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SHOT
APPLE 2
A Test of the
TEAPOT Series
5 MAY 1955



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United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes the activities of more than 2,000 DOD personnel, both military and civilian, in Shot APPLE 2, the thirteenth nuclear test in the TEAPOT atmospheric nuclear weapons testing series. The test was conducted on 5 May 1955 and involved participants from Exercise Desert Rock VI, AFSWP, AFSWC, AEC, Test Groups, and the Air Weather Service. The largest activity was the test of an armored task force, Task Force RAZOR, which involved approximately 1,000 troops.		

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PREFACE

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

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

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

- Identify DOD personnel who had taken part in the atmospheric nuclear weapons tests
- Determine the extent of the participants' exposure to ionizing radiation

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

- Provide public disclosure of information concerning participation by DOD personnel in the atmospheric nuclear weapons tests.

This report on Shot APPLE 2 is based on the historical record of military and technical documents associated with each of the nuclear weapons test events. These reports provide a public record of the activities and possible radiation exposure of DOD personnel for ongoing public health research and policy analysis.

Many of the documents pertaining specifically to DOD involvement during Shot APPLE 2 were found in the Defense Nuclear Agency Technical Library, the National Federal Archives Record Center, the Department of Energy Nevada Operations Office, and the Los Alamos Scientific Laboratory (LASL).

Commonly, the surviving historical documentation of activities conducted at Shot APPLE 2 addresses test specifications and technical information rather than the personnel data critical to the study undertaken by the Defense Nuclear Agency. Moreover, instances have arisen in which available historical documentation has revealed inconsistencies in vital factual data, such as the number of DOD participants in a certain project at a given shot or their locations and assignments at a given time. These inconsistencies in data usually occur between two or more documents, but occasionally appear within the same document. Efforts have been made to resolve these data inconsistencies wherever possible, or to otherwise bring them to the attention of the reader.

An important example of such discrepancies is the documentation dealing with air operations at Operation TEAPOT. Several postshot and post-series documents were analyzed to determine the nature and extent of these air activities, including Parsons' Operational Summary (WT-1158) and Fackler's Technical Air

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

CONTENTS OF TEAPOT SERIES REPORTS

This volume details participation by DOD personnel in Shot APPLE 2, the 13th nuclear detonation of the Operation TEAPOT nuclear weapons testing series. Four other publications address DOD activities during the TEAPOT Series:

- Series volume: Operation TEAPOT, Atmospheric Nuclear Weapons Tests, 1955
- Multi-shot volume: Shots WASP through HORNET, the First Five TEAPOT Tests
- Shot volume: Shot BEE
- Multi-shot volume: Shots ESS through MET and Shot ZUCCHINI, the Final TEAPOT Tests.

The volumes addressing the test events of Operation TEAPOT have been designed for use with one another. The Series volume contains information that applies to those dimensions of Operation TEAPOT that transcend specific events, such as historical background, organizational relationships, and radiological safety procedures. In addition, the TEAPOT Series volume contains a

bibliography of works consulted in the preparation of all five Operation TEAPOT reports. The single-shot volumes describe DOD participation in Shots BEE and APPLE 2, respectively. These two events have been bound separately because they included significant Exercise Desert Rock maneuvers involving large numbers of DOD personnel. Each multi-shot volume combines shot-specific descriptions for several nuclear events. The shot and multi-shot volumes contain reference lists of only those sources referenced in each text. Descriptions of activities concerning any particular shot in the TEAPOT Series, whether the shot is addressed in a single-shot volume or in a multi-shot volume, should be supplemented by the general organizational and radiological safety information contained in the TEAPOT Series volume.

Another important supplement to the information for this report is the Reference Manual: Background Materials for the CONUS Volumes, which summarizes information on radiation physics, radiation health concepts, exposure criteria, and measurement techniques, as well as listing acronyms and a glossary of terms used in the DOD reports addressing test events in the continental U.S.

TABLE OF CONTENTS

<u>Chapter</u>	<u>Page</u>
P R E F A C E	1
LIST OF ILLUSTRATIONS.	6
LIST OF TABLES	7
LIST OF ABBREVIATIONS AND ACRONYMS	8
SHOT APPLE 2 SYNOPSIS.	9
1 INTRODUCTION	
1.1 Setting and Characteristics of the APPLE 2 Detonation	11
1.2 Department of Defense Participation in Military Effects, Scientific, Operational Training, and Support Activities at Shot APPLE 2	14
1.3 Exercise Desert Rock Activities at Shot APPLE 2	17
1.4 Organization of the APPLE 2 Volume	18
2 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT APPLE 2	
2.1 Troop Orientation and Indoctrination Projects at Shot APPLE 2	20
2.2 Troop Tests at Shot APPLE 2.	25
2.3 Technical Service Projects at Shot APPLE 2	40
3 JOINT TEST ORGANIZATION OPERATIONS AT SHOT APPLE 2	
3.1 Field Command Military Effects Group Projects at Shot APPLE 2.	41
3.2 Department of Defense Participation in Los Alamos Scientific Laboratory Test Group Projects at Shot APPLE 2	49
3.3 Department of Defense Participation in the University of California Radiation Laboratory Test Group Project at Shot APPLE 2	51
3.4 Department of Defense Participation in Civil Effects Test Group Projects at Shot APPLE 2.	51
3.5 Department of Defense Operational Training Projects at Shot APPLE 2	56
3.6 Air Force Special Weapons Center Activities at Shot APPLE 2.	59
3.6.1 Cloud Sampling.	59
3.6.2 Courier Service	61
3.6.3 Cloud Tracking.	62

TABLE OF CONTENTS (Continued)

<u>Chapter</u>	<u>Page</u>
3.6.4 Aerial Surveys of Terrain	63
3.6.5 Radio Relay	63
4 RADIATION PROTECTION ACTIVITIES AT SHOT APPLE 2	
4.1 Desert Rock Radiation Protection Activities at Shot APPLE 2.	65
4.1.1 Radiation Protection Activities for Project 41.2, Armored Task Force Exercise, Task Force RAZOR.	65
4.1.2 Radiation Protection for Project 40.22, Army Volunteer Officer Observers	66
4.1.3 Radiation Protection for Other Desert Rock Observers.	67
4.2 Joint Test Organization Radiation Protection Activities at Shot APPLE 2	67
4.2.1 Dosimetry Records	67
4.2.2 Logistical Data for Radiological Safety Equipment	69
4.2.3 Monitoring Activities	69
4.2.4 Recovery and Re-entry Procedures.	74
4.2.5 Decontamination Activities.	74
REFERENCE LIST	75

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Page</u>
1-1 Location of Shot APPLE 2 at the Nevada Test Site, in Relation to Other Shots in the TEAPOT Series. . .	12
2-1 Location of DOD Observers at Shot APPLE 2, (Projects 40.11, 40.22, 41.3, 41.4, 41.7).	23
2-2 Project 41.2, Armored Task Force Exercise at Shot APPLE 2	32
2-3 A Tank-infantry Team from Task Force RAZOR Demonstrates the Final Phase of t-he Maneuver, the Attack on Objective "A".	33
2-4 Operations of the 1st Combat Aviation Company (Provisional) (-) in Project 41.2, Armored Task Force Exercise	39

LIST OF ILLUSTRATIONS (Continued)

<u>Figure</u>		<u>Page</u>
4-1	Initial Survey for Shot APPLE 2, 5 May 1955, 0550 to 0650 Hours.	71
4-2	Resurvey for Shot APPLE 2, 6 May 1955, 0632 to 0731 Hours	72
4-3	Resurvey for Shot APPLE 2, 9 May 1955, 1030 to 1120 Hours	73

LIST OF TABLES

<u>Table</u>		<u>Page</u>
2-1	Exercise Desert Rock VI Projects, Shot APPLE 2 . . .	21
3-1	Field Command Military Effects Group Projects, Shot APPLE 2	42
3-2	LASL and UCRL Projects with DOD Personnel Involvement, Shot APPLE 2	50
3-3	CETG Projects with DOD Personnel Involvement, Shot APPLE 2	53
3-4	DOD Operational Training Projects, Shot APPLE 2. . .	57
3-5	AFSWC Air Mission Support, Shot APPLE 2.	59

LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used in this volume:

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

APPLE 2

SHOT SYNOPSIS

AEC TEST SERIES: TEAPOT
DOD EXERCISE: Desert Rock VI
DATE/TIME: 5 May 1955, 0510 Hours
YIELD: 29 kilotons
HEIGHT OF BURST: 500 feet (tower shot)

Objectives: (1) To evaluate the nuclear yield and the blast, thermal, and radiation phenomena produced by this nuclear device
(2) To evaluate the utility of the device for military applications, and to investigate additional specifications for further nuclear weapons development
(3) To train selected military personnel in planning and conducting combat operations under the conditions of a nuclear battlefield.
(4) To assess the effects of nuclear detonations on civilian populations and to evaluate Civil Defense emergency preparedness plans.

Weather: At shot-time, the wind was calm at surface level. At 10,000 feet, the wind was from the south-southeast at about 14 knots and from the southwest at 36 knots at 50,000 feet.

Radiation Data: Onsite fallout greater than 0.1 R/h occurred northwest of ground zero. Fallout between 0.01 and 0.1 R/h also occurred northwest of ground zero. A small area of fallout with an intensity of 0.01 R/h extended about three kilometers south of ground zero about one hour after the detonation.

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

CHAPTER 1

INTRODUCTION

Shot APPLE 2 was a test of a nuclear device with a yield of 29 kilotons. The test was conducted at 0510 hours on 5 May 1955 at the Nevada Test Site (NTS), the U.S. Atomic Energy Commission (AEC) continental nuclear test site, located northwest of Las Vegas. APPLE 2 was the 13th nuclear test of Operation TEAPOT, a series of 14 nuclear weapons tests and one non-nuclear test performed at the NTS from 18 February through 15 May 1955 (23; 29).

The APPLE 2 nuclear device was developed for the AEC by the Los Alamos Scientific Laboratory (LASL). The primary objective of the APPLE 2 test was to evaluate the nuclear yield and the blast, thermal, and radiation phenomena produced by this nuclear device. To fulfill this primary objective, LASL and the University of California Radiation Laboratory (UCRL) conducted scientific experiments to study the characteristics of the detonation. Department of Defense (DOD) personnel assisted in a total of 12 projects conducted by LASL, UCRL, and the Federal Civil Defense Administration's Civil Effects Test Group (CETG).

In addition, 12 military effects projects were conducted by the Armed Forces Special Weapons Project (AFSWP) of the DOD. These projects were fielded to evaluate the utility of the device for military applications and to investigate additional specifications for future nuclear weapons development.

A number of other test activities related to the conditions and phenomena produced by a nuclear detonation were also conducted during the APPLE 2 event. The armed services fielded ten projects to evaluate military equipment and tactics, as part

of Exercise Desert Rock VI, the Army technical testing and training program at Operation TEAPOT. In one project, the Army Armored School conducted a demonstration test of an armored task force (Task Force RAZOR) assault. This assault passed near the APPLE 2 ground zero shortly after the detonation. The maneuver involved about 1,000 troops, 89 armored vehicles, and 19 helicopters providing airlift support. In another project, officer volunteers elected to observe the detonation from a forward trench located about 2,380 meters* south of ground zero. The armed services also conducted six operational training projects during APPLE 2, which enabled aircrews and personnel from the Air Force, Navy, and Marine Corps to witness and respond to a nuclear detonation (36; 37; 40; 41).

The Civil Effects Test Group performed 40 separate projects at Shot APPLE 2, the largest number of CETG projects at any shot of the TEAPOT Series. Most of these CETG projects were sponsored by private industry or civil agencies associated with FCDA Operation CUE.

1.1 SETTING AND CHARACTERISTICS OF THE APPLE 2 DETONATION

The nuclear device tested at Shot APPLE 2 was positioned on top of a 500-foot steel tower at UTM coordinates 798009⁺ in Area 1 of Yucca Flat, about 50 kilometers by road from the base facilities at Mercury and Camp Desert Rock. Figure 1-1 shows the

*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.

⁺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.

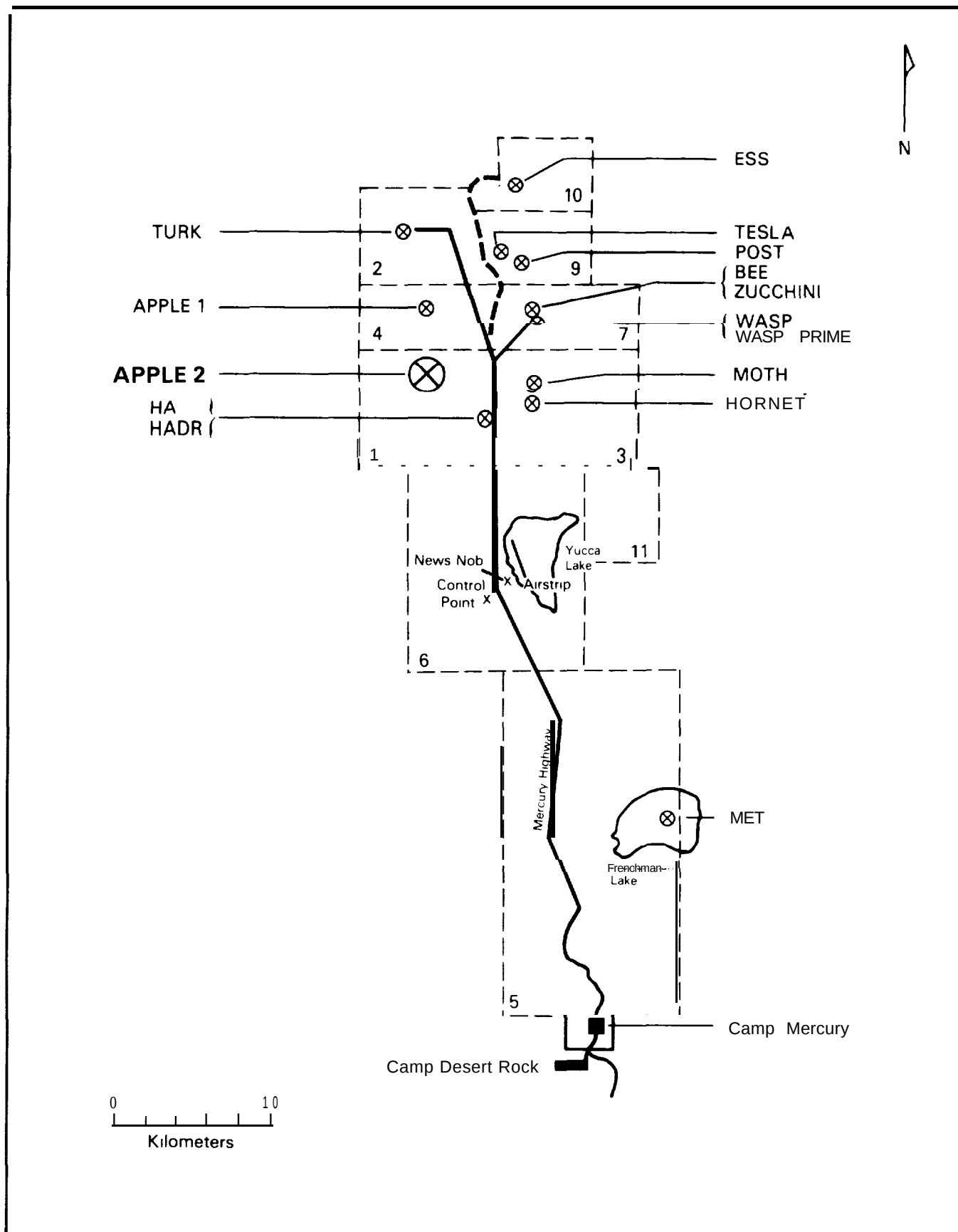


Figure I-I: LOCATION OF SHOT APPLE 2 AT THE NEVADA TEST SITE, IN RELATION TO OTHER SHOTS IN THE TEAPOT SERIES

location of the APPLE 2 detonation in relation to other shots in the TEAPOT Series. The APPLE 2 event was delayed for ten days because of unfavorable weather conditions (29; 31; 33; 55).*

During the night of 4-5 May 1955, the tanks and armored personnel carriers of Task Force RAZOR were manned and positioned as close as 2,835 meters south-southwest of the APPLE 2 shot-tower. Other vehicles were positioned between 3,570 and 6,400 meters south of the tower. In addition, non-armored support units and infantry units waited with their helicopters at Yucca Lake airstrip, near the AEC Control Point, about 13 kilometers southeast of the APPLE 2 site (4; 5; 33).

Early in the morning of 5 May, the ten Army volunteer observers, nine officers and one civilian, awaited the detonation in their trench 2,380 meters south of the tower (12; 33; 44). Most of the remaining 783 DOD observers crouched in long trenches 3,200 meters south of ground zero, east of the armored task force, or in trenches on Mine Mountain, 4,480 meters southwest of the APPLE 2 ground zero. Many of the FCDA Operation CUE observers, including news media personnel, manufacturer's representatives, Civil Defense volunteers, and officials, waited in the FCDA observer area at News Nob, near the AEC Control Point and Yucca Lake airstrip. A special FCDA volunteer group waited in a trench 3,200 meters south of the APPLE 2 shot-tower with the Desert Rock observers (31; 33; 44). Instruments and equipment of the many military effects and diagnostic projects had been placed around ground zero. In the air, aircraft participating in operational training projects and support activities positioned themselves for the detonation.

