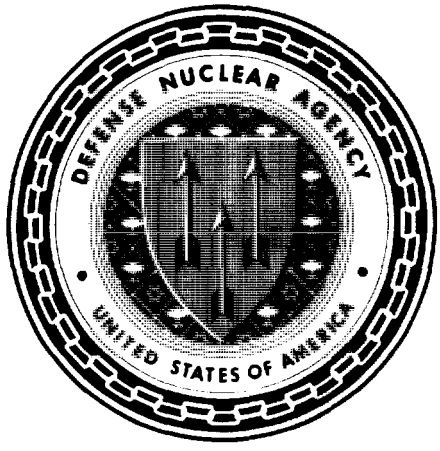
DNA 6001F

SHOT GALILEO

A Test of the PLUMBBOB Series 2 September 1957



United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

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

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the activities of DOD personnel, both military and civilian, in Shot GALILEO, the 16th nuclear test in the PLUMBBOB atmospheric weapons testing series. The test was conducted on 2 September 1957 and involved participants from Exercise Desert Rock VIII, AFSWP, AFSWC, and AEC test groups. This volume also describes the radiological safety criteria and procedures in effect at Shot GALILEO.

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18. SUPPLEMENTARY NOTES (continued)

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

PREFACE

Between 1945 and 1962, the United States 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, U.S. Department of Health, Education, and Welfare (now the Centers for Disease Control, U.S. Department of Health and Human Services), noted a possible leukemia cluster among a small group of soldiers present at Shot SMOKY, the 15th test of Operation PLUMBBOB, the series of nuclear weapons tests conducted in 1957. Following that initial report by the Center for Disease Control, the Veterans Administration received a number of claims for medical benefits from former military personnel who believe their health may have been affected by their participation in the nuclear weapons tests.

In late 1977, DOD began a study to provide data to both the Center for Disease Control and the Veterans Administration on potential exposures to ionizing radiation among its military and civilian participants in the atmospheric nuclear weapons tests 15 to 30 years earlier. DOD organized an effort to:

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

This report on Shot GALILEO is based on the historical record of military and technical documents associated with each of the nuclear weapons test events. The reports of the Nuclear Test Personnel Review provide a public record of the activities and associated potential for radiation exposure of DOD personnel, for use in ongoing public health research and policy analvsis.

Many of the documents pertaining specifically to DOD involvement during Shot GALILEO 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). The most significant documents used in the development of this report include:

- Report on Desert Rock VII and VIII prepared by the Human Resources Research Office
- Report on Task Force BIG BANG prepared by the Defense Nuclear Agency
- Final Report of Operations for Exercise Desert Rock VII and VIII
- Report of the Test Manager, Operation PLUMBBOB
- Weapons Test Reports for the Armed Forces Special Weapons Project (AFSWP)
- Air Force Special Weapons Center (AFSWC) Final Report of the 4950th Test Group (Nuclear), Operation PLLJMBBOB
- Air Mission Summary Reports for Shot GALILEO
- AFSWC Operation Plan 1-57
- Unit Histories for AFSWC, Operation PLUMBBOB
- Report of the Test Director, Operation TEAPOT
- PLUMBBOB Onsite Radiological Safety Report, prepared for the Nevada Test Organization (NTO) by Reynolds Electrical and Engineering Company.

Frequently, the surviving historical documentation Of activities conducted at Shot GALILEO 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 inconsistencies wherever possible, or otherwise bring them to the attention of the reader.

ORGANIZATION AND CONTENT OF PLUMRBOB SERIES REPORTS

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

- Series volume: PLUMBBOB Series, 1957
- Multi-shot volume: Shots BOLTZMANN to WILSON, the First Four Tests of the PLUMBBOB Series
- Shot volume: Shot PRISCILLA, a Test of the PLUMBBOB Series
- Shot volume: Shot HOOD, a Test of the PLUMBBOR Series
- Multi-shot volume: Shots DIABLO to FRANKLIN PRIME, the Mid-series PLUMBBOB Tests
- Shot volume: Shot SMOKY, a Test of the PLUMBBOB Series
- Multi-shot volume: Shots WHEELER to MORGAN, the Final PLUMBBOR Tests

The volumes addressing the test events of Operation PLUMBBOB have been designed for use with one another. The Series volume

contains information applying to those dimensions of Operation PLUMBBOB that transcend specific events, such as historical background, organizational relationships, and radiological safety procedures. In addition, the Series volume contains a bibliography of works consulted in the preparation of all eight Operation PLUMBBOB reports.

The single-shot volumes describe DOD participation in Shots PRISCILLA, HOOD, and SMOKY. These events have been bound separately because the events included substantial numbers of DOD participants. Each multi-shot volume combines shot-specific descriptions for several nuclear events, each involving smaller numbers of DOD personnel. The shot and multi-shot volumes contain bibliographies only of the sources referenced in each text. Descriptions of activities concerning any particular shot in the PLUMBBOB 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 safetv information contained in the PLUMBBOR Series volume.

The information in this volume is supplemented by the "Reference Manual: Background Materials for the CONUS Volumes," which summarizes information on the physical processes and characteristics of a detonation, radiation physics, radiation health concepts, exposure criteria, and measurement techniques, and lists acronyms and a glossary of terms used in the Nuclear Test Personnel Review reports addressing test events in the continental U.S.

Chapter 1 of this volume describes the physical setting of the GALILEO detonation and introduces the Desert Rock maneuvers and those NTO scientific activities in which DOD personnel participated.

Chapter 2 describes the Exercise Desert Rock VII and VIII military projects conducted at Shot GALILEO, while chapter 3 describes various training activities, scientific experiments, and support missions conducted at GALILEO by the NTO in which DOD personnel took part. These chapters provide information about the number of DOD people involved in specific projects fielded at Shot GALILEO, the time spent by project personnel in the test area, and their positions relative to the point of detonation and areas of radioactivity before, during, and after the test.

Chapter 4 of this volume describes the radiological environment and safety procedures pertinent to Shot GALILEO, including isointensity contour maps illustrating the radiological contamination around ground zero following the detonation, and available shot-specific exposure data for individuals. Details of the overall radiation protection program at Operation PLIJMBBOB are provided in the Series volume.

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LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used in this volume:

AEC	Atomic Energy Commission
AFB	Air Force Base
AFSWC	Air Force Special Weapons Center
AFSWP	Armed Forces Special Weapons Project
BJY	Buster-Jangle "Y"
CETG	Civil Effects Test Group
DOD	Department of Defense
FCDA	Federal Civil Defense Administration
HumRRO	Human Resources Research Office
LASL	Los Alamos Scientific Laboratory
NTO	Nevada Test Organization
NTS	Nevada Test Site
OCAFF	Office, Chief of Army Field Forces
REECo	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
WETG	Weapons Effects Test Group

GALILEO

SHOT SYNOPSIS

AEC TEST SERIES:	PLUMBBOB
DOD EXERCISES:	Desert Rock VII and VIII
DATE/TIME:	2 September 1957, 0540 hours
YIELD:	11 kilotons
HEIGHT OF BURST:	500 feet (tower shot)

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

DOD Objectives: (1) To test performance of military personnel as affected by witnessing a nuclear detonation
(2) To perform AFSWP military effects experiments to measure the effects of a nuclear weapon with a known yield and characteristics on military equipment, material, structures, and ordnance
(3) To provide DOD personnel an opportunity to observe a nuclear detonation and to become familiar with its effects
(4) To evaluate military equipment and tactics.

Weather: At shot-time, temperature was 15.8° C.; relative humidity, 30%; pressure, 878 mb; wind calm.

Radiation Data: Fallout greater than 0.1 R/h was detected during the initial survey (mid-time: 0726 hours) in the quadrant northwest of ground zero. Fallout intensities of 0.01 R/h also extended as far as 3,000 meters east of ground zero. Exposure to initial radiation from GALILEO was not significant.

Participants: Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Exercise Desert Rock troops, Los Alamos Scientific Laboratory, University of California Radiation Laboratory, Federal Civil Defense Administration, Contractors.

