

Savannah Public & Effingham Liberty Regional  
Library  
ATTN: Librn

Scottsbluff Public Library  
ATTN: Librn

Scranton Public Library  
ATTN: Librn

Seattle Public Library  
ATTN: Ref Docs Asst

OTHER (Continued)

Selby Public Library  
ATTN Librn

Shawnee Library System  
ATTN Librn

Shreve Memorial Library  
ATTN Librn

Silas Bronson Public Library  
ATTN Librn

Sioux City Public Library  
ATTN Librn

Skidmore College  
ATTN Librn

Slippery Rock State College Library  
ATTN Librn

South Carolina State Library  
ATTN Librn

University of South Carolina  
ATTN Librn

University of South Carolina  
ATTN Gov Docs

South Dakota School of Mines & Technical Library  
ATTN Librn

South Dakota State Library  
ATTN Fed Docs Dept

University of South Dakota  
ATTN Docs Librn

South Florida University Library  
ATTN Librn

Southeast Missouri State University  
ATTN Librn

Southeastern Massachusetts University Library  
ATTN Docs Sec

University of Southern Alabama  
ATTN Librn

Southern California University Library  
ATTN Docs Dept

Southern Connecticut State College  
ATTN Library

Southern Illinois University  
ATTN Librn

Southern Illinois University  
ATTN Docs Ctr

Southern Methodist University  
ATTN Librn

University of Southern Mississippi  
ATTN Library

OTHER (Continued)

Southern Oregon College  
ATTN Library

Southern University in New Orleans Library  
ATTN Librn

Southern Utah State College Library  
ATTN Docs Dept

Southwest Missouri State College  
ATTN Library

University of Southwestern Louisiana Libraries  
ATTN Librn

Southwestern University  
ATTN Librn

Spokane Public Library  
ATTN Ref Dept

Springfield City Library  
ATTN Docs Sec

St Bonaventure University  
ATTN Librn

St Joseph Public Library  
ATTN Librn

St Lawrence University  
ATTN Librn

St Louis Public Library  
ATTN Librn

St Paul Public Library  
ATTN Librn

Stanford University Library  
ATTN Gov Docs Dept

State Historical Soc Library  
ATTN Docs Serials Sec

State Library of Massachusetts  
ATTN Librn

State University of New York  
ATTN Librn

Stetson University  
ATTN Librn

University of Steubenville  
ATTN Librn

Stockton & San Joaquin Public Library  
ATTN Librn

Stockton State College Library  
ATTN Librn

Albion College  
ATTN Gov Docs Librn

OTHER (Continued)

Superior Public Library  
ATTN: Librn

Swarthmore College Library  
ATTN: Ref Dept

Syracuse University Library  
ATTN: Docs Div

Tacoma Public Library  
ATTN: Librn

Hillsborough County Public Library at Tampa  
ATTN: Librn

Temple University  
ATTN: Librn

Tennessee Technological University  
ATTN: Librn

University of Tennessee  
ATTN: Dir of Libraries

College of Idaho  
ATTN: Librn

Texas A & M University Library  
ATTN: Librn

University of Texas at Arlington  
ATTN: Library Docs

University of Texas at San Antonio  
ATTN: Library

Texas Christian University  
ATTN: Librn

Texas State Library  
ATTN: U.S. Docs Sec

Texas Tech University Library  
ATTN: Gov Docs Dept

Texas University at Austin  
ATTN: Docs Coll

University of Toledo Library  
ATTN: Librn

Toledo Public Library  
ATTN: Social Science Dept

Torrance Civic Center Library  
ATTN: Librn

Traverse City Public Library  
ATTN: Librn

Trenton Free Public Library  
ATTN: Librn

Trinity College Library  
ATTN: Librn

Trinity University Library  
ATTN: Docs Coll

OTHER (Continued)

Tufts University Library  
ATTN: Docs Dept

University of Tulsa  
ATTN: Librn

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

Uniformed Services University of the Health Sciences  
ATTN: LRC Library

University Libraries  
ATTN: Dir of Lib

University of Maine at Orono  
ATTN: Librn

University of Northern Iowa  
ATTN: Library

Upper Iowa College  
ATTN: Docs Coll

Utah State University  
ATTN: Librn

University of Utah  
ATTN: Special Collections

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

Utica Public Library  
ATTN: Librn

Valencia Library  
ATTN: Librn

Valparaiso University  
ATTN: Librn

Vanderbilt University Library  
ATTN: Gov Docs Sec

University of Vermont  
ATTN: Dir of Libraries

Virginia Commonwealth University  
ATTN: Librn

Virginia Military Institute  
ATTN: Librn

Virginia Polytechnic Institute Library  
ATTN: Docs Dept

Virginia State Library  
ATTN: Serials Sec

University of Virginia  
ATTN: Pub Docs

Volusia County Public Library  
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OTHER (Continued)

Washington State Library  
ATTN: Docs Sec

Washington State University  
ATTN: Lib Docs Sec

Washington University Libraries  
ATTN: Dir of Lib

University of Washington  
ATTN: Docs Div

Wayne State University Library  
ATTN: Librn

Wayne State University Law Library  
ATTN: Docs Dept

Weber State College Library  
ATTN: Librn

Wesleyan University  
ATTN: Docs Librn

West Chester State College  
ATTN: Docs Dept

West Covina Library  
ATTN: Librn

University of West Florida  
ATTN: Librn

West Hills Community College  
ATTN: Library

West Texas State University  
ATTN: Library

West Virginia College of Grad Studies Library  
ATTN: Librn

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

Westerly Public Library  
ATTN: Librn

Western Carolina University  
ATTN: Librn

Western Illinois University Library  
ATTN: Librn

Western Washington University  
ATTN: Librn

Western Wyoming Community College Library  
ATTN: Librn

Westmoreland City Community College  
ATTN: Learning Resource Ctr

OTHER (Continued)

Whitman College  
ATTN: Librn

Wichita State University Library  
ATTN: Librn

Williams & Mary College  
ATTN: Docs Dept

Emporia Kansas State College  
ATTN: Gov Docs Div

William College Library  
ATTN: Librn

Willimantic Public Library  
ATTN: Librn

Winthrop College  
ATTN: Docs Dept

University of Wisconsin at Whitewater  
ATTN: Gov Docs Lib

University of Wisconsin at Milwaukee  
ATTN: Lib Docs

University of Wisconsin at Oshkosh  
ATTN: Librn

University of Wisconsin at Platteville  
ATTN: Doc Unit Lib

University of Wisconsin at Stevens Point  
ATTN: Docs Sec

University of Wisconsin  
ATTN: Gov Pubs Dept

University of Wisconsin  
ATTN: Acquisitions Dept

Worcester Public Library  
ATTN: Librn

Wright State University Library  
ATTN: Gov Docs Librn

Wyoming State Library  
ATTN: Librn

University of Wyoming  
ATTN: Docs Div

Yale University  
ATTN: Dir of Libraries

Yeshiva University  
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