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

At the time of the detonation, 0510 hours on 5 May, the sky was clear with an unlimited ceiling. Winds were calm at the surface, 14 knots from the southeast at 10,000 feet*, 32 knots from the south at 20,000 feet, 22 knots from the south-southwest at 30,000 feet, 29 knots from the southwest at 40,000 feet, and 36 knots from the southwest at 50,000 feet. The nuclear cloud rose to an altitude of about 51,000 feet and proceeded north from the point of detonation. Onsite fallout occurred northwest of ground zero. The area near ground zero was obscured by dust caused by the detonation. The dust persisted for about four hours, by which time the armored task force assault had been completed, the test area had been surveyed for radioactive contamination, recovery operations had begun, and many military observers had returned to Camp Desert Rock (25; 29; 33).

1.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT APPLE 2

The Joint Test Organization (JTO) was established for planning, coordinating, and conducting atmospheric nuclear weapons tests during Operation TEAPOT. All activities of the JTO were under the control of an AEC-appointed Test Manager, assisted by the Test Director. Composed of personnel from AEC, DOD, and FCDA, the JTO included representatives from the AFSWP Field Command Military Effects Group, the LASL Test Group, the UCRL Test Group, and the FCDA Civil Effects Test Group (CETG). These test groups conducted about 75 military effects and scientific projects at Shot APPLE 2. About one-third of these projects included DOD participants. Six other projects were conducted by the Air Force, Navy, and Marine Corps as part of the DOD operational training program. In addition to those personnel

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

conducting experiments and training, other DOD staff and support personnel provided necessary services to other participants at the test site. For example, Air Force Special Weapons Center (AFSWC) personnel flew special missions for the Test Manager, and soldiers from the 1st Radiological Safety Support Unit monitored radiation intensity areas.

Personnel from DOD agencies and all four armed services participated in the experiments conducted by the four test groups, whose activities were coordinated by the Test Director. The largest DOD scientific involvement was in the 12 projects of the Military Effects Group. DOD personnel also assisted in 12 of the projects conducted by the other test groups, but participation was limited. Participants in the experiments placed data-collection instruments around ground zero in the days and weeks preceding the scheduled event. One hour and 40 minutes after the detonation, when the Test Manager had determined that the radiological environment in the test area would permit limited access, some participants returned to the area to recover instruments and equipment.

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

One important support function during Shot APPLE 2 was provided by the Air Force Special Weapons Center, based at Kirtland Air Force Base (AFB), Albuquerque, New Mexico. This organization provided air support to the Test Manager and to three test group projects. During Operation TEAPOT, AFSWC was composed of units of the 4925th Test Group (Atomic), including the 4926th Test Squadron (Sampling) and the 4935th Air Base Squadron. These units operated from Indian Springs AFB, 38 kilometers southeast of the NTS. Additional support was provided by the 4900th Air

Base Group from Kirtland AFB. For APPLE 2, AFSWC performed several missions, including cloud sampling, cloud tracking, a radio relay, terrain surveys, and courier and transportation services (25; 59; 61).

Radiation protection procedures were established by the JTO to minimize exposure to ionizing radiation. Participants could receive no more than 3.9 roentgens of whole-body gamma radiation for any 13-week period and 15 roentgens of whole-body gamma radiation annually. In implementing these criteria, the 1st Radiological Safety Support Unit rigidly controlled access to contaminated areas, and all project personnel recovering test instruments from areas of high radiation intensity were accompanied by radiological safety monitors. The monitors, who continuously checked the radiation intensity in the recovery area, alerted project leaders if intensities were too great or the length of time in the area was too long. Project personnel were issued film badges to wear at all times when in the test area, to monitor cumulative exposures. These film badges were periodically collected, developed, and evaluated. Any individual whose accumulated exposure exceeded or would be expected to exceed the established limits was barred from further participation in project activities in the forward area. The 1st Radiological Safety Support Unit also implemented personnel decontamination procedures and developed emergency evacuation plans for all test events (16).

With one exception, the radiation protection procedures for the AFSWC aircrew and ground crew personnel were the same as those established for the other JTO participants. The Test Manager authorized cloud-sampler pilots to receive up to a total of 15 roentgens of gamma radiation throughout the TEAPOT Series. Complete decontamination, including showers and changes 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 had decayed to predetermined levels (1; 11; 16; 25).

1.3 EXERCISE DESERT ROCK ACTIVITIES AT SHOT APPLE 2

More than the 1,919 DOD personnel documented in the Desert Rock Final Report are likely to have been involved in Shot APPLE 2. Nine projects were fielded by Exercise Desert Rock VI during the shot. These projects included five troop orientation and indoctrination projects, three troop tests, and one technical service project. Camp Desert Rock support troops participated in two unnumbered projects: the Camp Desert Rock observer program, and damage effects evaluation.

The largest Desert Rock activity included about 1,000 soldiers of Task Force RAZOR who participated in a test of an armored task force. Another group of individuals took part in troop orientation and indoctrination projects: 742 in the numbered projects and 57 Camp Desert Rock support personnel (33; 35-37; 49).

In addition to those already mentioned, Camp Desert Rock support troops from various Army units maintained and operated Camp Desert Rock, providing transportation, communications, engineer, administrative, and security services. The activities of Desert Rock and JTO support personnel, as they took place throughout the entire TEAPOT Series, are described in the TEAPOT Series volume.

During Operation TEAPOT, Camp Desert Rock exercise participants and support personnel were limited to six roentgens of whole-body gamma radiation during any six-month period. The

radiation protection procedures of Exercise Desert Rock used to enforce these criteria included provisions for (12; 16; 17; 34):

- Maintaining minimum safe distances from nuclear detonations
- Enforcing protective procedures for personnel observing the detonation
- Controlling access to areas of high radiation intensity
- Monitoring individuals working in areas of high radiation intensity
- Issuing film badges for Desert Rock personnel and monitoring the cumulative exposure
- Decontaminating all equipment and personnel leaving the test area after the detonation.

Radiation protection procedures at Exercise Desert Rock, as well as those of the JTO, are detailed in the TEAPOT Series volume. They were designed to minimize potential exposure to ionizing radiation while allowing participants to accomplish their project objectives.

1.4 ORGANIZATION OF THE APPLE 2 VOLUME

The remainder of this volume presents a detailed account of DOD activities and the resulting potential for participant exposure to radiation during the APPLE 2 event.

Chapter 2 describes the Exercise Desert Rock VI military activities and chapter 3 describes JTO training activities, scientific experiments, and support missions in which DOD personnel took part. One Desert Rock VI maneuver, the Army test of an armored task force, conducted at APPLE 2 by Task Force RAZOR, involved a thousand soldiers in a single activity. JTO projects, on the other hand, may have included only a few DOD people among a staff of civilian scientists working for the AEC or the FCDA. Chapters 2 and 3 provide information about the

number of DOD participants involved in specific projects fielded at Shot APPLE 2, the time spent by project personnel in the test area, and their positions relative to ground zero (and subsequent radioactive areas) before, during, and after the test. Chapter 4 of this volume describes the radiological environment and safety procedures pertinent to Shot APPLE 2, including isointensity contour maps that illustrate the radioactivity around ground zero following the detonation, and available shot-specific exposure data for individuals. Details of the overall radiation protection program at Operation TEAPOT are provided in the Series volume.

CHAPTER 2

EXERCISE DESERT ROCK VI OPERATIONS AT SHOT APPLE 2

This chapter describes those Desert Rock activities that may have exposed participants to ionizing radiation before, during, and after the detonation. Although the Desert Rock Final Report indicates that 1,919 individuals took part, it is likely that more than 2,000 individuals performed the nine Desert Rock projects at APPLE 2 (33). Approximately half of these participated in a single activity, the Army demonstration test of an armored task force, Task Force RAZOR. The other Desert Rock programs at APPLE 2 included troop orientation and indoctrination, troop tests, and technical service projects. Table 2-1 displays the Desert Rock programs, the subordinate projects, and the estimated number of DOD personnel who took part in each. In addition to the projects listed, Camp Desert Rock personnel assessed the damage to items in the equipment display area.

2.1 TROOP ORIENTATION AND INDOCTRINATION PROJECTS AT SHOT APPLE 2

Troop orientation and indoctrination was an observer program designed to familiarize armed services personnel with the effects of a nuclear detonation. The observer program at Shot APPLE 2 involved several phases, including a preshot orientation, observation of the detonation itself, and postshot inspection of the equipment display area. The military observers in the five numbered projects shown in table 2-1 were drawn from various units of the armed services. The sixth group of observers, not attached to any project, was comprised of soldiers from Camp Desert Rock who witnessed a nuclear test as part of their support duties at the Camp. Among the observer troops at Shot APPLE 2 were the Army volunteer officer observers of Project 40.22.

Table 2-I: EXERCISE DESERT ROCK VI PROJECTS, SHOT APPLE 2

Program Type	Project	Title	Participants	Estimated DOD Personnel
Troop Orientation and Indoctrination	41 3	Army Observers	Army	666
	4622	Army Volunteer Officer Observers	Various Army Service Schools	10*
	41 4	Navy Observers	Navy	36
	4611	Marine Observers	Marine Corps	11
	41 7	Air Force Observers	Air Force	25
		Camp Desert Rock Observers	Camp Desert Rock Support Troops	57
Troop Tests	46.18	Location of Atomic Bursts	Battery C (-) 532nd Field Artillery (Observation) Battalion	48
	41.1	Infantry Regimental Communications Test	Provisional Company, 8th Infantry Division	200
	41 2	Armored Task Force Exercise	Task Force RAZOR †	1000
Technical Service	40.17	Effects on Steel Transporters or Containers	Army Transportation Research and Development Command	10

*Includes one civilian

† Units comprising Task Force RAZOR:

723rd Tank Battalion (-)

Company C, 510th Armored Infantry Battalion

Battery A, 22nd Armored Field Artillery Battalion

1 st Platoon, Company C, 24th Armored Engineer Battalion

1 st Platoon, Company B, 510th Armored Infantry Battalion

Provisional Aviation Company, 1st Combat Aviation Company (-), 1st Armored Division

(-) Indicates that some subordinate units were not present.

The group is discussed with the other four projects in the following paragraphs (31; 33; 36; 49; 50; 62).

Each group of observer participants performed as a unit and remained together before, during, and after the detonation. At APPLE 2, all observers inspected the military equipment display area on 25 April 1955, ten days before the actual detonation. On 5 May 1955, the day APPLE 2 was detonated, the observers left Camp Desert Rock shortly after 0100 hours and arrived at their assigned positions by 0300 hours, two hours before shot-time. Figure 2-1 shows the three areas of Department of Defense (DOD) observer trenches in relation to ground zero and other landmarks at Shot APPLE 2.

The Army volunteer officer observers of Project 40.22 occupied a six-foot-deep trench 2,380 meters south of ground zero. This contingent consisted of nine officers and one civilian from various Army service schools. These volunteers had calculated the minimum safe distance for the upper limit of the anticipated yield of the APPLE 2 nuclear device. By consensus, and with the approval of the Test Director, they had determined the distance at which they would position themselves (31; 33; 34; 50). Most of the 783 other Exercise Desert Rock observers were assembled in long trenches 820 meters farther south. Two female Army observers were among the troops in this command trench, located 3,200 meters from the APPLE 2 ground zero.

A third group of observers included VIPs, members of the news media, and some NATO foreign military observers. These people were positioned in a trench on Mine Mountain, about 4,480 meters southwest of ground zero. A fourth group, dignitaries and press representatives, assembled on News Nob, near the Atomic Energy Commission (AEC) Control Point, about 13 kilometers south of the shot-tower. Volunteer observers for Federal Civil Defense Administration (FCDA) Operation CUE were located in a trench

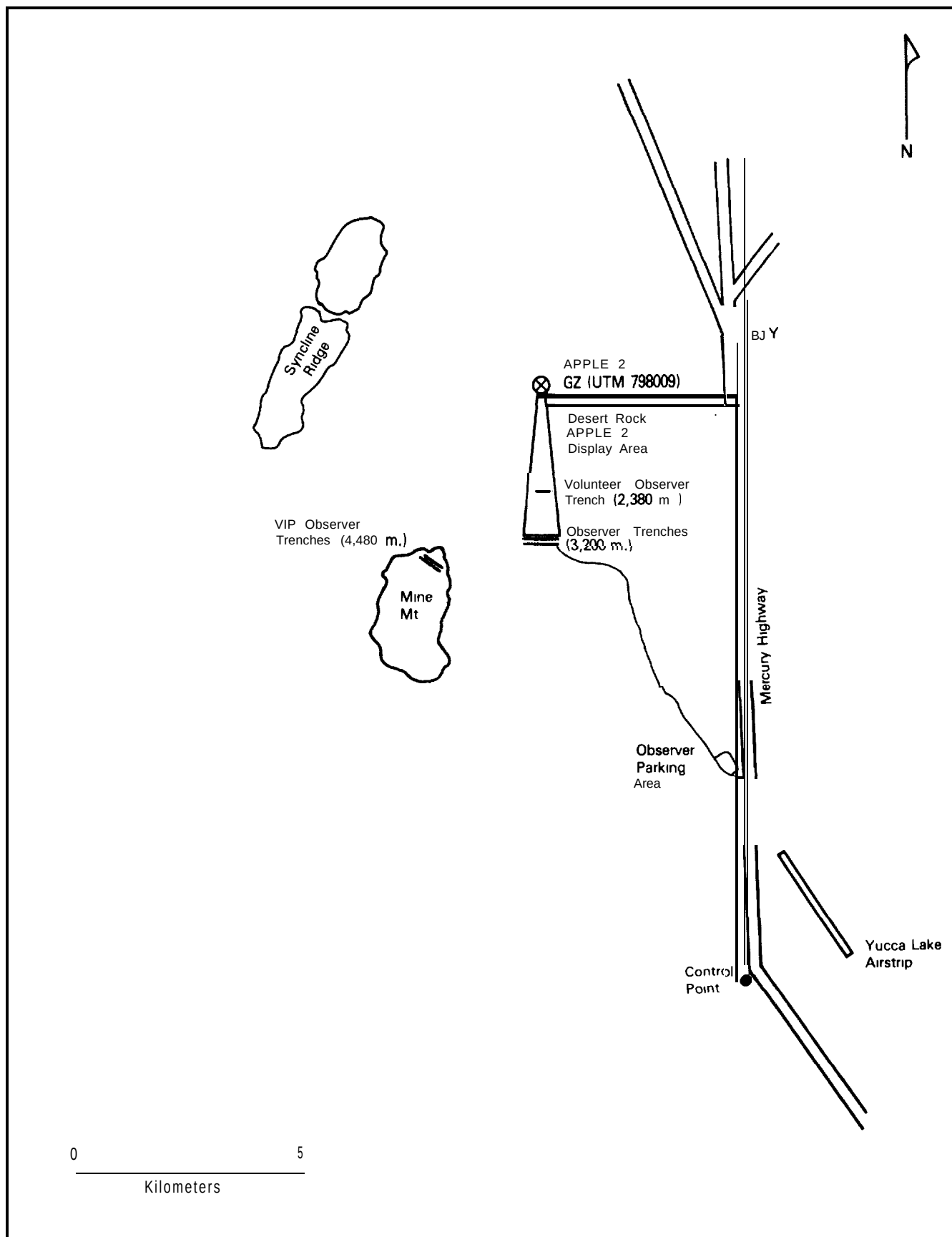


Figure 2-I: LOCATION OF DOD OBSERVERS AT SHOT APPLE 2, (PROJECTS 40.11, 40.22, 41.3, 41.4, 41.7)

3,200 meters southeast of ground zero. These last two observer groups included no Desert Rock participants and few DOD personnel, and are not discussed at length in this chapter (31; 33; 44; 50).

Before the detonation, the observers were in position for preshot checks and orientation. They remained in their positions through the countdown and the detonation. After the detonation, the ten Army volunteer officer observers remained in their trench for about five minutes, and then walked back to the command trench 3,200 meters from ground zero. Although the documentation is unclear, these men probably arrived at the command trench about 15 minutes after the detonation, as radiological safety monitors were completing their initial survey of the display area.

By 20 minutes after the shot, the Desert Rock observers may have begun their inspection of the military equipment display area, the triangular area stretching from ground zero to the trenches 3,200 meters to the south. Documentation is unclear as to whether the ten Army volunteer officer observers joined the other Exercise Desert Rock observers in the inspection of the military equipment display area. Due to the medical and press interest in their postshot condition, the volunteer officer observers may have returned directly to Camp Desert Rock after their arrival at the command trench.

Since radiation intensities at the 450-meter line registered up to 10 roentgens per hour (R/h), the observers who did tour the display area were allowed no closer than 900 meters from ground zero to view equipment. During this time, the observers probably watched the armored assault, conducted by Task Force RAZOR, which was underway to the west (31; 33).

It is estimated that within an hour after the shot, the main group of Desert Rock observers completed their tour of the equipment display area and assembled at the bus loading area for the return trip to Camp Desert Rock. The bus loading area was located near the volunteer officer observer trench, 2,380 meters from ground zero. By 0640 hours, 90 minutes after the detonation, the Desert Rock observers had mustered, brushed themselves off, boarded the buses, and departed for Camp Desert Rock.

Documentation is not specific as to whether the various observers at the Mine Mountain trenches, 4,480 meters from ground zero, were brought up to inspect the military equipment display area after the shot. According to the Desert Rock VI Operation Order for Shot APPLE 2, these VIP observers, military personnel, and members of the news media walked a short distance to a vantage point on Mine Mountain after the detonation. There, they observed the Task Force RAZOR assault underway to the north and east. They sat on bleachers while a military commentator, provided with a public address system, terrain chart, and tape recorder, described the entire maneuver. The VIP and press observers stayed at this vantage point until the task force maneuver was completed, about one hour after the detonation. At that time, buses arrived at Mine Mountain to load and return them to Camp Desert Rock (31; 33-35; 44; 50).

2.2 TROOP TESTS AT SHOT APPLE 2

Troop tests were designed to provide data about tactics and doctrine, as well as to train command and staff personnel in all phases of planning and conducting combat operations under the anticipated conditions of a nuclear battlefield. Three Army service schools sponsored troop tests as part of the Desert Rock exercises, as listed in table 2-1 (31; 33; 50).