CHAPTER 1

INTRODUCTION

Shot GALILEO was a test of an ll-kiloton nuclear device conducted at 0540 hours Pacific Daylight Time on 2 September 1957 at the Nevada Test Site (NTS), the U.S. Atomic Energy Commission (AEC) continental nuclear test area, located northwest of Las Vegas. GALILEO was the 16th nuclear test of Operation PLUMBBOB, a series of 24 nuclear weapons tests and six safety experiments performed in Nevada between 24 April and 7 October 1957.

The GALILEO nuclear device was designed and built for the AEC by the Los Alamos Scientific Laboratory (LASL). The primary objective of the GALILEO event was to test a newly designed nuclear device for possible inclusion in the U.S. arsenal. To fulfill this objective, LASL and the University of California Radiation Laboratory (UCRL) fielded scientific experiments to study the characteristics of the detonation. Other scientific experiments were conducted by the Armed Forces Special Weapons Project (AFSWP) of the Department of Defense (DOD) to evaluate the nuclear yield and the blast, thermal, and radiation phenomena produced by this nuclear device (19).*

A number of other activities related to the conditions and phenomena produced by a nuclear detonation were also conducted during the GALILEO event. These included the Desert Rock exercises, one operational training project, and Federal Civil Defense Administration (FCDA) projects.

As part of Exercise Desert Rock VII and VIII, the armed services fielded three projects to evaluate the performance of

*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.

military personnel and the usefulness of military equipment under the conditions of a nuclear battlefield. A provisional company of the 82nd Airborne Division, named Task Force BIG BANG, participated in a project sponsored by the Human Resources Research Office (HumRRO). The other two projects required an additional 128 Army personnel to perform tests of equipment. Similarly, the Air Force conducted one operational training project at GALILEO to test equipment and to familiarize personnel with the effects of a nuclear detonation.

The FCDA Civil Effects Test Group (CETG) conducted projects to assess the effects of nuclear detonations on civilian populations and to evaluate Civil Defense emergency preparedness plans. DOD participation in these projects was limited.

1.1 SETTING AND CHARACTERISTICS OF THE GALILEO DETONATION

The nuclear device tested at Shot GALILEO was positioned atop a 500-foot tower located at UTM coordinates 797009* in Area 1 of Yucca Flat. Figure l-l shows the location of the GALILEO detonation in relation to other shots in the PLUMBBOB Series (14).

At 0130 hours on 2 September, the morning of the shot, Task Force BIG BANG troops and a team of radiological safety monitors and HumRRO evaluators left Camp Desert Rock for the GALILEO observer area (15). By 0245 hours, the Task Force arrived at the

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

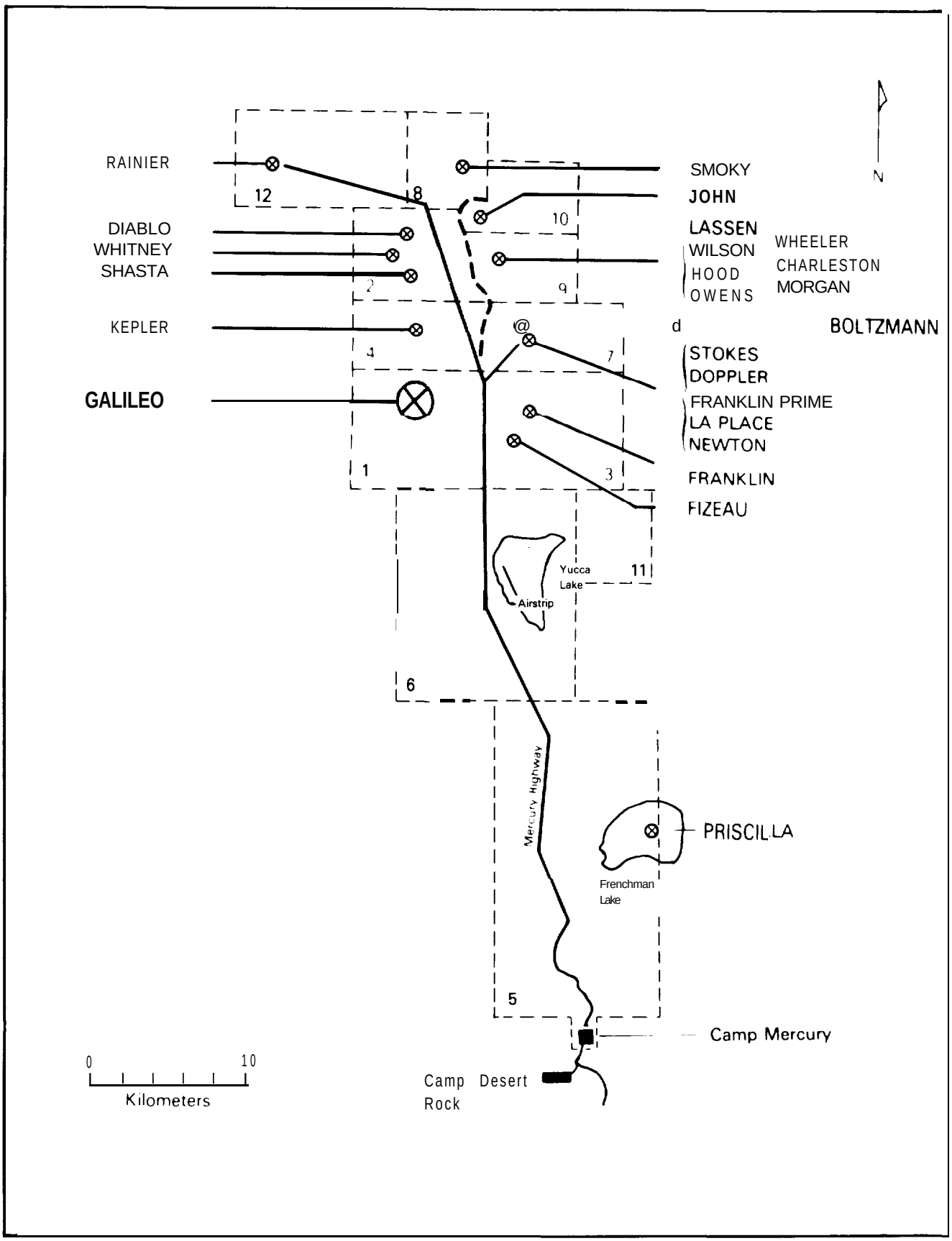

Figure I-I: LOCATION OF SHOT GALILEO IN THE NEVADA TEST SITE, IN RELATION TO OTHER SHOTS IN THE PLUMBBOB SERIES

GALILEO observer area, 4,500 meters* from the shot-tower, to await the detonation. By the time of the detonation, members of the Weapons Effects Test Group (WETG), LASL, UCRL, and CETG had completed their preshot activities. Instruments and equipment associated with their experiments ringed the area of ground zero. In the air, aircraft participating in operational training projects and scientific support missions were enroute to the NTS for the detonation.

The GALILEO device was detonated at 0540 hours Pacific Daylight Time on 2 September 1957. At the time of the detonation, the weather was clear and the surface winds were calm. The nuclear cloud rose to an altitude of about 37,000 feet.+ The GALILEO fallout occurred in an area north-northwest of ground zero (14).

Immediately after the detonation, Task Force BIG BANG personnel performed exercises designed to measure their psychological reactions to the detonation. First, they conducted a rifle disassembly-assembly test in the same area in which they had observed Shot GALILEO. After that, they performed an exercise at an infiltration course constructed 3,250 meters south-southeast of the SMOKY ground zero (15). When the Test Manager declared that conditions were safe to do so, test group participants recovered instruments from the area around ground zero. Meanwhile, Air Force Special Weapons Center (AFSWC) pilots conducted their missions, including cloud sampling and cloud tracking, and two aircraft from the Tennesssee Air National Guard conducted their operational training project.

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

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

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

The Nevada Test Organization (NTO) was established for planning, coordinating, and conducting atmospheric nuclear weapons tests during Operation PLUMBBOB. All activities of the NTO were under the overall control of an AEC-appointed Test Manager, assisted by a Test Director. The NTO was composed of personnel from AEC, DOD, and FCDA, and included representatives of the AFSWP WETG, the LASL Test Group, the UCRL Test Group, and the FCDA CETG. These test groups conducted 16 scientific projects at Shot GALILEO in which DOD personnel took part. One other project was performed by Air Force personnel as part of the DOD operational training program.