Project 40.18, Location of Atomic Bursts, was performed by Battery C (-), 532nd Field Artillery (Observation) Battalion, and was designed to determine the suitability of conventional military equipment, procedures, and techniques developed by The Army Artillery School, Fort Sill, Oklahoma, to locate nuclear bursts (33; 35; 44; 50).

The project required that participants establish and occupy ten observation stations located in various areas around ground zero. Their objective was to monitor equipment to establish a three-dimensional location of the detonation. Ten stations, manned by a total of 48 DOD project personnel were at the following locations within the Nevada Test Site (NTS) (35; 44; 50).

<u>STATIONS</u>	<u>UTM COORDINATES</u>
Flash Control Point	822906
Station #1	867868
Station #2	843886
Station #3	822906
Station #4	805922
Station #5	791938
Station #6	740958
Sound Control Point 1	858874
Sound Control Point 2	822928
Radar	800951

These stations were positioned to approximate the standard deployment of an observation battery under tactical conditions. They were positioned at intervals of several kilometers stretching from Yucca Lake northwest toward Mine Mountain, ten to 13 kilometers south of ground zero.

The ten stations were occupied by Project 40.18 personnel from about 1630 hours on the day before the event until just after the detonation. During the detonation, project personnel attempted to determine the blast location on a three-dimensional grid and to assess the yield of the burst. After the detonation, the project personnel returned to Camp Desert Rock (33; 35; 44; 50).

Project 41.1, Infantry Regimental Communications Test, was conducted by a Provisional Company of the 8th Infantry Division from Fort Carson, Colorado. This troop test, which was sponsored by The Infantry School, Fort Renning, Georgia, was to determine the capability of:

- The communications systems within an infantry regiment to withstand a nuclear detonation
- Table of Organization and Equipment (TOE) personnel to restore communications with an infantry regiment following a nuclear burst (33; 50).

This project involved establishing a series of communications stations at various locations in the shot area. These stations included one regimental and three battalion communications command post networks, all arranged near ground zero in extended defensive positions. The regimental communications system was located between 1,300 and 1,700 meters south of ground zero. One battalion communications command post was located east of ground zero, between 850 and 1,100 meters from the point of detonation. The second battalion command post was located about 2,200 meters west of the APPLE 2 ground zero. The third (reserve) battalion command post was about 2,700 meters south of ground zero. On the day before the shot, all regimental communications systems were installed and tested by project personnel (33; 35; 44; 50).

About 12 hours before the shot, project personnel moved by convoy from Camp Desert Rock into their preshot position in the Desert Rock observer trenches 3,200 meters south of ground zero. Four radiological safety monitors from the 50th Chemical Service Platoon were to accompany participants. Before the shot, project personnel were in position with the Desert Rock observers and remained there through the countdown and detonation. About 30 minutes after the detonation, after Joint Test Organization (JTO) and Desert Rock radiological safety teams had surveyed the test

area, most project personnel were transported with their radio-logical safety monitors to the four command posts. Some of the personnel who simulated casualties remained behind in the trenches. According to the operation order, the participants were deployed as follows:

- Two officers and three noncommissioned officers, representing the regimental communications platoon, proceeded by truck to the regimental headquarters command post, south of ground zero
- One officer and two noncommissioned officers went by truck to the first battalion command post to the west of ground zero
- One officer and about four noncommissioned officers proceeded to the second battalion command post to the east of ground zero
- One officer and two noncommissioned officers went by truck to the reserve battalion command post located near the regimental command post south of ground zero.

Personnel inspected communications equipment and attempted to repair and restore lines of communications. They then reassembled and returned by truck to Camp Desert Rock after spending about 90 minutes in the test area (33; 35; 44; 50; 62).

Project 41.2, Armored Task Force Exercise, involved more DOD personnel than any other JTO or Desert Rock project conducted at Shot APPLE 2. It was a military exercise designed to demonstrate the capability of a reinforced tank battalion (Task Force RAZOR) to seize an objective immediately after a nuclear detonation. The exercise, which consisted of a ground attack with helicopter support, was sponsored by The Army Armored School, Fort Knox, Kentucky. Approximately 1,000 soldiers participated in this single maneuver (4; 5; 33; 35; 50; 62).

Task Force RAZOR was composed of the following armored units from Camp Irwin, California, and from Fort Hood, Texas:

Camp Irwin, California:

- 723rd Tank Battalion (three tank companies)

Fort Hood, Texas:

- Company C, 510th Armored Infantry Battalion, 4th Armored Division
- Battery A, 22nd Armored Field Artillery Battalion, 4th Armored Division
- 1st Platoon, Company C, 24th Armored Engineer Battalion, 4th Armored Division
- 1st Platoon, Company B, 510th Armored Infantry Battalion (less vehicles) (4; 5; 62).

The number of personnel in each of these units has not been determined. In addition, members of the Provisional Aviation Company, 1st Combat Aviation Company (Provisional) (-), 1st Armored Division from Fort Hood, Texas, provided airlift and photographic support.

A total of 238 vehicles were used in the overall exercise, as listed below (4; 5; 33).

<u>VEHICLES</u>	<u>NUMBER</u>
M48 tanks	55
M41 tanks	2
M74 tank recovery vehicles	5
M75 armored personnel carrier	1
M59 armored personnel carriers	25
M7B2 self-propelled 105mm howitzers	4
D7 tractor dozer	1
Five-ton tractor with 25-ton lowboy trailer	1
Five-ton tractor with trailer	1
Five-ton dump trucks	2
2 1/2-ton tractor with ten-ton van	1
M62 wreckers	4

M34 2 1/2-ton trucks	5
3/4-ton trucks	10
M42 ambulances	2
M170 1/4-ton ambulances	6
M38A1 1/4-ton trucks	55
M34 gasoline tanker trucks (1,200 gal. cap.)	2
M135 2 1/2-ton trucks	56

The armored task force exercise consisted of four parts:

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

Between 9 March and 13 March 1955, elements of the Army 4th Armored Division and the 1st Combat Aviation Company (Provisional) arrived at Camp Irwin, California, from Fort Hood, Texas, to take part in the exercise. Between 9 March and 17 April 1955, the newly-formed task force conducted training in preparation for the troop test. They rehearsed formations, movement to an assembly area, movement to attack position, attack, and seizure of the objective.

On 18 April 1955, the task force left Camp Irwin for the NTS. The route of march passed over eroded desert flats and mountain ranges up to 5,000 feet in elevation. Most of the route for the tracked vehicles was across open terrain. The 250-kilometer march from Camp Irwin to the NTS took four days.

After arriving at the NTS on 21 April 1955, the task force assembled at an area called Midvallev, at Mine Mountain Junction (location 1 on figure 2-2), approximately 11 kilometers south-southwest of the APPLE 2 ground zero and about eight kilometers from the task force preshot assault position (location 2 on figure 2-2). In the assembly area, an administrative bivouac was established and maintained throughout the troop test. From 22 April to 4 May, the task force rehearsed for the troop test in the forward areas of the NTS. Three times during this period, the task force moved to Yucca Flat the day before the planned shot. However, in each instance, the shot was postponed because of poor weather, and the task force returned to the assembly area at Midvallev the following morning.

On the day before the actual detonation, 4 May, the task force once again moved into preshot position in Area 1 of the NTS. The task force was positioned in a northbound tactical formation from three to beyond five kilometers south of ground zero. Approximately 55 M48 tanks, each with a crew of four, led the wedge-shaped formation; the closest tank was about three kilometers from ground zero. Figure 2-3 shows an M48 tank and troops of Company C, 510th Armored Infantry Battalion rehearsing for the attack. The M59 armored personnel carriers, each containing about 13 soldiers, were positioned 3,500 meters and more from ground zero. Other elements, such as M41 tanks and M74 tank recovery vehicles, were as far as 6,400 meters south of ground zero. The crews camped overnight at these preshot positions (location 2 on figure 2-2).

On shot-day, radio communication was maintained until 30 minutes before the detonation, when all radio sets and engines were turned off. Then, field telephones were used for control and communication between elements of the task force. By ten minutes before the detonation, all tank turrets had been rotated to the rear, all sight apertures sealed with opaque tape, and

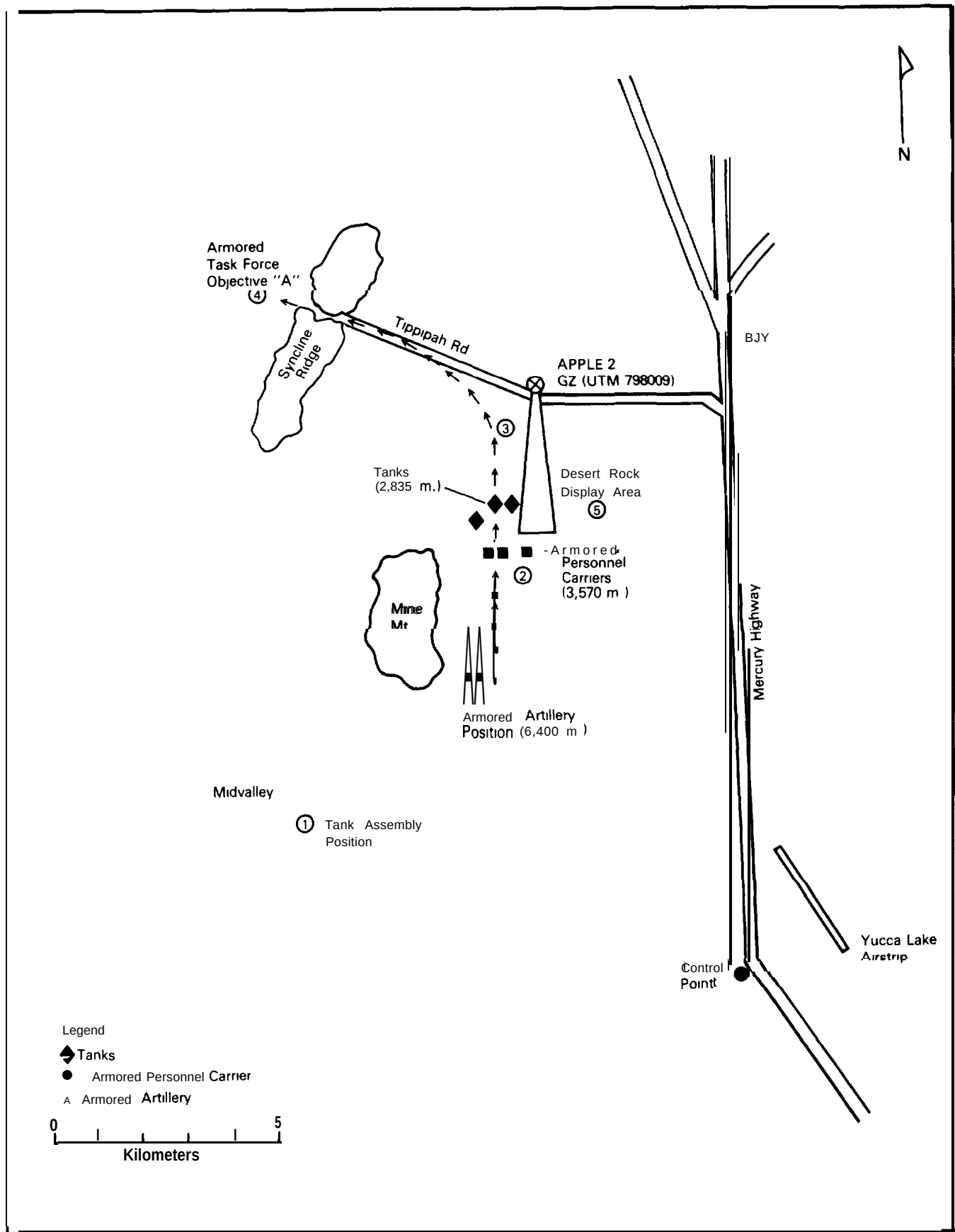


Figure 2-2: PROJECT 41.2, ARMORED TASK FORCE EXERCISE AT SHOT APPLE 2



Figure 2-3: A TANK-INFANTRY TEAM FROM TASK FORCE RAZOR DEMONSTRATES THE FINAL PHASE OF THE MANEUVER, THE ATTACK ON OBJECTIVE "A"

a.11 hatches closed and secured. The battalion reconnaissance platoon was not included in the forward position during the attack phase, since wheeled vehicles of this platoon were not armored. These units and vehicles remained at the assembly area in Midvalley. within the NTS.

The 1st Combat Aviation Company (Provisional) (-) and the Armored Infantry Platoon were standing ready at Yucca Lake airstrip, prepared to be airlifted to Task Force RAZOR objectives when ordered by the Task Force Commander. Aircraft for observation and aerial resupply were also on standby status at Yucca Lake airstrip, 13 kilometers southeast of ground zero.

At the time of the detonation, all vehicles and personnel of the armored task force were standing by. The nuclear detonation caused no significant damage to the task force. Most of the engine- and fan-access panels were dislodged from the M59 armored personnel carriers. However, this displacement required only straightening and repositioning of the panels in the field. Upon clearance by the Test Director, the engines of the armored task force were restarted and radio communications were reestablished. The driver and commander sight-prisms were reinstalled and the masking tape was removed from all sight apertures. About five minutes after the detonation, the Task Force Commander radioed the order to attack. Within eight minutes, the entire task force was moving toward its objective. All tanks remained shut and secure, and command and control was maintained by radio communications throughout the remainder of the maneuver.

Moving at about three to ten kilometers per hour, the task force began its advance north toward ground zero. Dust created by the detonation and by the tanks themselves reduced forward visibility to about 450 to 700 meters for the first ten to 15 minutes of the maneuver, requiring some tanks and personnel carriers in the rear of the formation to turn on driving lights

to maintain their positions in the moving formation. The tank company closest to ground zero, on the right of the task force formation, wore field protective masks, but elements farther from the point of the detonation did not wear such gear. In the early stages of the assault, the rate of advance was ten kilometers per hour, increasing to 16 kilometers per hour in later stages, as visibility improved. The axis of the advance was initially to the north, as shown in figure 2-2.

Approximately 20 radiological safety monitors from the 50th Chemical Service Platoon stationed at Camp Desert Rock were provided to Task Force RAZOR to ensure continuous area and vehicle monitoring during the assault. Most of the monitors were positioned in the tanks at the lead and on the right flank of the formation, with the rest dispersed throughout the formation.

The radiological safety personnel in the lead tanks on the extreme right flank of the formation, those closest to ground zero, notified the Task Force Commander when a reading of 1.0 R/h was reached inside their vehicles. The original attack plan called for the task force to advance directly through the blast area. However, technical and radiological safety restrictions prevented this. At 890 meters from ground zero, the radiation intensity level inside the tanks closest to ground zero reached the 1.0 R/h limit. At that point, the Task Force Commander ordered the formation to execute a partial left turn and proceed west, away from ground zero, as shown in location 3 of figure 2-2. From this point, the axis of advance was along Tippipah Spring Road to the objective area, about 5,200 meters west-northwest of ground zero, shown in location 4 on figure 2-2. Two M59 armored personnel carriers in the rear of the formation temporarily lost contact with the task force and moved to within 820 meters of ground zero. However, control was quickly recovered, and they promptly rejoined the task force without difficulty.

The company on the right of the formation was advancing at about 16 kilometers per hour, 30 minutes after the assault began, when the task force reached the point where Tippipah Spring Road passes to the north of Syncline Ridge. There the advance slowed to form a column for passage through the defile north of Syncline Ridge. The task force then proceeded to its objective, a distance of about 6.4 kilometers from its preshot position, in about 40 to 60 minutes. To bring realism to the maneuver, tank guns and coaxial machine-guns fired blanks at every opportunity in the final stages of the assault. After the task force reached its objective, the tactical maneuver ended.

The task force personnel and armored vehicles were promptly brushed off with brooms to remove dust and debris, even though radiological safety surveys of both personnel and vehicles showed no contamination above background. The vehicles were then parked in an assembly area near the assault objective, so that all personnel who desired could be transported by truck back to the military equipment display area, shown at location 5 on figure 2-2, to view the damage produced by the nuclear detonation. It is estimated that the tanks reached their assembly area about an hour after the detonation, that cleanup took one hour, and that the truck transport was loaded and ready to move to the equipment display area two hours after the detonation. After spending about one hour and 15 minutes in the display area, the Task Force RAZOR troops were transported back to their vehicles, about four hours after the detonation, where they were again checked for contamination. The troops then returned to the bivouac area at Midvalley near Mine Mountain Junction, location 1 on figure 2-2. The task force spent 6 May preparing for their return march to Camp Irwin. On 7 May, the task force departed from the NTS and arrived at Camp Irwin on 9 May (4; 5; 31; 33; 35; 44; 50).

The airlift support for Task Force RAZOR was provided by the 1st Combat Aviation Company (Provisional) (-) from Fort Hood,

Texas. This unit also provided aerial observation support and airlifted an armored infantry platoon to the assault objective. Participation was designed to determine the capability of a combat aviation company to support a reinforced tank battalion during the offensive use of a nuclear weapon. The company, composed of 19 officers and 28 enlisted men, used the following aircraft and vehicles:

- Seven H-19 helicopters
- Three H-23B helicopters
- Three L-19A aircraft
- Three L-20A aircraft
- Four 1/4-ton trucks with trailers
- Two 2 1/2-ton trucks
- One 1 1/2-ton trailer
- One 2 1/2-ton truck, with a 1,200-gallon fuel tank.

From 28 March to 17 April 1955, the company trained with the Task Force RAZOR units in preparation for the Exercise Desert Rock VI troop test. This training included three field exercises and familiarization flights over the 250-kilometer route from Camp Irwin to the NTS. During this time, the company also performed numerous administrative flights for Headquarters, Camp Irwin.