People 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 AFSWP Field Command WETG conducted five military effects projects. Other DOD personnel participated to a limited extent in 11 of the projects conducted by the other test groups. Participants in the military effects and scientific experiments placed data-collection instruments around the point of detonation in the days and weeks preceding the scheduled event. Some time after the detonation, when the Test Manager had determined that the radiological environment in the test area would permit limited access, participants recovered instruments and equipment (4; 19).

The operational training project, which involved two pilots from the Tennessee Air National Guard, was designed to train pilots in bomb damage assessment through photo-reconnaissance techniques. This project required the pilots to fly their aircraft in the vicinity of the NTS at the time of the detonation to observe the shot. About ten minutes after the shot, the aircraft made a pass over ground zero to photograph the shot area.

In addition to those people involved in experiments and training, staff and support personnel, including AFSWC personnel flying special missions for the Test Manager, provided necessary services to other participants at the test site (4; 19).

One important support function during Shot GALILEO was provided by AFSWC, based at Kirtland Air Force Base (AFR), New Mexico: This group provided air support to the Test Manager and to various test group projects. During Operation PLUMBBOB, AFSWC was comprised of a total of 493 airmen and 23 officers from the 4950th Test Group (Nuclear), including the 4926th Test Squadron (Sampling) and the 4935th Air Base Squadron (11). These units operated from Indian Springs AFB, 38 kilometers southeast of the NTS. Support was also provided by the 4900th Air Base Group from Kirtland AFB. For GALILEO, AFSWC performed several missions, including aircraft control, security sweeps, cloud sampling, cloud tracking, a radio relay, terrain surveys, and courier and transportation services (4; 19).

TO minimize exposure to ionizing radiation, radiation protection procedures were established by the NTO. Participants were limited to no more then three roentgens of whole-body gamma radiation for any 13-week period and five roentgens of whole-body gamma radiation annually. To ensure that these criteria be followed, access to areas of radioactivity was rigidly controlled, and project personnel who entered highly radioactive areas were accompanied by radiological safety monitors. The monitors, who continuously checked the radiation intensities in the recovery area, had the authority to order a halt to recovery operations 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. These film badges were collected, processed, and evaluated at regular intervals. 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.

Although not implemented during PLUMBBOB, emergency evacuation procedures were prepared for all test events (3; 20).

With one exception, the radiation protection procedures for the AFSWC aircrew and ground crew were the same as those established for the NTO. As the single exception, cloud sampler pilots were authorized by the Test Manager to receive up to a total of 7.5 roentgens of gamma radiation annually. Complete decontamination, including showers and changes of clothing, was required of all aircrew members following each project mission, regardless of the exposure received on the flight. Aircraft were either decontaminated by washing or were isolated until radiation intensities had decayed to predetermined levels.

This report on Shot GALILEO documents the activities of these DOD personnel before, during, and after the detonation on 2 September 1957. These descriptions focus on the potential for exposure to ionizing radiation during the performance of these assigned duties.

1.3 EXERCISE DESEHT ROCK ACTIVITIES AT SHOT GALILEO

About 295 DOD personnel involved in Shot GALILEO participated in the three projects fielded by Exercise Desert Rock VII and VIII, the Army testing and training program conducted during Operation PLUMBBOB. These projects included one troop test and two technical service projects.

The troop test was conducted by the George Washington University HumRRO, an Army contractor, to monitor the performance of persons who had witnessed a nuclear detonation for the first time. This project was originally to have involved 167 servicemen, who were to observe a detonation from trench positions and to perform several tests.

Another 128 individuals took part in two Exercise Desert Rock technical service projects. In one project, military equipment was exposed to the detonation and evaluated to determine the damage sustained. The other project tested military equipment and techniques for detecting nuclear bursts and fallout.

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

Radiation protection procedures at Exercise Desert Rock, as well as those of the NTO, are detailed in the PLUMBBOB Series volume. The procedures were designed to minimize potential exposure to ionizing radiation while allowing participants to accomplish their project objectives. Camp Desert Rock support personnel and exercise participants were limited to no more than five roentgens of whole-body gamma radiation during any six-month period. The radiation protection procedures of Exercise Desert Rock included provisions for (17; 22):

- Maintaining minimum safe distances from nuclear detonations
- Enforcing protective procedures for personnel observing the detonations
- Controlling access to radioactive areas
- Monitoring individuals working in radioactive areas
- Issuing film-badges to Desert Rock personnel and monitoring the cumulative exposure of Desert Rock personnel

- Decontaminating all equipment and personnel leaving the test area after the detonation.

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

CHAPTER 2

EXERCISE DESERT ROCK VII AND VIII OPERATIONS AT SHOT GALILEO

Department of Defense (DOD) personnel participated in three Exercise Desert Rock VII and VIII projects during Shot GALILEO. This chapter describes the Desert Rock activities that may have exposed participants to ionizing radiation before, during, and after the detonation. In all, about 295 individuals took part in these Desert Rock exercises, and approximately 57 percent of these participated in a single project, an Army troop test sponsored by the Human Resources Research Office (HumRRO). The HumRRO Troop Test was designed to test how the performance of military personnel would be affected by witnessing a nuclear detonation. The remaining Desert Rock participants took part in two Technical Service projects intended to study the effects of nuclear weapons detonations on ordnance **materiel, fortifications,** structures, and equipment.

Detailed descriptions of project objectives and general project activities are contained in the PLUMBBOB Series volume that accompanies this report. The information contained in this chapter addresses only those project operations conducted during Shot GALILEO.

Table 2-l displays the Desert Rock programs and their projects conducted at Shot GALILEO, and includes the approximate number of DOD personnel who took part in each (17).

Table 2-I: EXERCISE DESERT ROCK VII AND VIII PROJECTS, SHOT GALILEO

Program Type	Project	Title	Estimated DOD Personnel	Participants
Troop Test		HumRRO Troop Test	167	Provisional Company, 82nd Airborne Division (Task Force BIG BANG)
Technical Service	50.3	Evaluation of Medium Range Detonation-detection and Cloud Tracking Systems	23	Army Signal Research and Development Laboratories; 665th Aircraft Control and Warning Squadron
	50.8	Detection of Atomic Burst and Radioactive Fallout	105	Army Artillery and Guided Missile School; Army Chemical School; Air Defense Board; Artillery Board; Air Weather Service

2.1 TROOP TEST AT SHOT GALILEO

Task Force BIG BANG was a provisional company of the 82nd Airborne Division from Fort Bragg, North Carolina. Not all members of this provisional company participated in all Task Force BIG BANG activities, particularly the activities that took place on the GALILEO shot-day. Additional Camp Desert Rock support personnel, including two radiological safety monitors and such elements as the military police and the truck companies, supported the BIG BANG troop test (15).

The purpose of this troop test was to determine whether the performance of individuals was diminished after they witnessed a nuclear detonation for the first time, as compared with an established preshot performance standard. In performing the test, troops were required to (6; 15):

- Disassemble and reassemble a rifle
- Clear a practice minefield

- Negotiate a combat course in an area the participants believed to be contaminated by radiation.

This troop test was originally scheduled for the SMOKY shot on 19 August 1957. Task Force WARRIOR troops from the 1st Rattle Group, 12th Infantry, were to participate in the HumRRO troop test. This unit was to observe its first nuclear detonation from trenches located about 4,400 meters from the SMOKY ground zero. Immediately after the detonation, some of the troops were to leave the trenches and move to a cleared area for the rifle disassembly-assembly test. Then the unit was to clear a dummy minefield by probing it with bayonets. Finally, the Task Force WARRIOR unit would maneuver through an infiltration course they thought was contaminated with radioactive fallout, and throw grenades at a target (6; 15).

This plan was changed late in July, when a decision was made to have this infantry battle group observe Shot SHASTA on 18 August. This decision negated the HumRRO criterion that troops participating in the project witness their first nuclear detonation immediately prior to the testing. Therefore, a decision was made to replace Task Force WARRIOR troops with a provisional company from the 82nd Airborne Division, which was scheduled to arrive at Camp Desert Rock from Fort Bragg, North Carolina, on 30 July 1957. This provisional company, designated Task Force RIG BANG, originally consisted of 167 men: seven officers and 160 enlisted men. Those 100 men who had rifles were selected to participate in the HumRRO troop test. The remaining 67 were to assist HumRRO in various tasks in support of the troop test (15).

Task Force HIG RANG troops arrived at Camp Desert Rock on Monday, 12 August, 13 days after their scheduled arrival date. Preliminary training and briefings, such as the radiological safety training at Camp Desert Rock, shown in figure 2-1, were

Figure 2-1: TROOPS OF THE 82nd AIRBORNE (TASK FORCE BIG BANG) UNDERGOING RADIOLOGICAL SAFETY TRAINING IN PREPARATION FOR THE ARMY INFANTRY TROOP TESTS

conducted for the rest of that week in preparation for a final practice run on Sunday, 18 August, and for participation in Shot SMOKY the next day. On 18 August, however, Shot **SMOKY was** delayed and rescheduled for Wednesday, 28 August.

The Task Force continued to train for participation in the troop test. On Friday, 23 August, after Shot DOPPLER had been detonated and the area declared clear, the troops were escorted to the forward area for the first time, so that they could familiarize themselves with the planned troop test. The troops departed from Camp Desert Rock for the forward area at about 0830 hours by truck convoy, which was provided by one of the several support units stationed at Camp Desert Rock. The trucks arrived at the SMOKY trench area at about 1100 hours. The Task Force troops located the SMOKY trenches and practiced the countdown, as well as the rifle disassembly-assembly, minefield, and infiltration tests. For the rifle test, shown in figure 2-2, the troops wore protective masks; they removed them to perform the minefield and infiltration course tests (15).

The rehearsal for the HumRRO troop test was completed at 1330 hours. The Task Force troops then departed from the infiltration course and returned to the SMOKY trench area, where they were scheduled to lunch at 1345 hours. At 1430 hours, the troops boarded the trucks and returned to Camp Desert Rock.

On Monday, 26 August, the Task Force returned to the forward area for baseline testing, the final rehearsal in anticipation of the SMOKY shot, which had been rescheduled for 28 August. The troops left Camp Desert Rock by truck convoy at 0300 hours and arrived at the SMOKY trenches at an estimated time of 0445 hours. At about 0525 hours, the troops entered assigned trenches to practice the shot countdown. At 9535 hours, the rifle disassembly-assembly test was rehearsed, followed by the minefield test and the infiltration course test. This entire

Figure 2-2: DURING THE TASK FORCE REHEARSAL, 82nd AIRBORNE DIVISION TROOPS ARE TIMED ON THE RIFLE DISASSEMBLY/ ASSEMBLY TEST

maneuver was completed by about 0800 hours, at which time the troops breakfasted at the trench area. They departed by truck convoy for Camp Desert Rock around 0845 (15).

Shot SMOKY was postponed again on 28 August. With the continuing delays of SMOKY, the Task Force BIG BANG troops not participating in the troop test and the HumRRO team witnessed Shot FRANKLIN PRIME on Friday, 30 August, presumably from News Nob (15). Meanwhile, Shot SMOKY was rescheduled for 31 August 1957. The HUMRRO troop test could not take place as planned, because it was believed that the HumRRO area would be contaminated for several days after the shot.

By this time, military personnel were concerned that the Task Force would not be able to participate in the troop test before their scheduled departure on 5 September. Therefore, the entire Task Force witnessed Shot SMOKY on 31 August from News Nob, an observation site near the Control Point at Yucca Pass. As a result of observing Shot SMOKY, the Task Force was introduced to the effects of a nuclear detonation, thus negating a significant element in the HumRRO troop test.

Because there was not enough time to construct new trenches or clear new test areas for Shot GALILEO, it was decided that the Task Force would witness Shot GALILEO in open terrain approximately 4,500 yards from ground zero. The rifle disassembly-assembly test would be conducted at the observation point, and the infiltration course maneuver would be performed at the original SMOKY test area, if radiation from that shot had decayed to an acceptable level. The other part of the troop test, the minefield clearing exercise, was cancelled (15).

The actual locations of the GALILEO observation area, the SMOKY trench location, and the HumRRO test area for the Task

Force have been the source of some uncertainty. Official Exercise Desert Rock reports do not specify the exact location from which the troops observed Shot GALILEO. A HumRRO staff memorandum maintains that they were to observe the detonation in the open, approximately 4,500 yards from the GALILEO tower (6). Researchers who assisted in the historical reconstruction of activities at Operation PLUMBBOB determined that the most likely location for BIG BANG troops to have observed Shot GALILEO was along Mercury Highway at or near the Buster-Jangle "Y" (BJY). This location, given in figure 2-3, would have placed the troops 4,500 meters, rather than 4,500 yards, from the GALILEO ground zero (15; 17).

The same HumRRO staff memorandum describes the HumRRo test area as being next to the SMOKY trenches (6). The SMOKY trenches have been reported by various documents to be from 3,500 to 4,340 meters south-southeast of the SMOKY ground zero. Operation Order 17 identified the SMOKY trench area as located 4,340 meters or 4,730 yards from SMOKY ground zero (16). The same approximate location is indicated by a U.S. Geological Survey topographic map (Oak Spring 1:24,000), which shows a well-defined system of seven trenches, oriented at right angles to the SMOKY shot-point azimuth; the first of the seven trench lines is located 4,350 meters from the site of the SMOKY detonation at UTM coordinates 849120. Researchers consider this to be the most reliable location of the SMOKY trenches, and it is used for the rest of this narrative (15).

Specifications for the Task Force BIG BANG infiltration course are contained in the HumRRO staff memorandum. The specifications require a strip of land about 180 meters wide by 1,100 meters long, oriented approximately north-south toward SMOKY ground zero, with its eastern edge 45 meters from the SMOKY trenches and its southern edge 4,100 meters south-southeast of SMOKY ground zero. It was originally planned that the Task Force