Between 18 April and 21 April 1955, the 1st Combat Aviation Company (Provisional) participated in the armored task force overland march from Camp Irwin, although high winds on 18 April limited the use of fixed-wing aircraft. The aviation company accomplished various missions during the overland march:

- Airlifting a dismounted armored infantry platoon over critical terrain with H-19 helicopters
- Providing column control and radio relay with L-19 aircraft and H-23 helicopters
- Airlifting engineer spanners to points where the route of march crossed hard-surfaced roads.

The aviation company was based at the Camp Desert Rock airstrip from 21 April to 4 May. During this time, it participated in several troop test rehearsals and provided administrative flights in support of Headquarters, Camp Desert Rock. On 4 May, the day before the APPLE 2 detonation, the company moved to the Yucca Lake airstrip, about 13 kilometers southeast of the shot-tower. On shot-day, 5 May, all aircraft remained on the ground until after the detonation. As a safety measure, all aircraft doors and windows were opened before the detonation. There was no damage to aircraft from the shock wave, except that some windows in the cargo compartments of the H-19s were dislodged. These windows were easily pushed back into position.

Three minutes after the detonation, one L-19 took off to provide observation and radio relay for the armored task force test, which was underway about 3,000 meters south of ground zero. As previously rehearsed, two H-23 helicopters left the Yucca Lake airstrip to evacuate simulated casualties from the maneuver. An H-19 was also used to mark the task force objectives as a control measure.

Nine minutes after the detonation, six H-19 helicopters each airlifted six combat-equipped troops of the armored infantry platoon to an objective on the left flank of the Task Force RAZOR column, shown as Objective B in figure 2-4. The H-19s each took about five to ten minutes to reach the objective. Two radio-logical safety monitors accompanied the armored infantry platoon to survey all areas in which the troops maneuvered.

Reduced visibility caused by dust from the blast and from the armored formation's advance across the desert caused the aircraft some difficulty. While the tanks were moving toward their objective, five H-19s, two L-20s, and one L-19 airlifted supplies from the Yucca Lake airstrip to the task force objective. Flying time for the L-20 aircraft from the Yucca Lake

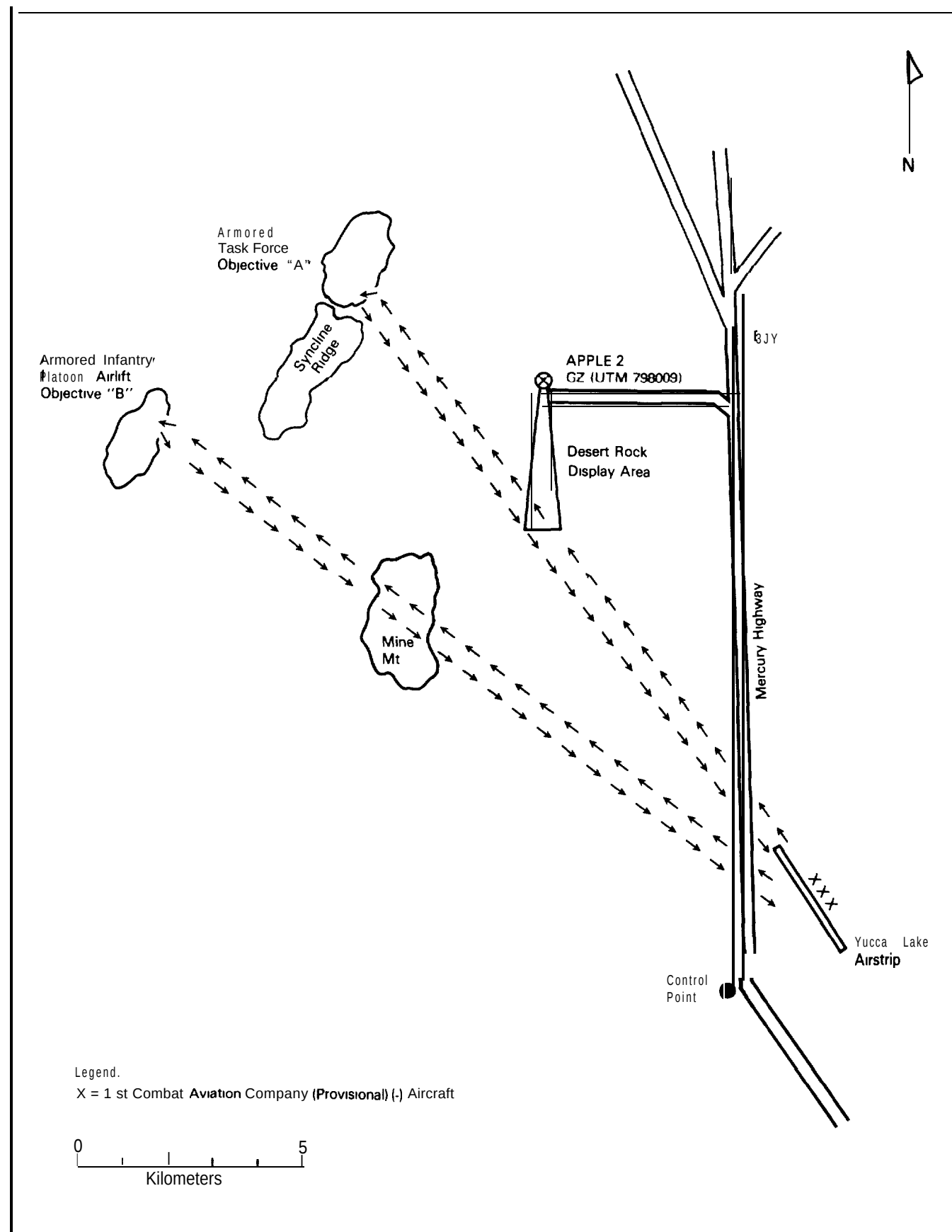


Figure 2-4: OPERATIONS OF THE 1ST COMBAT AVIATION COMPANY (PROVISIONAL) (-) IN PROJECT 41.2, ARMORED TASK FORCE EXERCISE

airstrip to objective A, shown in figure 2-4, was seven minutes. The aircraft dropped its supplies and immediately returned to the Yucca Lake airstrip.

On the afternoon of 5 May, the 1st Combat Aviation Company (Provisional) was released from task force control and prepared to return to Fort Hood, Texas. However, three L-19s remained to support the armored task force on its return march to Camp Irwin, California (4; 5; 33; 35; 44; 50).

2.3 TECHNICAL SERVICE PROJECTS AT SHOT APPLE 2

Technical Service Projects were used to test the effects of nuclear weapons on ordnance equipment, materials, fortifications, structures, and equipment. At Shot APPLE 2, Project 40.17, Effects on Steel Transporters or Containers, was sponsored by the Army Transportation Research and Development Command, Fort Eustis, Virginia. This project was to determine the amount of protection afforded goods by several types of cargo containers. Although the project was originally intended to be performed only at Shot MET, it was repeated at Shot APPLE 2 (33; 50).

Containers and crates of various construction were positioned in three locations about 500, 670, and 880 meters from ground zero. They were moved by crane and truck from the MET shot area to the APPLE 2 shot area in the days between the two detonations. According to the Test Director's schedule of planned events, at 2315 hours on the day before the shot, one officer and one enlisted man from Camp Desert Rock were to enter the test area in a vehicle to set up and check instruments. These two men were to spend up to about two hours in the test area. Project personnel reentered the area in the days following the detonation, when radiation intensities had decayed, to assess and photograph the damage to the containers and evaluate results of the test (33; 44; 50).

CHAPTER 3

JOINT TEST ORGANIZATION OPERATIONS AT SHOT APPLE 2

During Shot APPLE 2, Department of Defense (DOD) personnel participated in a variety of military effects projects and diagnostic experiments, operational training projects, and Air Force Special Weapons Center (AFSWC) support missions. These activities required Department of Defense personnel to enter the forward area before, during, and after the shot. The Test Manager declared the area safe for recovery operations at 0650 hours, about one hour and 40 minutes after the detonation. The military personnel of the Armed Forces Special Weapons Project (AFSWP) Field Command Military Effects Group conducted 12 projects during the APPLE 2 event. DOD personnel were also involved in five projects conducted by the Los Alamos Scientific Laboratory (LASL) Test Group and one project fielded by the University of California Radiation Laboratory (UCRL) Test Group. DOD personnel participated in seven of the 40 projects conducted by the Federal Civil Defense Administration Civil Effects Test Group (CETG) and were active in the six DOD operational training projects fielded during APPLE 2. In addition, AFSWC provided support to the four test group projects and to the AEC Test Manager (6; 12).

Detailed descriptions of project objectives and general project activities are contained in the TEAPOT Series volume. The information contained in this chapter addresses only those project operations specific to Shot APPLE 2.

3.1 FIELD COMMAND MILITARY EFFECTS GROUP PROJECTS AT SHOT APPLE 2

The Military Effects Group of AFSWP Field Command performed 12 projects at Shot APPLE 2. Table 3-1 lists the AFSWP projects,

**Table 3-1: FIELD COMMAND MILITARY EFFECTS GROUP PROJECTS,
SHOT APPLE 2**

Project	Title	Participants	Estimated DOD Personnel
1 14b	Measurements of Airblast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	6
2 6	Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field	Naval Medical Research Institute	2
2 8a	Contact Radiation Hazard Associated with Contaminated Aircraft	Air Force Special Weapons Center	10
2 8b	Manned Penetration of Atomic Clouds	Air Force Special Weapons Center	4
3 1	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	6
5 1	Destructive Loads on Aircraft in Flight	Wright Air Development Center, Air Proving Ground	36
5 2	Effects on Fighter Type Aircraft in Flight	Wright Air Development Center	1
6 3	Missile Detonation Locator	Army Signal Corps Engineer Laboratories	*
6 4	Test of IBDA Equipment	Wright Air Development Center	14
6 5	Test of Airborne Naval Radars for IBDA	Bureau of Aeronautics	*
8.1	Measurement of Direct and Ground-reflected Thermal Radiation at Altitude	Bureau of Aeronautics	*
9 4	Atomic Cloud Growth Study	Air Force Cambridge Research Center, Strategic Air Command; U S Weather Bureau, EG and G	*

*Unknown

the sponsoring agency, and the approximate numbers of personnel involved in each project. Because, in most cases, the same individuals performed both pre- and postshot activities, estimates reflect the maximum number of DOD personnel who would have been involved in a project.

Project 1.14b, Measurement of Air-blast Phenomena with Self-recording Gauges, was conducted at Shot APPLE 2 according to the Weapons Test report for that project; however, the Operational Summary Report for TEAPOT does not list this project for APPLE 2. If this project did take place, preparations would have included preshot surveying, constructing instrumentation mounts, and installing and checking gauges. An estimated six personnel spent two weeks preparing for this experiment.

Postshot recovery of data from the farthest station was to be accomplished on shot-day by two project participants in about four hours. Recovery of the data from the stations closest to ground zero was to be accomplished in two days by three individuals, when the area was declared open for reentry (21; 43; 44; 67).

Project 2.6, Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field, involved measuring radiation intensities of the fallout by placing a masonite mannequin instrumented with radiation detectors within the fallout field after the detonation. At 0840 hours on 5 May, two personnel accompanied by a radiological safety monitor, entered the test area in one vehicle and placed one mannequin 2,410 meters from ground zero at the 2 R/h line north-northwest of ground zero. The party probably spent about five to ten minutes in the fallout field. Project personnel reentered the shot area at about 1400 hours to place a second mannequin 2,230 meters from ground zero in a similar radiation field north-northwest of ground zero. The recovery party probably returned to recover the mannequins within two days after detonation, when radiation intensities had decayed substantially (39; 43; 44; 47).

Project 2.8, Contact Radiation Hazard Associated with Contaminated Aircraft, was performed by air and ground crews of AFSWC. The project had two parts: Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, and Project 2.8b, Manned Penetration of Atomic Clouds. On the ground, Project 2.8a personnel determined the radiation exposure potential for ground crews working on contaminated aircraft flown during Project 2.8b.

The Research Directorate of the AFSWC Biophysics Division planned and performed Project 2.8b. Before the APPLE 2 detonation, two T-33 aircraft, each with a pilot and a radiological safety monitor serving as a technical observer, took off from Indian Springs AFB, Nevada. The two aircraft penetrated the nuclear cloud at 17 minutes and 57 minutes after the detonation. Both penetrated the cloud at an altitude of 38,000 feet. The first T-33 spent a total of 52 seconds within the visible cloud, while the second spent 33 seconds in the cloud. On exiting the cloud, both aircraft immediately returned to Indian Springs AFB. In light of the special nature of the project, the pilots and technical observers in Project 2.8b were authorized by the AEC Test Manager to receive a maximum cumulative exposure of 15 roentgens of gamma radiation for the duration of the entire TEAPOT Series (12; 19; 30; 43; 44; 49; 60; 66).

When the aircraft landed at Indian Springs AFB following their flights through the nuclear cloud, Project 2.8a ground personnel made successive radiological surveys at varying distances from the aircraft skin using AN/PDR-T1B, JUNO, and AN/PDR-27C survey meters. Following these dose-rate measurements, project personnel performed radioactive decay studies on various parts of the aircraft. They also studied the contact-radiation exposure potentials for personnel performing these surveys. As many as ten AFSWC ground crew personnel participated in surveying these aircraft. The entire survey took about two hours for each aircraft (12; 19; 30; 43; 44; 59; 60; 66).

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, was designed to investigate the effects of nuclear shock waves on military vehicles. The objectives of the project were to determine the damage sustained from variations in a nuclear weapon's yield, to determine the damage caused by the shock wave only, and to increase knowledge about damage to equipment and established damage measurement criteria. As in Project 1.14b, the Weapons Test reports and the TEAPOT Series Operational Summary report disagree as to whether this project was conducted during Shot APPLE 2. According to the Weapons Test reports, this project had been previously conducted at Shot TURK, where some of the wheeled vehicles suffered severe damage at most locations. However, to obtain more information on the difference between light and severe damage, some of the vehicles were exposed at APPLE 2. The five quarter-ton trucks that were still in good condition after the TURK detonation were placed between 610 and 910 meters from ground zero. A Marine Corps truck and two Desert Rock 3/4-ton trucks used for field operations throughout the previous 12 TEAPOT events were also placed in the Project 3.1 display area.

Three M48 tanks used in Project 3.1, which had received only light damage in previous shots, were placed in a region where higher dynamic pressure was expected. A T97 self-propelled gun, although overturned violently on a previous test, was still structurally sound and was placed at the same ground range as the three M48 tanks.

According to plan, before the APPLE 2 scheduled detonation, four individuals probably took several days to place and instrument the vehicles. After the shot, when the area was declared safe for recovery operations, four individuals, including a crane operator, were to take one day to clear the area. In addition, two photographers probably spent a day photographing the damage (8; 12; 43; 44).

Project 5.1, Destructive Loads on Aircraft in Flight, was planned as support for Projects 5.2 and 8.1. Although no documentation is available to verify that the project was conducted as planned, it was to be coordinated with Projects 5.2 and 8.1, which did occur as planned. If Project 5.1 took place at APPLE 2, only the ground radar units were active. According to the Test Director's schedule of events, 36 men were to take part in this project. At 0030 hours on shot-day, four and one half hours before the APPLE 2 detonation, seven personnel in three vehicles were scheduled to leave Camp Mercury for the MSQ-1 Radar Site #4, located 23 kilometers southwest of ground zero. These seven project personnel would have arrived on location several hours before the scheduled detonation and remained until 0850 hours. Their mission was to track Project 5.2 aircraft on radar. In addition, nine other project participants were scheduled to leave Camp Mercury in three vehicles at 0045 hours on shot-day for the MSQ-1 Radar Site #1, 18 kilometers southeast of ground zero. These participants were also to remain at their station until 0850 hours to track Project 8.1 aircraft. Twelve more individuals were to leave Camp Mercury in three vehicles for MSQ-1 Radar Site #2, located about 19 kilometers southeast of ground zero, and remain there until 0850 hours to track Project 8.1 aircraft. Finally, eight men were to leave Camp Mercury at 0045 hours on shot-day to occupy MSQ-1 Radar Site #3, 21 kilometers southeast of ground zero, to track Project 5.2 aircraft. All project participants remained at their stations until 0850 hours and then returned to Camp Mercury (21; 43; 44; 53).

Project 5.2, Effects on Fighter Type Aircraft in Flight, was designed to determine the structural response of the F-84F aircraft when exposed during flight to the effects of a nuclear detonation. For the operational flight, two aircraft, with all external pods removed, were to fly patterns at different altitudes and were to be oriented in level-flight position to receive the impact of the blast wave tail-on.

The aircraft left Indian Springs AFB 35 minutes before shot-time. They entered the flight pattern about 23 minutes before the detonation and made two complete flyarounds to position the aircraft accurately at the moment of detonation. Eight minutes before the detonation, one of the aircraft aborted because of UHF radio receiver failure and returned to Indian Springs AFB. The other aircraft entered the final flight leg three minutes before the scheduled detonation and proceeded on course until after detonation and the final blast wave had passed. At shot-time, the aircraft was at a slant range of about 6,100 meters from the burst and at an altitude of 16,890 feet. The aircraft returned to Indian Springs AFB about five minutes after the shot (12; 25; 43; 44; 54).

Project 6.3, Missile Detonation Locator, was designed to test the feasibility of a tactical range detonation-locator system. The system was designed to locate ground zero by detection and analysis of the electromagnetic radiation emitted by the burst. This project was not fielded at the Nevada Test Site.

The detonation locator consisted of broad-band receivers set up in California on baselines approximately 115 and 320 kilometers from the NTS. Radio links between the stations provided the time comparisons necessary to determine relative times of arrival of the electromagnetic pulse at each station. Crystal clocks were used for accurate time-of-arrival analysis (12; 43; 48).