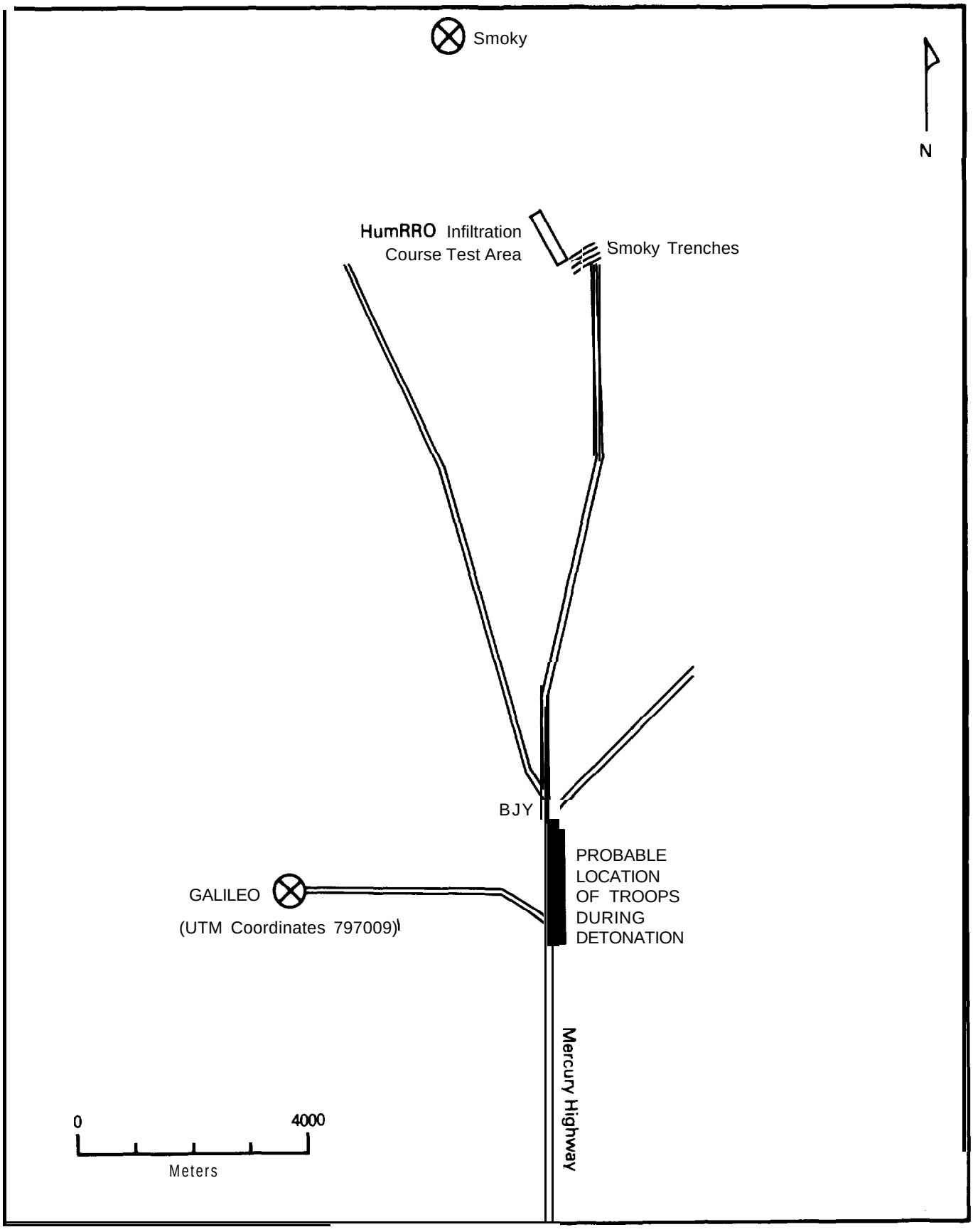

Figure 2-3: MAP OF TASK FORCE BIG BANG TROOP TEST AREA

BIG BANG troops would perform the disassembly-assembly test in the southern sector of this strip, the minefield test in the central area, and the infiltration course at the northern edge of the strip, 3,250 meters from the SMOKY ground zero at TJTM coordinates 840129. Figure 2-4 shows the dimensions and layout of this test area (6; 15).

Final plans for the troop test, devised about 24 hours before the scheduled detonation of Shot GALILEO, called for participants to leave Camp Desert Rock after midnight on 2 September. After observing the detonation in open terrain, they would conduct the rifle disassembly-assembly test in the observation area. Then, contingent upon a radiological safetv clearance, the troops would conduct the infiltration course tests near the SMOKY trench area (15).

Task Force BIG BANG troops and the team of monitors from HumRRO left Camp Desert Rock at about 0130 hours on 2 September 1957. The Task Force and the HumRRO team were not at full strength: the HumRRO team had been reduced from ten monitors to three because of early departures from the Nevada Test Site (NTS). Moreover, some of the Task Force BIG BANG military personnel failed to return from weekend pass (15). Film badge records indicate that only 110 of the 167 servicemen scheduled to participate actually took part in the troop test. Eighty-six of these were test troops, and seven were troop monitors who were to supplement the HumRRO monitors who had left early (6). The remaining 17 probably also assisted the HumRRO team as monitors (15).

The troops were carried into the forward testing area by one of the transportation support units stationed at Camp Desert Rock. At about 0245 hours, the Task Force arrived at the GALILEO observer area.

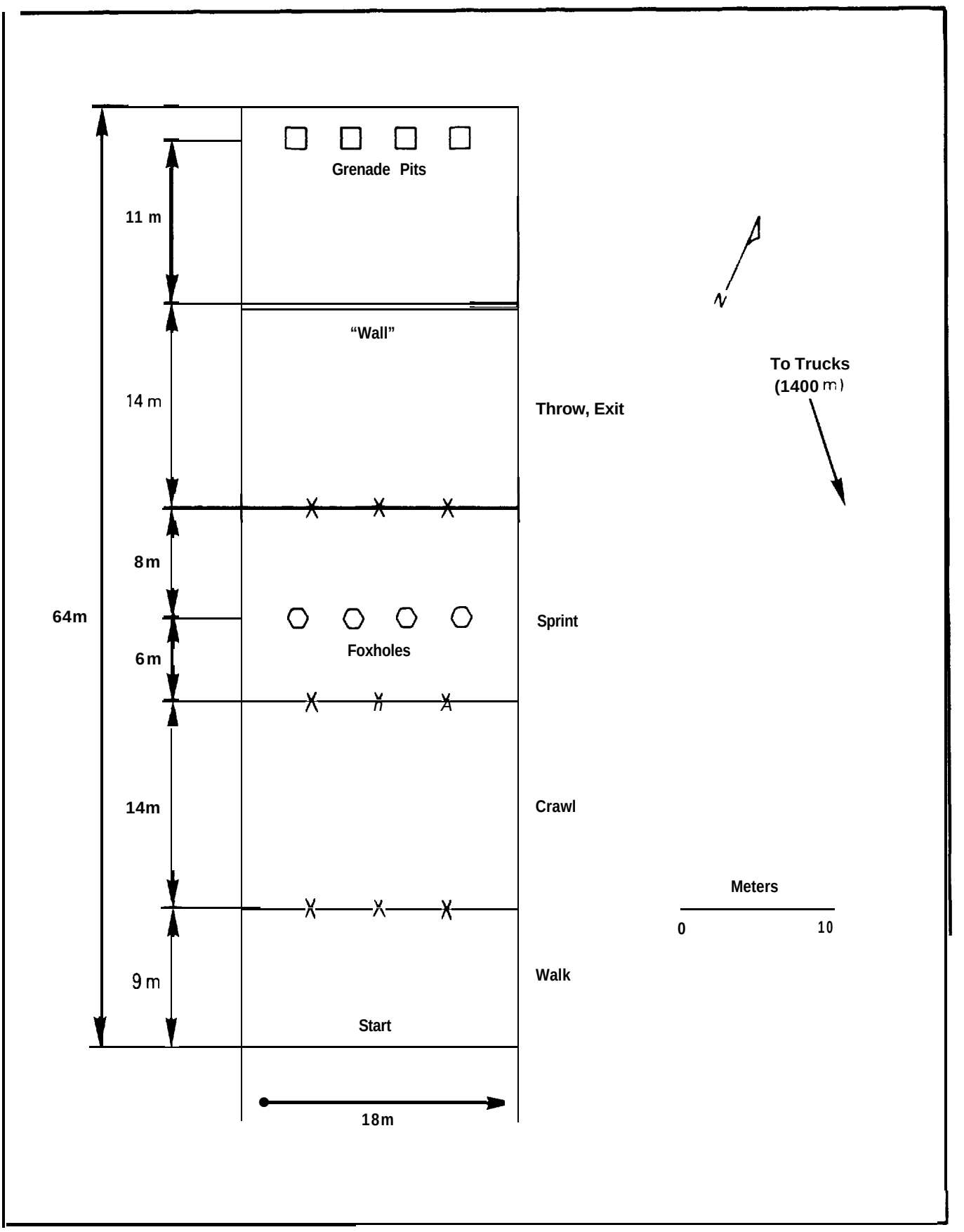

Figure 2-4: TASK FORCE BIG BANG TROOP TEST (HumRRO INFILTRATION COURSE)

Shot GALILEO was detonated at 0540 hours. As planned, the troops witnessed the detonation in open terrain 4500 meters east of ground zero. The blast wave caused momentary winds of about 36 knots at the observation area, and raised considerable dust. Troops performed the rifle disassembly-assembly test immediately after the blast wave passed. Following the rifle test, radiological safety monitors and one member of the HumRRO team left the GALILEO observer area for the infiltration course to determine whether residual radiation levels from the SMOKY shot two days earlier were low enough to allow troop entry. While the monitors performed this task, the Task Force BIG BANG troops had breakfast consisting of assault rations. By 0710 hours, the radiological safety monitors returned from the SMOKY trenches to report that the fallout level at the infiltration course was considered safe for a one-hour stay. The radiological safety monitors briefed the troop test participants on the SMOKY trench conditions and gave them clearance to remain in the infiltration course area for one hour. The Task Force BIG BANG troops then departed from the GALILEO observer area by truck convoy and arrived at the SMOKY trench parking area at 0740 hours. After leaving the trucks, the troops went to the infiltration course located about 1,400 meters to the northwest of the parking area (15).

At about 0805 hours, the troops began the timed infiltration test. They assembled near the starting line in groups of four and five. Each group moved to the starting line, where, on a signal from a HumRRO monitor, they began the 63-meter (70-yard) course. As indicated in figure 2-4, each group walked nine meters, crawled under a barbed-wire barrier, and continued to crawl for 14 meters (15 yards) and under a second barbed-wire barrier. After the soldiers had cleared the second barbed-wire barrier, they sprinted about six meters (6 1/2 yards) to a foxhole, where they remained for ten seconds. After the designated

time had elapsed, the soldiers sprinted eight more meters (8 1/2 yards) to a third barrier, crawled under it, and sprinted 14 meters (15 yards) to a "wall" of smooth wire, where they each threw two practice hand grenades at a 1.2-meter square pit, which was located 11 meters (12 yards) away. The infiltration test ended with each soldier giving his name to the assistant monitor waiting at the end of the course and leaving the course to the right. When the first group of men had completed the test and the course was clear, the monitor gave the signal for the next group waiting at the starting line to begin the maneuver (15).

As each group of soldiers completed the infiltration course test, they returned to the truck parking area. The last group finished the course at 0855. By 0915, the last group of the test troops and the HumRRO monitors had returned to the truck parking area 1,400 meters southeast of the infiltration course. The trucks then left the SMOKY trench area for Camp Desert Rock, stopping at the Decontamination Station near Yucca Pass, about 24 kilometers south of the infiltration course. 4n estimate of the transit time required indicates that the Task Force should have arrived at the Decontamination Station at about 1000 hours. Personnel and their vehicles were monitored and decontaminated, if necessary, by brushing, washing, and confiscation or exchange of clothing.

The troops turned in their film badges to radiological safety personnel when they returned to Camp Desert Rock. Apparently, several of the troops lost their film badges while performing the infiltration test. Radges could have been lost, depending on where they were clipped to the individual's uniform, because activities performed during the test might have caused them to slip off. At about 1030, the troops of Task Force BIG BANG left the Decontamination Station for Camp Desert Rock (15). On Wednesday, 3 September, they departed Camp Desert Rock for Fort Bragg.

2.2 TECHNICAL SERVICE PROJECTS AT SHOT GALILEO

As listed in table 2-1, members of various military agencies performed two technical service projects at Shot GALILEO. Many of the 128 DOD personnel who took part in these projects also performed them at other PLUMBBOB shots, both before and after Shot GALILEO.

Project 50.3, Evaluation of Medium Range Detonation-detection and Cloud Tracking Systems, involved about 23 **people** from the Army Signal Research and Development Laboratories. The project was designed to test the capacity of standard radar equipment to detect nuclear detonations and track radioactive clouds, and to examine Army fallout prediction methods. Project 50.3 required the use of two radar sets: the AN/CPS-9 and the AN/FPS-6. Before the detonation, Army participants transported the AN/CPS-9 radar set by truck to a location near Hiko Village, Utah, and put the unit in operational order. In a similar manner, participants placed the AN/FPS-6 radar set at Angel's Peak, Nevada, located 58 kilometers southeast of the NTS. Personnel from the 865th Aircraft Control and Warning Squadron and from the Army Signal Research and Development Laboratory were stationed at Angel's Peak. Project 50.3 also involved an unspecified number of personnel from the Fallout Prediction Unit, who were in an M-109 van situated next to the weather station at Camp Mercury. The Fallout Prediction Unit routinely gathered data necessary to make fallout plots, and they field-tested and evaluated plots made by the Signal Corps method of fallout prediction (7; 13; 21).

Project 50.8, Detection of Atomic Burst and Radioactive Fallout, was sponsored by the Army Artillery and Guided Missile School, with support from the Army Chemical School, the Air Defense Board, the Artillery Board, and the Air Weather Service. The purpose of the project was to assess how well equipment found in a typical Army unit could determine the location, height of

burst, and yield of a nuclear detonation. A total of 105 individuals participated in the project. The participants performed their tasks at distances of between 10 and 80 kilometers from ground zero (13).

CHAPTER 3

NEVADA TEST ORGANIZATION OPERATIONS AT SHOT GALILEO

This chapter describes the activities performed by Department of Defense (DOD) personnel involved in the scientific, diagnostic, and training projects conducted by the four test groups and the armed services at Shot GALILEO. DOD personnel were involved in five projects conducted by the Armed Forces Special Weapons Project (AFSWP) Weapons Effects Test Group, in one of the 16 projects conducted by the Los Alamos Scientific Laboratory (LASL) Test Group, and in the one project fielded by the University of California Radiation Laboratory (UCRL) Test Group. DOD personnel also participated in nine projects conducted by the Federal Civil Defense Administration (FCDA) Civil Effects Test Group (CETG). Except for those projects conducted by the AFSWP Weapons Effects Test Group, DOD participation in these other test group projects appears to be limited. In addition to the scientific projects, the Air Force conducted one DOD operational training project during GALILEO. Finally, Air Force Special Weapons Center (AFSWC) personnel flew support missions for the test groups and the Test Manager.

Detailed descriptions of project objectives and general project activities are contained in the PLUMBBOB Series volume. The information contained in this chapter addresses only those project operations conducted during Shot GALILEO.

3.1 FIELD COMMAND WEAPONS EFFECTS TEST GROUP PROJECTS AT SHOT GALILEO

The Weapons Effects Test Group of AFSWP Field Command performed five projects at Shot GALILEO. Table 3-l lists the projects, the participating organizations, and, when possible, the estimated numbers of participants. The estimates are based on a

knowledge of fielding and recovery procedures, or the Test Director's Operation Plan for GALILEO. Because in most cases the same people performed both pre- and postshot activities, estimates reflect the maximum number of DOD people who been involved in the project.

Table 3-I: FIELD COMMAND WEAPONS EFFECTS TEST GROUP PROJECTS, SHOT GALILEO

Project	Title	Participating Agency	Estimated DOD Personnel
1.1	Basic Airblast Phenomena	Ballistic Research Laboratories	3
1.9	Spectra of Ground Shocks Produced by Nuclear Detonations	Air Research and Development Command; Ramo-Woolridge Corporation	5
4.3	Secondary Missiles Generated by Nuclear-produced Blast Waves	Lovelace Foundation for Medical Education and Research	*
6.4	Accuracy and Reliability of the Short-baseline NAROL System	Air Force Cambridge Research Center	*
9.1	Support Photography	Armed Forces Special Weapons Project; Lookout Mountain Laboratory; Military Air Transport Service	10

* Unknown

Project 1.1, Basic Airblast Phenomena, was designed to obtain data on overpressure and dynamic pressure as a function of time and distance from ground zero. The performance of various pressure gauges, measurement devices, and techniques was also evaluated. Before the shot, personnel installed six gauges at each of 15 stations along a main blast line about 400 to 1,200 meters southeast of ground zero. The survey and preparation for installing the gauges probably required two AEC support persons to spend approximately 16 days onsite. Placing and checking the gauges in their mounts would probably have been performed by three members of the Ballistic Research Laboratories and would have required 18 days.

The evening before the shot, three men activated and removed tapes from the gauges. They left the area by 2200 hours. Two or three project personnel and a radiation monitor recovered instruments and recorded the measurements following the detonation. These personnel carried respirators and wore film badges and protective clothing. They remained in the GALILEO area for about two hours, recovering the gauges most distant from ground zero on shot-day. Three men spent a total of about five hours recovering the remaining gauges over the next three days (5; 9; 12;).

Project 1.9, Spectra of Ground Shocks Produced by Nuclear Detonations, was designed to measure and analyze the velocity and movement of the ground shock wave produced by nuclear detonations. Three self-contained mechanical reed shock gauges were placed inside cylindrical canisters 0.6 meters in diameter and 0.6 meters long. The canisters were buried in holes 190 meters north of the shot-tower, which were then backfilled and covered with three layers of sandbags. It is estimated that a crew of five worked three days to survey and dig the holes, place the gauges in the ground, backfill, and cover the gauges with sandbags. After the detonation, at a time when radiation intensities had decayed to permissible levels, five people are estimated to have spent one day recovering the gauges (5; 12; 13).