Project 6.4, Test of IBDA Equipment, was designed to gather engineering evaluation data for a complete Indirect Bomb Damage Assessment (IBDA) system installed in a B-50D aircraft. The secondary objective was to determine the maximum operating range of the yield-measuring component of the system. The Wright Air Development Center was responsible for this project.

The B-50D which staged out of Kirtland AFB usually carried a crew of ten. Since engineering evaluation tests were being conducted, two personnel (one engineer and one technician) went along to monitor and ensure the operation of the IBDA system. The B-50D, which was positioned by radar navigation, simulated an aircraft delivering a nuclear bomb. At shot-time, the B-50D was located about eleven kilometers from ground zero. In addition, two F-94s, with two crewmen each, staged out of Indian Springs AFB. The F-94s were positioned by radio navigational aids at altitudes of 30,000 to 35,000 feet and at distances of 180 to 210 kilometers west-southwest of ground zero. At least one crew member of each aircraft wore a film badge (20; 21; 25; 43; 44).

Project 6.5, Test of Airborne Naval Radars for IBDA, was intended to test the suitability of unmodified operational Navy radars for IBDA and to provide fleet personnel with experience in the analysis of IBDA data. At APPLE 2, two AJ-2s were to fly a simulated attack. However, one AJ-2 aircraft aborted its mission because of mechanical difficulties, and the other missed the target sufficiently to obtain no results. An R4D aircraft was in position at shot-time, however, at an altitude of 12,000 feet on a 300-degree magnetic heading and at a horizontal range of about 11 kilometers from ground zero. The R4D was able to obtain suitable data. Standard radarscope photography was used to record data from shot-time until about ten seconds after the detonation (12; 25; 43; 65).

Project 8.1, Measurement of Direct and Ground-reflected Thermal Radiation at Altitude, studied how thermal energy reflected from the earth's surface contributed to the total thermal radiation received by aircraft in the vicinity of a nuclear detonation. Three Navv AD aircraft were instrumented with calorimeters and radiometers. One aircraft was at a slant range of about four kilometers from the burst and at a height of

5,265 feet above the ground. A second was at a slant range of about six kilometers and at a height of 11,265 feet above the ground. The third aircraft was used as standby. The aircraft, with thermal hoods over the cockpits, were flown at approximately 175 knots counter-clockwise around ground zero. Approximately two seconds after the detonation, the pilots executed standard-rate breakaway turns to receive the subsequent blast wave in a tail-on position. Twenty seconds after the detonation, the pilot of each aircraft turned off his recording equipment (25; 43; 45).

Project 9.4, Atomic Cloud Growth Study, was performed at APPLE 2 by the aircrews from Project 40.5, an operational training project. The Strategic Air Command crews flew two KB-47 aircraft. At the time of detonation, one aircraft was at an altitude of 42,000 feet, three kilometers northwest of ground zero, and the other was at an altitude of 43,000 feet, 22.5 kilometers northwest of ground zero. After completing their mission, the RB-47s returned to their staging base. The Air Force Cambridge Research Center, in conjunction with the U.S. Weather Bureau, positioned a theodolite at the north fence of the Control Point to measure the rate of rise and cloud height (25; 32; 43; 44).

3.2 DEPARTMENT OF DEFENSE PARTICIPATION IN LOS ALAMOS SCIENTIFIC LABORATORY TEST GROUP PROJECTS AT SHOT APPLE 2

The LASL Test Group performed 20 projects at Shot APPLE 2. Of these 20 projects, only six are known to have included DOD personnel. Table 3-2 lists DOD participation in LASL and UCRL projects, as documented. All five of these projects were conducted at the NTS (12).

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

Project	Title	Sponsor	Estimated Personnel	Participants
11.21 21.2	Radiochemistry Sampling/ Sample Collecting	LASL/ UCRL	16	4926th Test Squadron, AFSWC
18 1	High Temperature Measurements	LASL	8	Naval Research Laboratory
18 2	High Altitude Measurements	LASL	*	Naval Research Laboratory
18 3	Time Interval Measurements	LASL	8	Naval Research Laboratory
18 4	Spectroscopy	LASL	5	Naval Research Laboratory

* Projects 18 1 and 18 2 were probably performed by the same personnel

Project 11.2, Radiochemistry Sampling, which was performed in conjunction with UCRL Project 21.2, was performed by sampling pilots from AFSWC 4926th Test Squadron (Sampling) and is discussed under AFSWC participation.

Projects 18.1, 18.2, 18.3, and 18.4 were performed for LASL by the Naval Research Laboratory of Washington, D.C. Little is known about the activities associated with these four projects (12). For Projects 18.1 and 18.2, High Temperature Measurements and High Altitude Measurements, eight participants were scheduled to complete instrumentation work at Station 1-480, about 900 meters east of ground zero, by 0030 hours on 5 May. Five of the participants were then to leave the test area for the Control Point at Yucca Pass. The remaining three were to complete last-minute instrument settings in Station 1-480 and leave the area by 0230 hours in two vehicles with the APPLE 2 arming party. At 0650 hours, when recovery operations were permitted by the Test Manager, four men were to enter the test area to recover film from Station 1-480. These personnel would have spent about 30

minutes in the area. One radiological safety monitor was furnished by the project to accompany this party (44).

For Project 18.3, Time Interval Measurements, camera stations were located 14 kilometers from ground zero. Before the shot, an estimated eight participants arrived to load film in cameras. After the detonation, when radiation intensities permitted, they returned to recover film for processing (43; 44).

For Project 18.4, Spectroscopy, five men set up instruments at Station 3-300, 6.5 kilometers east of ground zero. They left the test area for the Control Point in two vehicles around 0100 hours on the morning of the detonation. At recovery time, three participants in one vehicle, accompanied by a Radiological Safety Group divisional monitor, recovered film from the station. The project participants were to spend no more than 30 minutes in this area (44).

3.3 DEPARTMENT OF DEFENSE PARTICIPATION IN THE UNIVERSITY OF CALIFORNIA RADIATION LABORATORY TEST GROUP PROJECT AT SHOT APPLE 2

The UCRL Test Group performed only one project at Shot APPLE 2, Project 21.2, Sample Collecting. As indicated in table 3-2, this project was performed by the same sampler pilots from AFSWC 4926th Test Squadron (Sampling) who performed the LASL Test Group Project 11.2, Radiochemistry Sampling. DOD personnel involvement was limited to these AFSWC personnel. Consequently, this project is discussed under AFSWC participation.

3.4 DEPARTMENT OF DEFENSE PARTICIPATION IN CIVIL EFFECTS TEST GROUP PROJECTS AT SHOT APPLE 2

The most widely publicized of the civilian activities fielded during the APPLE 2 test was Operation CUE, conducted by

the Federal Civil Defense Administration (FCDA). The FCDA conducted 40 separate projects for Operation CUE, and seven projects involved DOD personnel, as listed in table 3-3. All projects were designed to evaluate the effects of a nuclear detonation on a civilian community and to test the capabilities of local Civil Defense organizations to respond to such an emergency with prompt rescue and recovery operations. The FCDA constructed ten buildings representing a typical American community, complete with houses, utility stations, automobiles, furniture, appliances, food, and mannequins dressed as family members. The houses were built of different materials and in different styles, and were heavily instrumented to measure the blast, thermal, and radiation effects of the detonation on the structures, furnishings, food, and mannequins positioned in various locations throughout the community. This community extended from 320 meters to approximately 3,000 meters southeast of the shot-tower (18; 40; 41; 42; 44).

Civil Defense personnel were drawn from around the country to practice emergency rescue, first aid, and recovery operations after the detonation. Fresh food and supplies were flown in from cities as far away as San Francisco and Chicago to demonstrate Civil Defense emergency support capabilities. Many news media representatives, official observers, and construction and product manufacturing representatives were invited to witness the Civil Defense demonstration and the Task Force RAZOR assault taking place nearby and report their experiences to the American public. In all, about 2,000 people came to the NTS to observe and participate in Operation CUE. This shot was the second nationally-televised nuclear test with an extensive civil effects program; the first was Shot ANNIE of the 1953 UPSHOT-KNOTHOLE Series (10; 12; 18).

**Table 3-3: CETG PROJECTS WITH DOD PERSONNEL INVOLVEMENT,
SHOT APPLE 2**

Project	Title	Sponsor	Estimated DOD Personnel	DOD Participants	Capacity
31 5	Thermal Ignition and Response of Materials	Federal Civil Defense Administration	*	Naval Material Laboratory; Army Quartermaster Research and Development Center, Army Chemical Center	Consultants
31 6	Methods for Determining Yields Location of Nuclear Explosions	Federal Civil Defense Administration; Army Chemical Center	*	Army Chemical Center, Ballistic Research Laboratories; Quartermaster Research and Development Center, Lovelace Biomedical Research Laboratory	Consultants
33 1	Biological Effects of Pressure Phenomena Occurring Inside Protective Shelters Following a Nuclear Detonation	Division of Biology and Medicine; Lovelace Foundation for Medical Education and Research	1	Air Force	*
34.1a	Effects of an Atomic Explosion on Group and Family-type Shelters	Federal Civil Defense Administration	*	Army Chemical Center	Consultants
34 1b	Evaluation of Indoor Home Shelters Exposed to Nuclear Effects	Federal Civil Defense Administration	*	Army Chemical Center	Consultants
34.3	Structural Behavior of Group Shelters Under Various Blast Loads	Federal Civil Defense Administration	*	Army Chemical Center	Consultants
38 1	Civil Defense Monitoring Techniques	Federal Civil Defense Administration	15	1st Radiological Safety Support Unit	*

* Unknown

DOD involvement in these CETG projects can be divided into two types: involvement in a consultant capacity and direct involvement in the field. The DOD was asked either to supply equipment to the CETG or to assist in the evaluation of data. In this capacity, DOD personnel were not required to work in the forward area of the NTS. The second type of DOD participation, however, did require DOD personnel to perform field work with CETG personnel in the forward area. Only two of the seven CETG projects were in the latter category.

Project 31.5, Thermal Ignition and Response of Materials, was performed by the CETG at Shot APPLE 2 only. For this project, the Naval Material Laboratory provided data evaluation, while the Army Quartermaster Research and Development Command and the Army Chemical Center acted as technical consultants to CETG project personnel. DOD personnel were not involved in field operations at the NTS (10; 18; 46).

Project 31.6, Methods of Determining Yield Location of Nuclear Explosions, was sponsored by the Federal Civil Defense Administration and conducted by the Army Chemical Center. In this project, the Army Quartermaster Research and Development Center prepared specially coated, heat-sensitive paper and glass spheres for use by project personnel. Ballistic Research Laboratories advised Project 31.6 personnel on shot phenomena and the use of large shock tubes. Documentation does not describe DOD participation in field operations for this project (10; 18).

Project 33.1, Biological Effects of Pressure Phenomena Occurring inside Protective Shelters Following a Nuclear Detonation, was sponsored by the AEC Division of Biology and Medicine in conjunction with Lovelace Biomedical Research Laboratory. Its main objective was to test the effects of a nuclear detonation on various species of animals which had been sealed in six instrumented containers in above- and below-ground

shelters. The only recorded DOD participant in this project was an Air Force officer, who assisted in this project and may not have been required to enter the test area (10; 18).

Project 34.1a, Effects of an Atomic Explosion on Group and Family-type Shelters, and Project 34.1b, Evaluation of Indoor Home Shelters Exposed to Nuclear Effects, were both part of the CETG Project 34.1. In both phases of Project 34.1, and in Project 34.3, Structural Behavior of Group Shelters under Various Blast Loads, the Army Chemical Center was asked by the CETG to evaluate the effectiveness of protected ventilation for buried shelters. DOD personnel were not required to take part in field operations during their assistance in this project (10; 18; 63; 64).

Project 38.1, Civil Defense Monitoring Techniques, was intended to develop techniques of radiation monitoring that would apply during Civil Defense emergencies. DOD involvement in this project at APPLE 2 included support from the 1st Radiological Safety Support Unit, which provided monitors for JTO activities, and from AFSWC helicopter crews (10; 18; 25; 44; 56).

For this project, AFSWC was assisted by the Nevada Civil Air Patrol in conducting helicopter surveys at APPLE 2 to determine the readings above certain selected geographic points at various elevations. These surveys were conducted by the Civil Air Patrol in an H-13 helicopter, and by AFSWC in three H-19 helicopters. Ground surveys were also conducted by vehicle and on foot.

At 0650 hours, when the Test Manager announced that recovery operations could begin, three individuals from Project 38.1 were scheduled to make aerial surveys over the fallout area, according to the Operation Order. At the same time, two persons in a jeep and a pickup truck and two others in a 1/2-ton pickup truck were to conduct ground surveys in predetermined areas. Before Project 38.1 personnel entered, these areas had already been surveyed by

AFSWP radiological safety personnel. Following this initial survey, project personnel were to repeat their radiological surveys of the areas at four and eight hours later, and at 0800, 1200, and 1600 hours on the two days following the detonation. Three AFSWP radiological safety monitors accompanied this project party while they performed their surveys.

At 1250 hours on shot-day, after recovery operations had begun, two FCDA participants in an H-19 helicopter conducted aerial surveys over the fallout area. The time required for this activity is estimated as one hour. Meanwhile, three FCDA participants in a truck proceeded as close to the APPLE 2 ground zero as radiation levels would permit, to recover radioactive samples. This recovery party spent approximately five minutes in the area (10; 18; 25; 44; 56).

3.5 DEPARTMENT OF DEFENSE OPERATIONAL TRAINING PROJECTS AT SHOT APPLE 2

At Shot APPLE 2, eight operational training projects were scheduled for the Air Force, Navy, and Marine Corps. The primary aims of these operational training projects were to test service tactics and equipment and to train military personnel in the effects of nuclear detonations. Of the DOD operational training projects planned for the APPLE 2 event, only six took place as addressed in this section and as listed in table 3-4. The other two Projects, 40.1 and 40.2, were cancelled because of closed airfields (1; 3; 25; 50; 57).

Project 40.5, Reconnaissance Crew Indoctrination, required two Strategic Air Command RB-47 aircraft to fly by the NTS at the time of the APPLE 2 detonation. One aircraft flew at an altitude of 42,000 feet, three kilometers northwest of ground zero, and the other flew at an altitude of 43,000 feet, 22.5 kilometers

Table 3-4: DOD OPERATIONAL TRAINING PROJECTS, SHOT APPLE 2

Project	Title	Sponsor	Type Mission	Type Aircraft	No Aircraft	Staging Base	Estimated DOD Personnel
40 5	Reconnaissance Crew Indoctnnatron	Strategic Air Command	Air	RB-47	2	March AFB, California	4
40 5a	Accurate Location of Electromagnetic Pulse	Air Force Cambridge Research Center	Ground	none	none	*	*
40 6	Calibration of Electromagnetic Effects	Air Force	Ground	none	none	*	4
40 8	Calibration of Bomb Debris	Air Force	Air	F-84	1	Kirtland AFB, New Mexico	1
4010	Delivery Crew Indoctnnatron	Navy	Air	AD F2H TV2	7 6 2	San Diego Naval Air Station, Marine Corps, Auxiliary Air Station, Mojave, California	7 6 4
40 13	Tactical Indoctnnatron for a Marine Crew	Marine Corps	Air	R4D AD	1 3	Marine Corps, Auxiliary Air Station, Mojave, California	20 3

*Information unavailable

northwest of the detonation. Project 40.5 crews also performed cloud photography for AFSWP Field Command Military Effects Group Project 9.4, Atomic Cloud Growth Study. This participation is addressed under AFSWP participation (3; 25; 50).

Project 40.5a, Accurate Location of Electromagnetic Pulse, was performed by the Air Force Cambridge Research Center. The electromagnetic pulse produced by the APPLE 2 detonation was monitored by Air Force personnel at stations in Santa Maria, Palo Alto, and Oceanside, California (3; 38; 50).

Project 40.6, Calibration of Electromagnetic Effects, was performed onsite by the Air Force personnel. Project 40.6 personnel measured the characteristics of the electromagnetic pulse created by the detonation of APPLE 2. Part of the project required personnel to occupy several stations located at various distances from ground zero during the detonation. At 0900 hours on the day before the shot, two men in a jeep left Station 40.6B on Yucca Lake, 19 kilometers south of the APPLE 2 ground zero.

From that station, they serviced eight sets of unmanned recording equipment located ten to 20 kilometers from the APPLE 2 shot-tower. These men were in the forward area about six hours. At 0315 hours on shot-day, about two hours before the detonation, four men in two trucks arrived to operate equipment at Station 40.6B. They remained there until about two hours following the detonation, when they recovered data and left for Camp Mercury to evaluate project results (3; 44; 50).

Project 40.8, Calibration of Bomb Debris, was also performed by Air Force personnel. This project was designed to collect and analyze airborne fission products and gases from the radioactive nuclear cloud. Collection of these samples was performed by AFSWC 4926th Test Squadron (Sampling) aircraft at the same time that the pilots collected cloud samples for LASL Project 11.2 and UCRL Project 21.2. This activity is discussed under AFSWC operations (25; 50).

Project 40.10, Deliverv Crew Indoctrination, was conducted by Navy air crews staging out of San Diego Naval Air Station and Mojave Marine Corps Auxiliary Air Station. In all, a total of seven AD aircraft, each with one pilot, six F2H aircraft, each with one pilot, and two TV2 aircraft, each with a crew of two, participated in a flyby maneuver during the detonation, about eight kilometers northeast of ground zero. On completing the flyby, all aircraft returned to the staging bases (3; 7; 25; 28; 44; 50).

Project 40.13, Tactical Indoctrination for a Marine Aircrew, was performed by one R4D aircraft and three AD aircraft staging out of Mojave Marine Corps Auxiliary Air Station. The four aircraft performed a flyby during the detonation and at distances between 35 and 40 kilometers south and southwest of ground zero. These aircraft returned to their staging base on completion of their mission. No onsite activities occurred (7; 25; 28; 44; 50).