Project 4.3, Secondary Missiles Generated by Nuclear-produced Blast Waves, was performed by members of Lovelace Foundation and was managed by CETG as Project 33.2. The purpose of Project 4.3 was to provide CETG with technical support. The activities of Project 4.3/33.2 are discussed with the other CETG activities later in this chapter.

Project 6.4, Accuracy and Reliability of the Short-baseline NAROL System, studied the inverse of the Long Range Aids to Navigation (LORAN) system. The project had three objectives:

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

The Indirect Bomb Damage Assessment NAROL system tested consisted of nets located at Albuquerque, New Mexico; Vale, Oregon; and Rapid City, South Dakota. Each NAROL net consisted of two unmanned slave stations and one manned station. The number of project personnel involved is not known (5; 12; 18).

Project 9.1, Support Photography, was primarily fielded by AFSWP photographers assigned to photograph the detonation. The project was designed to lend support in the area of technical project photography and to provide assistance in photographic documentation of nuclear detonations. For Shot GALILEO, no technical project photography was required for other Weapons Effects Test Group projects. Five hours before the shot, ten men established camera stations. An unknown number of personnel from Air Force Lookout Mountain Laboratory may have taken pictures from an aircraft flown by the Military Air Transport Service (2; 5; 12; 13).

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

The LASL Test Group performed 16 projects at Shot GALILEO. Of these 16 projects, only Project 11.2, Radiochemistry Sampling, included DOD personnel. The UCRL Test Group performed only one project at Shot GALILEO, Project 21.2, Radiochemistry Sampling,

which also involved DOD participation. Table 3-2 includes these projects along with those of CETG. The sponsor of each project, the estimated number of DOD participants, and the DOD agency and its capacity are indicated when that information is available.

Both Radiochemistry Sampling Projects were performed for LASL and UCRL by pilots from the AFSWC 4926th Test Squadron (Sampling). Their tasks are discussed under AFSWC participation in section 3.5 of this chapter.

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

Although DOD personnel took part to a limited extent in the nine CETG projects performed at Shot GALILEO, as at all shots in the PLUMBBOB Series. Information about the number of DOD participants and the nature of their agency affiliation is, in most cases, unavailable for these projects.

Project 33.2, Missiles Secondary to a Nuclear Blast, was conducted to determine the size, weight, and velocity of artificial and natural objects (steel fragments, gravel, etc.) that could be propelled by the blast wave from a nuclear detonation. It was partially funded, however, by the Field Command Weapons Effects Test Group as its Project 4.3, Secondary Missiles Generated by a Nuclear Detonation, which was conducted by the Lovelace Foundation for Medical Education and Research. Field Command also provided minor logistical support to CETG for this project. No DOD personnel appear to have taken part in project activities in the forward area (8; 10).

Project 37.1, Distribution Characteristics and Biotic Availability of Fallout, required four teams of four men each to study the longer-term aspects of biological accumulation of

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

Project	Title	Sponsor	DOD Agency	Capacity	Est. DOD Personnel
11.21 21.2	Radiochemistry Sampling	LASL/ UCRL	4926th Test Squadron, AFSWC	Cloud Sampling	9
33.2	Missiles Secondary to a Nuclear Blast	CETG	Lovelace Foundation for Medical Education and Research	support	*
37.1	Distribution Characteristics and Biotic Availability of Fallout	CETG	*	*	16
37.2/ 37.2a	Biophysical Aspects of Fallout/Physical Aspects of Fallout	CETG	AFSWC	Radio Relay	3
37.3	Biological Accumulation of Fission Products in Agricultural Environments	CETG	*	*	*
37.4	Measurements and Permanent Recordings of Fast Neutrons	CETG	*	*	*
37.5	Chemical Dosimetry Studies	CETG	*	*	*
37.6	Training in Techniques of Environmental Assessment	CETG	*	*	*
39.3	Thermal Radiation Measurements	CETG	*	*	*

* Unknown

fission products on and in native plants and animals. Project 37.1 recovery teams did not enter the field until three days after the GALILEO detonation. It is not known where the teams worked, what radiation intensities they encountered, how long the teams remained in the area, and what types of protective clothing they may have required (10; 24).

Project 37.2/37.2a, Riophysical Aspects of Fallout and Physical Aspects of Fallout, concerned the delineation and characterization of fallout patterns during the shot. Project 37.2 was conducted by approximately 30 people. Certain specific fission-product analyses were conducted by the Chemical Analysis Group of the Atomic Energy Project, University of California at Los Angeles. The personnel of Project 37.2a consisted of as many as 15 two-man teams, who were responsible for installation, operation, and recovery of sampling and monitoring equipment. Some DOD personnel probably assisted in these activities. Post-shot activities for these teams began on 3 September, the day after the GALILEO event (10; 24). The only documented DOD participation in Projects 37.2 and 37.2a is AFSWC radio-relay support, which is discussed in section 3.5.

Project 37.3, Riological Accumulation of Fission Products in Agricultural Environments, used a two-man team to obtain data on biological accumulation in livestock and farm products. Twelve hours after the detonation, Project 37.2a recovery teams assisted in directing Project 37.3 recovery teams to farms exhibiting certain dose rates. It is likely that some DOD medical and veterinary personnel may have taken part in this project (10; 24).

Project 37.4, Measurements and Permanent Recordings of Fast Neutrons, required laboratory and field tests to determine whether improved knowledge of the characteristics of Germanium dosimeters could be used to increase the accuracy and sensitivity

of fast neutron dosage measurements obtained near nuclear detonations (10; 24).

Project 37.5, Chemical Dosimetry Studies, used test animals to determine human exposure to prompt and residual radiation from a nuclear detonation. On- and offsite activities were required in this experiment. Offsite fallout measurements were made in conjunction with Project 37.2a (10; 24).

Project 37.6, Training in Techniques of Environmental Assessment, provided training to personnel from various scientific disciplines in the techniques of environmental assessment under fallout conditions. Rotating project assignments were an integral part of this training. Among the participants mentioned in the training program were Air Force veterinarians, but the number of veterinarians and their unit affiliations are not known. Information is not available on other possible DOD participants and their activities in the project (10; 24).

Project 39.3, Thermal Radiation Measurements, had a dual objective: to measure transient air temperature at selected locations in the blast biology underground shelter in Area 1, and to evaluate thermal burns from a nuclear detonation on biological specimens. Swine were used as the biological specimens (10; 24).

3.4 DEPARTMENT OF DEFENSE OPERATIONAL TRAINING PROJECT AT SHOT GALILEO

At Shot GALILEO, an Air Force Air National Guard Tactical Reconnaissance unit performed one operational training project. The primary aim of operational training projects was to test service tactics and equipment and to train military personnel in the effects of nuclear detonations.

Project 53.9, Photographic Reconnaissance Training, enabled Air National Guard Tactical Reconnaissance Units to observe Shot GALILEO and to assess the damage by means of photographic techniques. According to the Air Mission Summary Report for Shot GALILEO, two RF-84F aircraft, each flown by one pilot from the Tennessee Air National Guard, took part in the project. The aircraft left George Air Force Base (AFB), California, in the early morning of 2 September. Before shot-time, the two aircraft flew a right-hand elliptical course from Beatty to Lathrop Wells, at an inbound heading of 127 degrees true and an altitude of 31,000 feet (1; 2; 11; 13).

After the detonation, the two RF-84F aircraft were directed by the Air Operations Center to proceed to the GALILEO area to Position themselves for a timed pass over ground zero at 10,000 feet. The pass was to occur ten minutes after the detonation. Upon completing this photographic mission over ground zero, the aircraft returned to George AFB, where the aircraft were monitored by ground personnel (1; 2; 11; 13).

3.5 AIR FORCE SPECIAL WEAPONS CENTER ACTIVITIES AT SHOT GALILEO

AFSWC support during Shot GALILEO was provided by the 4950th Test Group (Nuclear), including the 4926th Test Squadron (Sampling) and the 4935th Air Base Squadron, with support from the 4900th Air Base Group. AFSWC missions consisted of nuclear cloud-sampling and sample return missions for LASL Project 11.2 and UCRL Project 21.2, a radio-relay for CETG Projects 37.2/37.2a, cloud-tracking missions, security sweeps, and terrain surveys performed for the Test Manager. In addition to these missions, AFSWC ground personnel exercised operational control of all aircraft from the air operations center at the Control Point. Table 3-3 indicates DOD participation in AFSWC projects, including the number and types of aircraft used.