3.6 AIR FORCE SPECIAL WEAPONS CENTER ACTIVITIES AT SHOT APPLE 2

The Air Force Special Weapons Center (AFSWC) performed several support missions during Shot APPLE 2. AFSWC support consisted of nuclear cloud-sampling, sample courier, and cloud-tracking missions, and aerial surveys of terrain for the Test Manager. Table 3-5 lists DOD participation in AFSWC projects, including the number and type of aircraft used (25-28; 61).

Table 3-5: AFSWC AIR MISSION SUPPORT, SHOT APPLE 2

Mission	Type Aircraft	Number of Aircraft	Estimated DOD Personnel
Cloud Sampling Sampler Control Sampler Sampler (Projects 11 2/212/40 8)	B-50	1	9
	F-84 G	5	5
	B-57 A	1	2
Sample Courier	B-25	1	5
	c-119	2	10
Cloud Tracking	B-50	2	24
	B-25	1	5
Aerial Survey of Terrain	H-19	3	15
	c-47	2	6
Radio Relay	c-47	1	3

3.6.1 Cloud Sampling

Six aircraft collected particulate and gaseous samples of the nuclear cloud for LASL Project 11.2, Radiochemistry Sampling, UCRL Project 21.2, Sample Collecting, and Air Force Project 40.8, Calibration of Bomb Debris. These six sampler aircraft were flown by pilots of the 4926th Test Squadron (Sampling) and

included five F-84G aircraft and one B-57A aircraft. The B-57A also carried one observer. A B-50 sampler control aircraft, which contained an aircrew of nine, including a scientific advisor from LASL, also participated (25-28).

Before the APPLE 2 shot, the five F-84G and one B-57A aircraft were readied for the sampling mission. Sample collectors were installed in wind pods on the aircraft. The pilots on this sampling mission made a total of six penetrations into the nuclear cloud.

The first cloud penetration took place at 0711 hours, two hours and one minute after the detonation. The pilot of the first F-84G aircraft penetrated the cloud at a directed altitude of 28,000 to 29,000 feet. Flying at an average airspeed of about 280 knots, the aircraft remained in the cloud for about four minutes and ten seconds collecting particulate samples (7; 25). One half-hour later, at 0741 hours, the B-57A aircraft penetrated the nuclear cloud at an altitude of 40,000 feet and remained in the cloud for a total of seven minutes.

A second F-84G sampling aircraft entered the cloud at 0743 hours at an altitude of 32,000 to 32,500 feet. This F-84G aircraft remained in the cloud for three and one-half minutes. Three remaining F-84G aircraft penetrated the nuclear cloud at 0740, 0825, and 0826 hours at altitudes of 32,000, 40,000, and 40,600 feet, respectively. Each of these sampling aircraft remained in the cloud four to five minutes.

After the sampling missions had been completed, all aircraft returned to Indian Springs AFB. The first F-84G landed at approximately 0733, followed by the remaining sampling aircraft at 0808, 0810, 0818, and 0902. The highest penetration intensity detected during this sampling mission was 35 R/h, and the highest pilot exposure was 1.29 roentgens (25; 28; 30; 57; 61).

After the sampling aircraft landed at Indian Springs AFB, they taxied to 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. Personnel from the 4926th sample-removing team and radiological safety monitors took samples from the aircraft by removing the filter papers and gaseous samples from each aircraft and placing them in shielded boxes. A total of 12 filter paper samples were removed from each aircraft (1; 25; 28; 30; 59; 61).

After the samples from each aircraft were removed and stored, the pilot shut down his oxygen and opened his canopy. The pilots of F-84G aircraft stepped onto a platform held by a forklift so they would not touch the outsides of the aircraft, and were placed in a pickup truck. The crew of the B-57A exited through the belly hatch of the aircraft. The trucks took the pilots to the decontamination station. The trucks then returned to the aircraft, where they were loaded with the stored, shielded samples, which they then transported to the sample courier aircraft. The sample courier aircraft took the particulate cloud samples to laboratories for analysis (1; 25; 28; 59; 61).

3.6.2 Courier Service

Immediately after the cloud samples were removed from the sampler aircraft, three aircraft transported them to laboratories for analyses. Two of these aircraft left for Kirtland AFB and the third left for McClellan AFB.

These missions were conducted by the 4900th Air Base Group* from Kirtland AFB, New Mexico. One B-25 departed from Indian

*On 5 May 1955, the 4901st Air Base Wing was redesignated the 4900th Air Base Group.

Springs AFB at 1240 hours enroute to Kirtland AFB with samples destined for LASL. One C-119 left Indian Springs AFB at 1245 hours enroute to Kirtland AFB. These samples were also destined for LASL. The second C-119 aircraft left Indian Springs AFB for McClellan AFB. These samples were destined for UCHL and Project 40.8 personnel at the University of California at Los Angeles. All courier aircraft departed as scheduled on 5 May 1955 and arrived at their destinations without incident (1; 7; 25; 28).

3.6.3 Cloud Tracking

Immediately after the detonation, three aircraft, two B-50s from Kirtland AFB and a B-25 from Indian Springs AFB, flew cloud-tracking missions over and beyond the NTS. Because of wind patterns, the nuclear cloud separated into three parts. One B-50 orbited a portion of the cloud at 30,000 feet in a northeasterly direction into Utah for four hours and 16 minutes. The second B-50 orbited another portion of the cloud at 23,000 feet north-northeastward for four hours and 22 minutes, to a point south of Ely, Nevada. The R-25 orbited a third portion of the cloud at 13,500 feet due north for three hours and 20 minutes to a point south of Eureka, Nevada (1; 7; 25; 28).

The nuclear cloud was visible at all times and the tracking mission was routine. The MX-5 radiological survey meter, which detects radiation up to 0.02 R/h, was in one of the B-50 aircraft and operated offscale during most of the cloud-tracking mission. The purpose of this mission was to determine the direction of the radioactive cloud and to assist the Test Manager in keeping the airways clear of any private or ~~commercial~~ aircraft which might encounter contaminated clouds. On completion of this mission, the three aircraft returned to their respective staging bases (1; 25; 28).

3.6.4 Aerial Surveys of Terrain

As directed by the Test Manager and Test Director, three H-19 helicopters and two C-47 aircraft flew radiological safety and aerial surveys following the detonation to record radiation intensities (1; 7; 25; 28).

The initial surveying was accomplished by a C-47 aircraft. Four hours after the detonation, the aircraft performed a low-altitude (300 to 500 feet absolute) survey of terrain. This aircraft measured radiation intensities as far north of the NTS as Eureka and Ely, Nevada (1; 25; 28).

3.6.5 Radio Relay

One C-47 provided radio relay support to CETG projects after the APPLE 2 detonation. This routine mission was conducted five hours before the shot (1; 18; 25).

CHAPTER 4

RADIATION PROTECTION ACTIVITIES AT SHOT APPLE 2

To minimize radiation exposures to APPLE 2 participants, Exercise Desert Rock VI, the Joint Test Organization (JTO), and the Air Force Special Weapons Center (AFSWC) each developed its own criteria and procedures to ensure the radiological safety of its members. These safety criteria and procedures, as well as the organizations developed to implement the procedures, are described in chapter 5 of the TEAPOT Series Volume.

In addition to ensuring that individual exposure to ionizing radiation was as low as possible, the various radiation protection procedures were planned to allow participants to accomplish their project objectives. Some of the procedures described in the series volume involved the development of records which enabled Exercise Desert Rock, JTO, and AFSWC to evaluate the effectiveness of their radiation protection programs. Such records included film badge data and isointensity maps.

The Radiological Safety Report summarizes the activities that took place at each shot during the TEAPOT Series. The Final Dosage Report contains a listing of film badge readings for all DOD personnel and civilians who received film badges issued by the 1st Radiological Safety Support Unit. Although this report contains individual names, units, and total exposures for the Operation, it does not list exposure dates. However, memoranda addressing shot-specific overexposures have been found (16; 52).

Information on Desert Rock radiological safety is available from three sources: the Test Manager's Report, the Operations Order for Shot APPLE 2, and the Desert Rock VI Final Report of Operations. While the Operations Order lists planned activities,

the Test Manager's Report and the Desert Rock Final Report contain some details of the radiation protection activities as they were actually performed.

4.1 DESERT ROCK RADIATION PROTECTION ACTIVITIES AT SHOT APPLE 2

This section presents specific differences between the standard radiation protection procedures described in chapter 5 of the TEAPOT Series volume and the activities that took place at Shot APPLE 2. For all of the other Desert Rock projects described in chapter 2, participants were required to follow the standard procedures described in chapter 5 of the TEAPOT Series volume.

4.1.1 Radiation Protection Activities for Project 41.2, Armored Task Force Exercise, Task Force RAZOR

For Exercise Desert Rock VI Project 41.2, Armored Task Force Exercise, armored vehicles were positioned from 3,570 to 6,400 meters from ground zero. Twenty radiation monitors from the Army 50th Chemical Service Platoon were provided to this project for continuous area and vehicle monitoring during the advance of the task force and after the objective was reached (4; 5; 35; 50).

The task force began to maneuver eight minutes after detonation. The lead tank, with a monitor inside, proceeded toward ground zero until the radiation intensity inside the tank reached 1.0 R/h, indicating a radiation intensity outside the vehicle of 8.0 to 10.0 R/h. This reading was obtained about 890 meters from ground zero. At that time, the task force veered left toward the assault objective. Because of the anticipated left turn, monitors were positioned mainly in the right flank vehicles, with remaining monitors dispersed throughout the formation. One film badge had been issued to each tank crew. A wide range of readings were

obtained, but the average exposure for personnel in this project was 0.5 roentgens (4; 5; 33; 50).

Specialized decontamination procedures were also in effect for the armored task force maneuver. After the task force had completed its assault, all personnel and vehicles were swept off with brooms and surveyed for contamination. Monitors conducted these surveys with AN/PDR-T1B instruments held five centimeters (two inches) from the surfaces being surveyed. If personal contamination could not be lowered to less than 0.02 R/h by brushing off contaminated dust, individuals were taken to the decontamination station. No Desert Rock personnel were required to be taken to the decontamination station during Operation TEAPOT (4; 5; 33; 35; 50).

4.1.2 Radiation Protection for Project 40.22, Army Volunteer Officer Observers

The Army Volunteer Officer Observer Program, Project 40.22, was to provide close observation of a nuclear detonation for ten individuals. This program was conducted at APPLE 2 only. These volunteers, nine officers and one civilian, were positioned about 2,380 meters south of ground zero, more than 800 meters closer to ground zero than other observers. However, the ten volunteers were also more than 1,000 meters farther from ground zero than the closest authorized distance for the project. All ten of the volunteer officer observers wore film badges, and the average film badge reading for these individuals was 1.3 roentgens (31; 33; 50; 55). The volunteer officer observers also received neutron exposures, which their film badges were not designed to detect. Dose reconstruction places the average neutron dose of the volunteer officer observers at 4.5 rem (31).

4.1.3 Radiation Protection for Other Desert Rock Observers

Film badge data are not available for any of the Desert Rock observers and troop participants other than volunteer officer observers described above. Dose reconstruction, however, places the average gamma dose of the other Desert Rock Service observers at 0.40 rem. In addition, these observers received an additional neutron exposure, which the film badges they wore were not capable of measuring. According to dose reconstruction data, the observers received an average neutron dose of 0.06 rem (31).

4.2 JOINT TEST ORGANIZATION RADIATION PROTECTION ACTIVITIES AT SHOT APPLE 2

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

4.2.1 Dosimetry Records

During the period of 4 to 9 May 1955, which covers the 5 May detonation of APPLE 2, the Dosimetry and Records Section of the JTO issued 894 film badges and 580 pocket dosimeters (16).

Film badge readings indicated that for the TEAPOT Operation through 9 May, 42 persons had accumulated total exposures greater than two roentgens, but less than the JTO-authorized limit of 3.9 roentgens. In addition, 12 persons exceeded the permissible exposure limit for the entire operation by accumulating a total exposure greater than 3.9 roentgens. Memoranda addressing the overexposures of these people have been found for six of the 12 individuals. These memoranda, from the onsite Radiological Safety Officer, prohibited the named individuals from entering contaminated areas for the remainder of Operation TEAPOT. Of the

six, two were Air Force helicopter pilots; one was from the Navy and was involved in Project 2.6; two were Air Force pilots involved in Project 2.8; and one was a civilian (2; 13-16; 22; 52; 60; 66).

On shot-day, the two helicopter pilots returned film badges which read 5.96 and 6.36 roentgens. These readings, plus those from prior film badges, made their cumulative exposures 6.2 and 6.5 roentgens, respectively. After their film badges had been turned in, Dosimetry and Records personnel determined that both pilots had been wearing the second film badges for over a week and had apparently been in contaminated areas during that time. Dosimetry and Records personnel estimated that the pilots' exposure on shot-day, 5 May, was about 3.5 roentgens. The exposures they had accumulated prior to Shot APPLE 2 were, therefore, about three roentgens (2; 14-15; 47; 52).

Two personnel from the 1st Radiological Safety Support Unit had total exposures of 4.2 roentgens after participating at APPLE 2 (13).

A Navy officer involved in the Naval Medical Research Institute Project 2.6, Radiation Hazard from a Fallout Field, received a shot-day exposure of 0.9 roentgens, making his cumulative exposure 4.41 roentgens (2; 14; 15; 47; 52).

Four Air Force officers involved in Project 2.8b, Manned Penetrations of Atomic Clouds, were authorized to receive up to 15.0 roentgens of gamma radiation by the Test Manager. Two of these officers received 16.9 and 16.6 roentgens of exposure on shot-day. Their cumulative exposures for Operation TEAPOT were 21.8 and 21.7 roentgens, respectively. These officers were ordered not to enter contaminated areas for the one remaining shot of the series, ZUCCHINI. The other two officers received gamma exposures of 2.2 and 1.9 roentgens at APPLE 2. Only the

four Air Force officers involved in Project 2.8 were granted this special radiation exposure limit, and research has determined that only two individuals participated in Project 2.8 at Shot ZUCCHINI. It is assumed that these two individuals were the remaining two who had not exceeded the 15.0 roentgen limit (14; 17; 52; 60).

Two Air Force personnel, one from the 3080th Depot Group and one from the 3081st Depot Group, had total exposures of 4.1 and 4.0 roentgens, respectively. Another individual from the Air Force, a pilot from the 4926th Test Squadron, had a total exposure of 4.2 roentgens after participating at APPLE 2 (13).

At Shot APPLE 2, the cloud-sampling mission involved five F-84G and one B-57A aircraft. Each F-84G held one crew member, while the B-57A held two crew members. The gamma exposures for the five F-84G pilots ranged from 0.4 roentgens to 0.8 roentgens for the mission. The gamma exposure for the two B-57A crew members were 1.0 and 1.5 roentgens for the mission (25).

4.2.2 Logistical Data for Radiological Safety Equipment

For Shot APPLE 2, the General Supply Section issued 1,821 pieces of protective clothing and 265 respirators. In addition, the Instrument Repair Section issued 383 radiation survey meters (16).

4.2.3 Monitoring Activities

The initial survey party, consisting of 12 people in six vehicles, together with the area and main checkpoint teams and the north road patrol, departed from the radiological safety building at the Control Point at 0512 hours. They proceeded to the security gate at the junction of the Yucca Lake access road and Mercury Highway. At 0550 hours, 40 minutes after detonation,

the radiological safety officer permitted the teams to begin their survey, which they completed an hour later, at 0650 hours (16). A copy of the initial isointensity map is shown in figure 4-1.

The survey was routine. The party found no contamination north or south of Mercury Highway. By 0600 hours, they had established three area checkpoints and one main checkpoint. From 0830 hours to 1030 hours, the sign detail had posted radiation warning and intensity signs along the main access road to Area 1. By 1030 hours, all access roads had been posted.

In addition to the initial survey, the shot area was resurveyed on 6 May and again on 9 May. Figures 4-2 and 4-3 present copies of the isointensity maps generated from these resurveys. According to film badge readings, the average exposures for the initial survey teams and first resurvey teams were 1.03 and 0.73 roentgens, respectively.

Three H-19 helicopters, each with a crew of five, began their survey at 0520 hours on shot-day. No results from this survey are available, since the probe, which was on a 150-meter-long cable suspended from the helicopter, was accidentally cut during the survey when the helicopter flew too low over power lines across Mercury Highway (16).

In addition to its survey work, the Monitoring Section furnished monitors to the various programs, projects, and groups on shot-day and during the four days after shot-day. In addition, REEC_o was provided two monitors for its activities during APPLE 2.

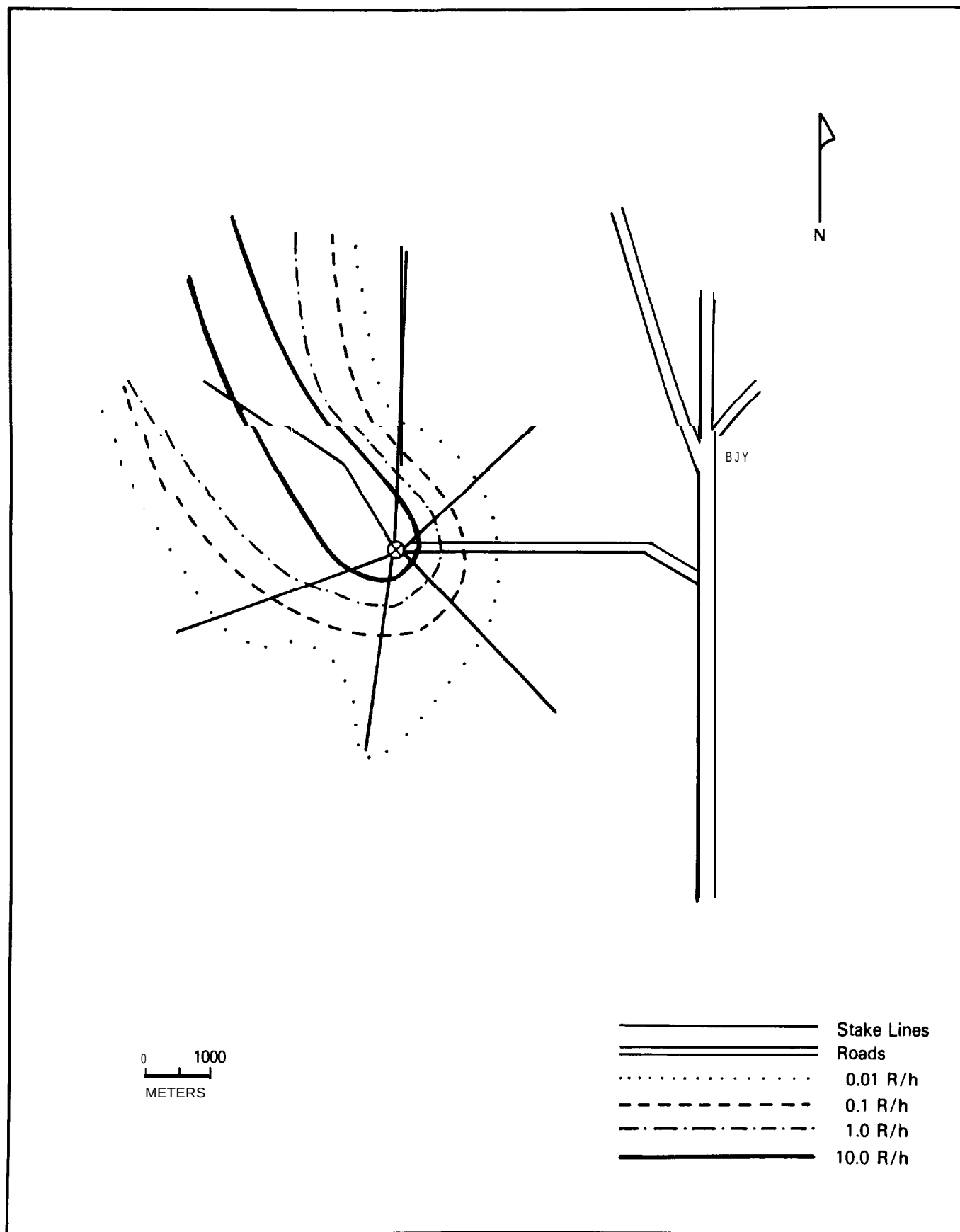


Figure 4-I: INITIAL SURVEY FOR SHOT APPLE 2, 5 MAY 1955, 0550 TO 0650 HOURS

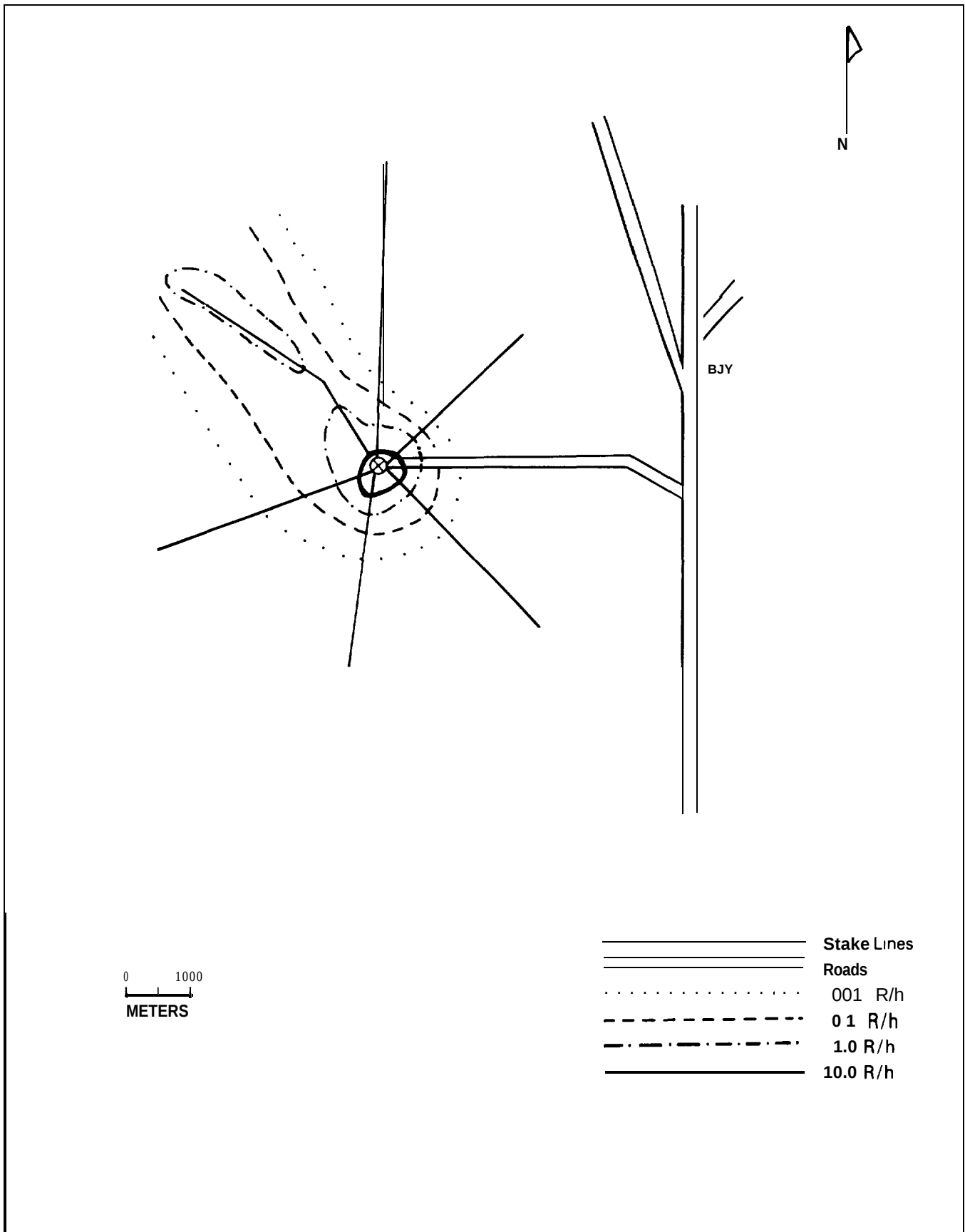


Figure 4-2: RESURVEY FOR SHOT APPLE 2, 6 MAY 19550632 TO 0731 HOURS

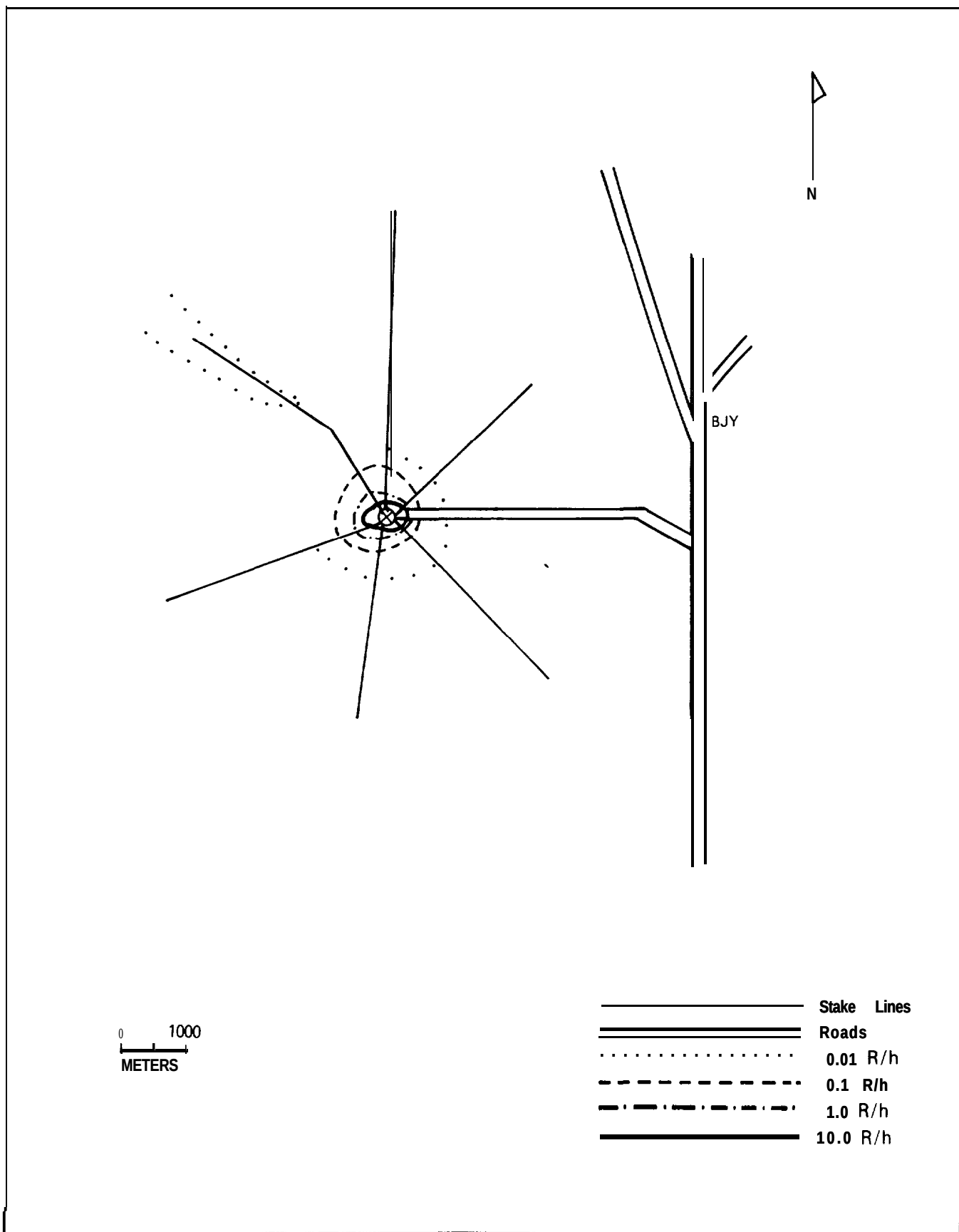


Figure 4-3: RESURVEY FOR SHOT APPLE 2, 9 MAY 1955, 1030 TO 1120 HOURS

4.2.4 Recovery and Re-entry Procedures

The Plotting and Briefing Section cleared 50 parties for entry into the shot area on 5 May. On 6 through 9 May, the following numbers of parties entered the shot area (16):

<u>Date</u>	<u>Number of Parties</u>
6 May	48
7 May	14
8 May	6
9 May	25

4.2.5 Decontamination Activities

During the period covering Shot APPLE 2, 5 May through 9 May 1955, personnel of the Decontamination Section decontaminated 59 vehicles, cleared 23 items for shipment, and placed 107 pieces of equipment in the hot park, an isolated area set aside for contaminated equipment and vehicles (16).

SHOT APPLE 2 REFERENCE LIST

The following list of references represents only those documents cited in the APPLE 2 **volume**. When a DASA-WT or DNA-WT document is followed by an EX, the latest version has been cited. A complete list of documents reviewed during the preparation of the TEAPOT Series volumes is contained in the Operation TEAPOT volume Bibliography.

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ATTN Tech Library

Air National Guard
ATTN Historian

Air Training Command
ATTN Historian

Air University Library
Department of the Air Force
ATTN AUL-LSE

Military Air Lift Command
ATTN Historian

Commander-in-Chief
Pacific Air Forces
ATTN Historian

Tactical Air Command
Department of the Air Force
ATTN Historian

DEPARTMENT OF THE AIR FORCE (Continued)

Strategic Air Command
Department of the Air Force
ATTN NRI-STINFO Library
ATTN: Historian

U S. Air Force Occupational & Env Health Lab
ATTN NIPR

DEPARTMENT OF ENERGY

Department of Energy
ATTN OMA

Department of Energy
Nevada Operations Office
ATTN: Health Physics Div
2 cy ATTN. R. Nutley

Department of Energy
Human Health & Assessments Division
ATTN EV-31

OTHER GOVERNMENT AGENCIES

Centers for Disease Control
U.S. Public Health Service
ATTN G Caldwell

Central Intelligence Agency
ATTN Office of Medical Services

Department of Health & Human Svcs
ATTN. Office of General Counsel

Exec Ofc of The President
Management & Budget Off Lib
ATTN. Librn

Library of Congress
ATTN. Library Service Division
ATTN- Science & Technology Div
ATTN Serial & Govt Publication

National Atomic Museum
ATTN Historian

Department of Commerce
National Bureau of Standards
ATTN Librn

National Technical Information Service
12 cy ATTN Customer Services

Occupational Safety & Health Admin
ATTN. C. Wright

Office of Health & Disability (ASPER)
ATTN R Copeland

Ofc of Workers Compensation Program
Department of Labor
ATTN R. Larson

U S. Coast Guard Academy Library
ATTN Librn

U S House of Representatives
ATTN Committee on Armed Svcs

OTHER GOVERNMENT AGENCIES (Continued)

U.S. House of Representatives
Committee on Interstate & Foreign Commerce
ATTN: Subcommittee on Health & Envir

U.S. Military Academy
ATTN: Director of Libraries

U.S. Senate
Committee on Armed Services
ATTN: Committee on Veterans Affairs

U S. Senate
ATTN: Committee on Veterans Affairs

Veterans Administration-RO
Providence, RI
ATTN: Director

Veterans Administration-RO
Montgomery, AL
ATTN Director

Veterans Administration-RO
Anchorage, AK
ATTN Director

Veterans Administration-RO
Phoenix, AZ
ATTN. Director

Veterans Administration-RO
Little Rock, AR
ATTN Director

Veterans Administration-RO
Los Angeles, CA
ATTN. Director

Veterans Administration-RO
San Francisco, CA
ATTN. Director

Veterans Administration-RO
Denver, CO
ATTN. Director

Veterans Administration-RO
Hartford, CT
ATTN Director

Veterans Administration-RO
Wilmington, DE
ATTN Director

Veterans Administration-OFC Central
Washington, D. C.
ATTN. Dept Veterans Benefit, Central Ofc
ATTN: Director
ATTN. Board of Veteran Appeal

Veterans Administration-RO
St. Petersburg, FL
ATTN: Director

Veterans Administration-RO
Atlanta, GA
ATTN. Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Honolulu, HI
ATTN: Director

Veterans Administration-RO
Chicago, IL
ATTN: Director

Veterans Administration-RO
Seattle, WA
ATTN: Director

Veterans Administration-RO
Indianapolis, IN
ATTN: Director

Veterans Administration-RO
Des Moines, IA
ATTN: Director

Veterans Administration-RO
Wichita, KS
ATTN: Director

Veterans Administration-RO
Louisville, KY
ATTN: Director

Veterans Administration-RO
New Orleans, LA
ATTN: Director

Veterans Administration-RO
Togus, ME
ATTN. Director

Veterans Administration-RO
Baltimore, MD
ATTN. Director

Veterans Administration-RO
Boston, MA
ATTN Director

Veterans Administration-RO
St. Paul, MN
ATTN Director

Veterans Administration-RO
Jackson, MS
ATTN: Director

Veterans Administration-RO
Huntington, WV
ATTN. Director

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

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

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Lincoln, NE
ATTN: Director

Veterans Administration-RO
Reno, NV
ATTN: Director

Veterans Administration-RO
Manchester, NH
ATTN: Director

Veterans Administration-RO
Newark, NJ
ATTN: Director

Veterans Administration-RO
Milwaukee, WI
ATTN: Director

Veterans Administration-RO
Albuquerque, NM
ATTN: Director

Veterans Administration-RO
Buffalo, NY
ATTN: Director

Veterans Administration-RO
New York, NY
ATTN: Director

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

Veterans Administration-RO
Fargo, ND
ATTN: Director

Veterans Administration-RO
Cleveland, OH
ATTN: Director

Veterans Administration-RO
Muskogee, OK
ATTN: Director

Veterans Administration-RO
Portland, OR
ATTN: Director

Veterans Administration-RO
Pittsburgh, PA
ATTN: Director

Veterans Administration-RO
Philadelphia, PA
ATTN: Director

Veterans Administration-RO
San Francisco, CA
ATTN: Director

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

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Columbia, SC
ATTN: Director

Veterans Administration-RO
Sioux Falls, SD
ATTN: Director

Veterans Administration-RO
Houston, TX
ATTN: Director

Veterans Administration-RO
Waco, TX
ATTN: Director

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

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

Veterans Administration-RO
Roanoke, VA
ATTN: Director

Veterans Administration-RO
Cheyenne, WY
ATTN: Director

Veterans Administration-RO
San Diego, CA
ATTN: Director

Veterans Administration-RO
Boise, ID
ATTN: Director

Veterans Administration-RO
Detroit, MI
ATTN: Director

Veterans Administration-RO
Nashville, TN
ATTN: Director

The White House
ATTN: Domestic Policy Staff

DEPARTMENT OF ENERGY CONTRACTORS

Lawrence Livermore National Lab
ATTN: Tech Info Dept Library

Los Alamos National Scientific Lab
ATTN: Library
ATTN: AOPA MS 195

Sandia National Lab
ATTN: W Hereford
ATTN: Central Library

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

OTHER

Adams State College
ATTN: Librn

Akron Public Library
ATTN: Librn

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

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

University of Alaska Library at Anchorage
ATTN: Dir of Libraries

University of Alaska
ATTN: Librn

Albany Public Library
ATTN: Librn

Alexander City State Jr College
ATTN: Librn

Allegheny College
ATTN: Librn

Allen County Public Library
ATTN: Librn

Altoona Area Public Library
ATTN: Librn

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

Anaheim Public Library
ATTN: Librn

College of Wooster
ATTN: Gov Docs

Angelo State University Library
ATTN: Librn

Angelo Jacoboni Public Library
ATTN: Librn

Anoka County Library
ATTN: Librn

Appalachian State University
ATTN: Library Docs

Arizona State University Library
ATTN: Librn

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

Arkansas College Library
ATTN: Library

Brooklyn College
ATTN: Doc Div

OTHER (Continued)

Arkansas Library Comm
ATTN: Library

Arkansas State University
ATTN: Library

University of Arkansas
ATTN: Gov Docs Div

Austin College
ATTN: Librn

Atlanta Public Library
ATTN: Ivan Allen Dept

Atlanta University
ATTN: Librn

Auburn University Library at Montgomery (Reg)
ATTN: Librn

C W. Post Ctr Long Island University
ATTN: Librn

Bangor Public Library
ATTN: Librn

Bates College Library
ATTN: Librn

Baylor University Library
ATTN: Docs Dept

Beloit College Libraries
ATTN: Serials Docs Dept

Bemidji State College
ATTN: Library

State University College
ATTN: Gov Docs

Akron University
ATTN: Gov Docs

Boston Public Library (Reg)
ATTN: Docs Dept

Bowdoin College
ATTN: Librn

Bowling Green State University
ATTN: Lib Gov Docs Services

Bradley University
ATTN: Librn

Brandeis University Library
ATTN: Docs Section

Brigham Young University
ATTN: Librn

Brigham Young University
ATTN: Docs Collection

Brookhaven National Laboratory
ATTN: Tech Library

brookhaven College
ATTN: Docs Div

OTHER(Continued)

Broward County Library Sys
ATTN Librn

Brown University
ATTN Librn

Bucknell University
ATTN: Reference Dept

Buffalo & Erie Co Public Library
ATTN Librn

State Unverslty Library of California at Fresno
ATTN. Library

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

University of California at San Diego
ATTN: Docs Dept

State College Library of California at Stanislaus
ATTN: Library

California State Polytechnic University Library
ATTN Librn

California State University at Northridge
ATTN Gov Doc

California State Library (Reg)
ATTN Librn

California State University at Long Beach Library
ATTN Librn

California State University
ATTN Librn

California State University
ATTN Librn

California University Library
ATTN. Gov Pub Dept

California Unverslty Library
ATTN Librn

California University Library
ATTN Gov Docs Dept

California Unverslty Library
ATTN: Docs Sec

University of California
ATTN Gov Docs Dept

Calvin College Library
ATTN Librn

Kearney State College
ATTN: Gov Docs Dept

Cambria County Library Sys
ATTN Librn

Carleton College Library
ATTN. Librn

OTHER (Continued)

Carnegie Library of Pittsburgh
ATTN Librn

Carnegie Mellon University
ATTN Dir of Libraries

Carson Regional Library
ATTN: Gov Pubs Unit

Case Western Reserve Unlverslty
ATTN: Librn

Casper College
ATTN: Librn

University of Central Florida
ATTN: Library Docs Dept

Central Michigan University
ATTN. Library Docs Sec

Central Missouri State Univ
ATTN Gov Docs

Central State University
ATTN: Lib Docs Dept

Central Washington Unlverslty
ATTN Lib Docs Sec

Central Wyoming College Library
ATTN Librn

Charleston County Library
ATTN Librn

Charlotte & Mecklenburg County Public Library
ATTN. E Correll

Chattanooga Hamilton County, 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

Citadel, Daniel Library
ATTN Librn

Claremont Colleges Libraries
ATTN: Doc Collection

Clemson University
ATTN. Dir of Libraries

OTHER (Continued)

Cleveland Public Library
ATTN: Docs Collection

Cleveland State University Library
ATTN: Librn

Coe Library
ATTN: Docs Div

Colgate University Library
ATTN: Ref Lib

Colorado State University Libraries
ATTN: Librn

University of Colorado Libraries
ATTN: Dir of Libraries

Columbia University Library
ATTN: Docs Svc Ctr

Columbus & Franklin Cty Public Library
ATTN: Gen Rec Div

Compton Library
ATTN: Librn

Connecticut State Library (Reg)
ATTN: Librn

University of Connecticut
ATTN: Gov't of Connecticut

University of Connecticut
ATTN: Dir of Libraries

Cornell University Library
ATTN: Librn

Corpus Christi State University Library
ATTN: Librn

Culver City Library
ATTN: Librn

Curry College Library
ATTN: Librn

University of North Carolina at Asheville
ATTN: Librn

Dallas County Public Library
ATTN: Librn

Dallas Public Library
ATTN: Librn

Dalton Junior College Library
ATTN: Librn

Dartmouth College
ATTN: Librn

Davenport Public Library
ATTN: Librn

Davidson College
ATTN: Librn

OTHER (Continued)

Dayton & Montgomery City Public Library
ATTN: Librn

University of Dayton
ATTN: Librn

Decatur Public Library
ATTN: Librn

Dekalb Community College SO CPUS
ATTN: Librn

Delaware 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

Dickinson College Library
ATTN: Librn

Dickinson State College
ATTN: Librn

Alabama Agricultural Mechanical University & Coll
ATTN: Librn

Drake University
ATTN: Cowles Library

Drew University
ATTN: Librn

Duke University
ATTN: Pub Docs Dept

Duluth Public Library
ATTN: Docs Sec

East Carolina University
ATTN: Lib Docs Dept

East Central University
ATTN: Librn

East Islip Public Library
ATTN: Librn

OTHER (Continued)

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

East Tennessee State University Sherrad Library
ATTN: Docs Dept

East Texas State University
ATTN: Library

Monmouth County Library Eastern Branch
ATTN: Librn

Eastern Illinois University
ATTN: Librn

Eastern Kentucky University
ATTN: Librn

Eastern Michigan University Library
ATTN: Library

Eastern Montana College Library
ATTN: Docs Dept

Eastern New Mexico University
ATTN: Librn

Eastern Oregon College Library
ATTN: Librn

Eastern Washington University
ATTN: Librn

El Paso Public Library
ATTN: Docs & Genealogy Dept

Elko County Library
ATTN: Librn

Elmira College
ATTN: Librn

Elon College Library
ATTN: Librn

Enoch Pratt Free Library
ATTN: Docs Ofc

Emory University
ATTN: Librn

Evansville & Vanderburgh Cty Public Library
ATTN: Librn

Everett Public Library
ATTN: Librn

Fairleigh Dickinson University
ATTN: Depository Dept

Florida A & M University
ATTN: Librn

Florida Atlantic University Library
ATTN: 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: Div of Library (Reg)
ATTN: Docs Dept

Fond Du Lac Public Library
ATTN: Librn

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

Ft Worth Public Library
ATTN: Librn

Free Public Library of Elizabeth
ATTN: Librn

Free Public Library
ATTN: Librn

Freeport Public Library
ATTN: Librn

Fresno Cty Free Library
ATTN: Librn

Gadsden Public Library
ATTN: Librn

Garden Public Library
ATTN: Librn

Gardner Webb College
ATTN: Docs Library

Gary Public Library
ATTN: Librn

Geauga Cty Public Library
ATTN: Librn

Georgetown University Library
ATTN: Gov Docs Room

Georgia Institute of Technology
ATTN: Librn

Georgia Southern College
ATTN: Librn

Georgia Southwestern College
ATTN: Dir of Libraries

Georgia State University Library
ATTN: Librn

OTHER (Continued)

University of Georgia
ATTN: Dir of Libraries (Reg)

Glassboro 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

Grinnell College Library
ATTN: Librn

Guam RFK Memorial University Library
ATTN: Fed Depository Coll

University of Guam
ATTN: Librn

Gustavus Adolphus College
ATTN: Librn

South Dakota University
ATTN: Librn

Hardin-Simmons University Library
ATTN: Librn

Hartford Public Library
ATTN: Librn

Harvard College Library
ATTN: Dir of Lib

Harvard College Library
ATTN: Serials Rec Div

University of Hawaii Library
ATTN: Gov Docs Coll

Hawaii State Library
ATTN: Fed Docs Unit

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

University of Hawaii
Hilo Campus Library
ATTN: Librn

Haydon Burns Library
ATTN: Librn

Hennepin County Library
ATTN: Gov Docs

Henry Ford Community College Library
ATTN: Librn

OTHER (Continued)

Herbert H. Lehman College
ATTN: Lib Docs Div

Hofstra University Library
ATTN: Docs Dept

Hollins College
ATTN: Librn

Hopkinsville Community College
ATTN: Librn

Wagner College
ATTN: Librn

University of Houston Library
ATTN: Docs Div

Houston Public Library
ATTN: Librn

Tulane University
ATTN: Docs Dept

Hoyt Public Library
ATTN: Librn

Humboldt State College Library
ATTN: Docs Dept

Huntington Park Library
ATTN: Librn

Hutchinson Public Library
ATTN: Librn

Idaho Public Library & Information Center
ATTN: Librn

Idaho State Library
ATTN: Librn

Idaho State University Library
ATTN: Docs Dept

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

University of Illinois Library
ATTN: Docs Sec

Illinois State Library (Reg)
ATTN: Gov Docs Br

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

Illinois Valley Community College
ATTN: Librn

Illinois State University
ATTN: Librn

Indiana State Library (Reg)
ATTN: Serial Sec

Indiana State University
ATTN: Docs Library

OTHER (Continued)

Indiana University Library
ATTN: DOCS Dept

Indianapolis Marion County Public Library
ATTN: Social Science Div

Iowa State University Library
ATTN: Gov DOCS Dept

Iowa University Library
ATTN: Gov DOCS Dept

Butler University
ATTN: Librn

Isaac Delchdo College
ATTN: Librn

James Madison University
ATTN: Librn

Jefferson County Public Library
Lakewood Regional Library
ATTN: Librn

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

Johns Hopkins University
ATTN: DOCS Library

La Roche College
ATTN: Librn

Johnson Free Public Library
ATTN: Librn

Kalamazoo Public Library
ATTN: Librn

Kansas City Public Library
ATTN: DOCS Div

Kansas State Library
ATTN: Librn

Kansas State University Library
ATTN: DOCS Dept

University of Kansas
ATTN: Dir of Library (Reg)

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

Maine Maritime Academy
ATTN: Librn

University of Maine
ATTN: Librn

OTHER (Continued)

Kent State University Library
ATTN: Docs Div

Kentucky Dept of Library & Archives
ATTN: Docs Sec

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

Kenyon College Library
ATTN: Librn

Lake Forest College
ATTN: Librn

Lake Sumter Community College Library
ATTN: Librn

Lakeland Public Library
ATTN: Librn

Lancaster Regional Library
ATTN: Librn

Lawrence University
ATTN: DOCS Dept

Brigham Young University
ATTN: DOCS & Map Sec

Lewis University Library
ATTN: Librn

Library and Statutory Dist & Svc
2 cy ATTN: Librn

Earlham College
ATTN: Librn

Little Rock Public Library
ATTN: Librn

Long Beach Public Library
ATTN: Librn

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

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

Louisville Free Public Library
ATTN: Librn

Louisville University Library
ATTN: Librn

Hoover Institution
ATTN: J. Bingham

OTHER (Continued)

Manchester City Library
ATTN: Librn

Mankato State College
ATTN: Gov Pubs

University of Maine at Farmington
ATTN: Dir of Libraries

Marathon County Public Library
ATTN: Librn

Principia College
ATTN: Librn

University of Maryland
ATTN: McKeldin Library Docs Div

University of Maryland
ATTN: Librn

University of Massachusetts
ATTN: Gov Docs Coll

Maui Public Library
Kahului Branch
ATTN: Librn

McNeese State University
ATTN: Librn

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

Memphis & Shelby County Public Library E
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

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

Murray State University Library
ATTN: Lib

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 Dir of Emergency Svcs
ATTN Librn

OTHER (Continued)

Northeast Missouri State University
ATTN Librn

Northeastern Oklahoma State University
ATTN Librn

Northeastern University
ATTN. Dodge Library

Northern Arizona University Library
ATTN Gov Docs Dept

Northern Illinois University
ATTN Librn

Northern Michigan University
ATTN. Docs

Northern Montana College Library
ATTN. Librn

Northwestern Michigan College
ATTN: Librn

Northwestern State University
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
ATTN Librn

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

Ouachita 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: Llbrn

Shawnee Library System
ATTN: Llbrn

Shreve Memorial Library
ATTN: Llbrn

Silas Bronson Public Library
ATTN: Llbrn

Sioux City Public Library
ATTN: Llbrn

Skidmore College
ATTN: Llbrn

Slippery Rock State College Library
ATTN: Llbrn

South Carolina State Library
ATTN: Llbrn

University of South Carolina
ATTN: Llbrn

University of South Carolina
ATTN: Gov Docs

South Dakota School of Mines & Technical Library
ATTN: Llbrn

South Dakota State Library
ATTN: Fed Docs Dept

University of South Dakota
ATTN: Docs Llbrn

South Florida University Library
ATTN: Llbrn

Southeast Missouri State University
ATTN: Llbrn

Southeastern Massachusetts University Library
ATTN: Docs Sec

University of Southern Alabama
ATTN: Llbrn

Southern California University Library
ATTN: Docs Dept

Southern Connecticut State College
ATTN: Library

Southern Illinois University
ATTN: Llbrn

Southern Illinois University
ATTN: Docs Ctr

Southern Methodist University
ATTN: Llbrn

University of Southern Mississippi
ATTN: Library

OTHER (Continued)

Southern Oregon College
ATTN: Library

Southern University in New Orleans Library
ATTN: Llbrn

Southern Utah State College Library
ATTN: Docs Dept

Southwest Missouri State College
ATTN: Library

University of Southwestern Louisiana Libraries
ATTN: Llbrn

Southwestern University
ATTN: Llbrn

Spokane Public Library
ATTN: Ref Dept

Springfield City Library
ATTN: Docs Sec

St Bonaventure University
ATTN: Llbrn

St Johns River Junior College
ATTN: Library

St Joseph Public Library
ATTN: Llbrn

St Lawrence University
ATTN: Llbrn

St Louis Public Library
ATTN: Llbrn

St Paul Public Library
ATTN: Llbrn

Stanford University Library
ATTN: Gov Docs Dept

State Historical Soc Library
ATTN: Docs Serials Sec

State Library of Massachusetts
ATTN: Llbrn

State University of New York
ATTN: Llbrn

Stetson University
ATTN: Llbrn

University of Steubenville
ATTN: Llbrn

Stockton & San Joaquin Public Library
ATTN: Llbrn

Stockton State College Library
ATTN: Llbrn

Albion College
ATTN: Gov Docs Llbrn

OTHER (continued)

Superior Public Library
ATTN: Librn

Swarthmore College Library
ATTN Ref Dept

Syracuse University Library
ATTN Docs Div

Tacoma Public Library
ATTN: Librn

Hillsborough County Public Library at Tampa
ATTN: Librn

Temple University
ATTN. Librn

Tennessee Technological University
ATTN. Librn

University of Tennessee
ATTN Dir of Libraries

College of Idaho
ATTN Librn

Texas A & M University Library
ATTN Librn

University of Texas at Arlington
ATTN. Library Docs

University of Texas at San Antonio
ATTN Library

Texas Christian University
ATTN Librn

Texas State Library
ATTN U S Docs Sec

Texas Tech University Library
ATTN. Gov Docs Dept

Texas University at Austin
ATTN Docs Coll

University of Toledo Library
ATTN Librn

Toledo Public Library
ATTN Social Science Dept

Torrance Civic Center Library
ATTN Librn

Traverse City Public Library
ATTN Librn

Trenton Free Public Library
ATTN Librn

Trinity College Library
ATTN Librn

Trinity University Library
ATTN. Docs Coll

OTHER (Continued)

Tufts University Library
ATTN. Docs Dept

University of Tulsa
ATTN: Librn

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

Uniformed Services University of the Health Sciences
ATTN: LRC Library

University Libraries
ATTN Dir of Lib

University of Maine at Orono
ATTN Librn

University of Northern Iowa
ATTN Library

Upper Iowa College
ATTN Docs Coll

Utah State University
ATTN. Librn

University of Utah
ATTN Special Collections

University of Utah
ATTN Dir of Library

Utica Public Library
ATTN Librn

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
ATTN Librn

OTHER (Continued)

Washington State Library
ATTN: Docs Sec

Washington State Unverslty
ATTN: Lib Docs Sec

Washington University Libraries
ATTN: Dir of Lib

University of Washington
ATTN: Docs Div

Wayne State University Library
ATTN: Librn

Wayne State University Law Library
ATTN: Docs Dept

Weber State College Library
ATTN: Librn

Wesleyan University
ATTN: Docs Librn

West Chester State College
ATTN: Docs Dept

West Covina Library
ATTN: Librn

University of West Florida
ATTN: Librn

West Georgia College
ATTN: Librn

West Hills Community College
ATTN: Library

West Texas State University
ATTN: Library

West Virginia College of Grad Studies Library
ATTN: Librn

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

Westerly Public Library
ATTN: Librn

Western Carolina University
ATTN: Librn

Western Illinois University Library
ATTN: Librn

Western Washington Unverslty
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 Dshkosh
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 Unverslty Library
ATTN: Gov Docs Librn

Wyoming State Library
ATTN: Librn

University of Wyoming
ATTN: Docs Div

Yale University
ATTN: Dir of Libraries

Yeshiva University
ATTN: Librn

Yuma City County Library
ATTN: Librn

Simon Schwob Mem Lib, Columbus Col
ATTN: Librn

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