Table 3-3: AFSWC AIR MISSION SUPPORT, SHOT GALILEO

Program/Project	Mission	Type Aircraft	Number of Aircraft	Estimated Number of DOD Personnel
[redacted]	Cloud Sampling			
	Sampler Control	B-57	1	1
	Sampler	F-84	4	4
	Sampler	B-57	2	4
C[redacted]	Sample Return	c-47	3	12
37.2/37.2a	Radio Relay	c-47	1	3
———	Cloud Tracking	B-50	1	10
		B-25	1	5
———	Security Sweep	L-20	1	2
———	Survey Mission	H-21	5	15

3.5.1 Cloud Sampling

At GALILEO, six aircraft collected samples of the nuclear cloud for LASL Project 11.2, Radiochemistry Sampling, and IJCRL Project 21.2, Radiochemistry Sampling. These six sampler aircraft were flown by pilots of the 4926th Test Squadron (Sampling) and included two B-57Bs, each with one pilot and an Air Force radiological monitor and four F-84s with one pilot each. A B-57B sampler control aircraft, flown by an AFSWC pilot accompanied by a scientific advisor from LASL, also participated.

The sampler control aircraft left Indian Springs AFR at 0525 hours and climbed to an altitude of 35,000 feet. At 0535 hours, the aircraft began its orbit pattern outside the test area.

The six sampler aircraft proceeded as follows. The first, a B-57B, left Indian Springs AFB at 0650 hours. Documentation does not specify what time this aircraft entered the cloud or completed its mission, but its mission was probably conducted within

an hour, as it was for the other samplers. Two of the F-84G aircraft left Indian Springs AFB at 0705 hours, entered the sampling area at 0710 hours, completed their sampling run at 0740 hours, left the area at 0745 hours, and landed at Indian Springs AFB at 0750 hours.

Two more F-84G aircraft flew from Indian Springs AFB at 0720 hours, entered the sampling area at 0725 hours, began their sampling missions at 0740 hours, completed their mission at 0755 hours, and landed at Indian Springs AFB at 0805 hours.

The final sampler was a B-57B with two crewmen. The aircraft left Indian Springs AFB at 0735 hours, entered the sampling area at 0740 hours, completed the mission at 0810 hours and, followed by the B-57B sampler control aircraft, landed at Indian Springs AFB at 0820 hours.

Sampler aircraft entered the vicinity of the detonation and, after establishing visual contact with the sampler control aircraft, were guided by the scientific advisor aboard the sampler control aircraft to areas from which samples of nuclear cloud were to be obtained. The sampler aircraft were each equipped with sampling equipment, filters, radiac meters, and integrating dosimeters. All crewmen were on full oxygen for the entire mission.

After the sampling aircraft landed, they taxied to the east taxi strip farthest from base operation areas, where ground personnel removed the cloud samples and placed them in metal containers that were then flown by three C-47 courier aircraft to the laboratories for analyses. The ground crews then began decontamination procedures of both aircraft and crew, as described in chapter 3 of the PLUMBBOB Series volume (1; 2; 11; 13).

3.5.2 Radio Relay

AFSWC support for Project 37.2/37.2a, Biophysical Aspects of Fallout and Physical Aspects of Fallout, was provided by one C-47 aircraft the day after Shot GALILEO. The aircraft, with at least three crewmen, flew a right-hand elliptical pattern southeast Of the test site at an altitude of 12,000 feet. This service was probably provided to assist CETG personnel in conducting their recovery operations by providing communications (1; 2; 10; 13).

3.5.3 Cloud Tracking

Immediately after the GALILEO detonation, two aircraft, a B-50 from Kirtland AFB and a B-25 from Indian Springs AFB, flew cloud-tracking missions over and beyond the Nevada Test Site (NTS) at altitudes of 25,000 feet and 15,000 feet, respectively. The time of departure for both aircraft is not known. The B-50 probably had a minimum crew of ten. The purpose of this mission was to determine the direction of the radioactive cloud and to keep the airways clear of any private or commercial aircraft that might encounter radioactive clouds. It is not known how far the two aircraft tracked the cloud. Standard operating procedures for cloud tracking required that crew members wear film badges.

The B-25 cloud tracker from Indian Springs AFB was under the operational control of the 4900th Air Base Group Operation Officer and the pilots were briefed by the Test Aircraft Unit Operation Officer. The B-50 cloud tracker from Kirtland AFB was briefed by the 4950th Test Group Operations Officer. The aircraft were in position near the NTS at the time of detonation. Following detonation, the Air Operations Center notified the cloud trackers to leave the holding pattern and proceed to the tracking area (1; 2; 11; 13).

3.5.4 Security Sweep Mission

The evening before the detonation, a single L-20 aircraft was dispatched from Yucca airstrip to perform the security sweep mission over the NTS area in general, and over the GALILEO test area in particular. For this mission, the aircraft crew consisted of two persons. Usually, a security guard officer accompanied the pilot during the security sweep (1; 2; 11; 13).

3.5.5 Survey Missions

After the detonation, five H-21 helicopters flew survey missions over the GALILEO test area to assess detonation damage and record radiation intensities. The H-21 helicopters each had a crew of three AFSWC personnel, and carried two radiological safety monitors from Reynolds Electrical and Engineering Companv. This survey mission is described as part of the monitoring procedures in chapter 4. Pilots wore regular flight suits during the mission, and other crew members wore protective clothing and respirators. Following the mission, helicopters returned to helicopter areas and were monitored and decontaminated as required (1; 2; 13; 20).

CHAPTER 4

RADIATION PROTECTION AT SHOT GALILEO

To protect participants at Shot GALILEO from the radiation associated with the detonation of a nuclear device, Exercise Desert Rock VII and VIII, the Nevada Test Organization (NTO), and the Air Force Special Weapons Center (AFSWC) each used accepted standards and 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 detailed in chapter 5 of the PLUMBBOB Series volume.

The purpose of the various radiation protection procedures developed for the PLLJMBBOB Series was to ensure that individual exposure to ionizing radiation be as low as possible. At the same time, the procedures were designed so that participants could meet the operational requirements of each activity or mission. Some of the procedures described in the Series volume required Exercise Desert Rock, the NTO, and AFSWC to keep records, which can be used to evaluate the effectiveness of their radiation protection programs.

The information that is available concerning the radiological protection procedures at Shot GALILEO includes film-badge data for the Human Resources Research Office (HumRRO) troop test and NTO data on radiological safety equipment, survey results and records, isointensity plots, and decontamination records.

4.1 FILM BADGE READINGS FOR TASK FORCE BIG BANG AT SHOT GALILEO

Each Exercise Desert Rock participant was issued a film badge. Form LSD SCTF 142, the Lexington Signal Depot Film Badge Service Radiation Report, was used to record the individual's name, rank, serial number, organization, film-badge number, and exposure. While the forms provided much useful information, they did not always provide information specific to Shot GALILEO. A number of recordkeeping problems existed that made planned procedures for film-badge processing difficult. Information on these forms was not always recorded accurately; e.g., names were misspelled, and incorrect organization names were recorded. Furthermore, LSD SCTF 142 forms list periods of exposure that vary from two days to two months.

Although film-badge data are available for all Desert Rock activities, the HumRRO troop test distinguished Shot GALILEO from the rest of the PLUMBBOB Series, making the separation of Task Force BIG BANG film-badge data from the rest of the Desert Rock data relatively easy in spite of recordkeeping problems.

All of the available PLUMBBOB LSD SCTF 142 forms have been searched to generate a list of Task Force BIG BANG participants who probably were at Shot GALILEO. About 16 percent of the DOD personnel participating at Shot GALILEO were involved in Task Force BIG BANG. The participants wore film badges for the period from 13 August to 3 September 1957.

Film-badge information is available for the 167 men assigned to Task Force BIG BANG. Research indicates that six film badges were damaged or otherwise unreadable. Figure 4-1 presents the distribution of readings for the 161 soldiers with readable badges (15).

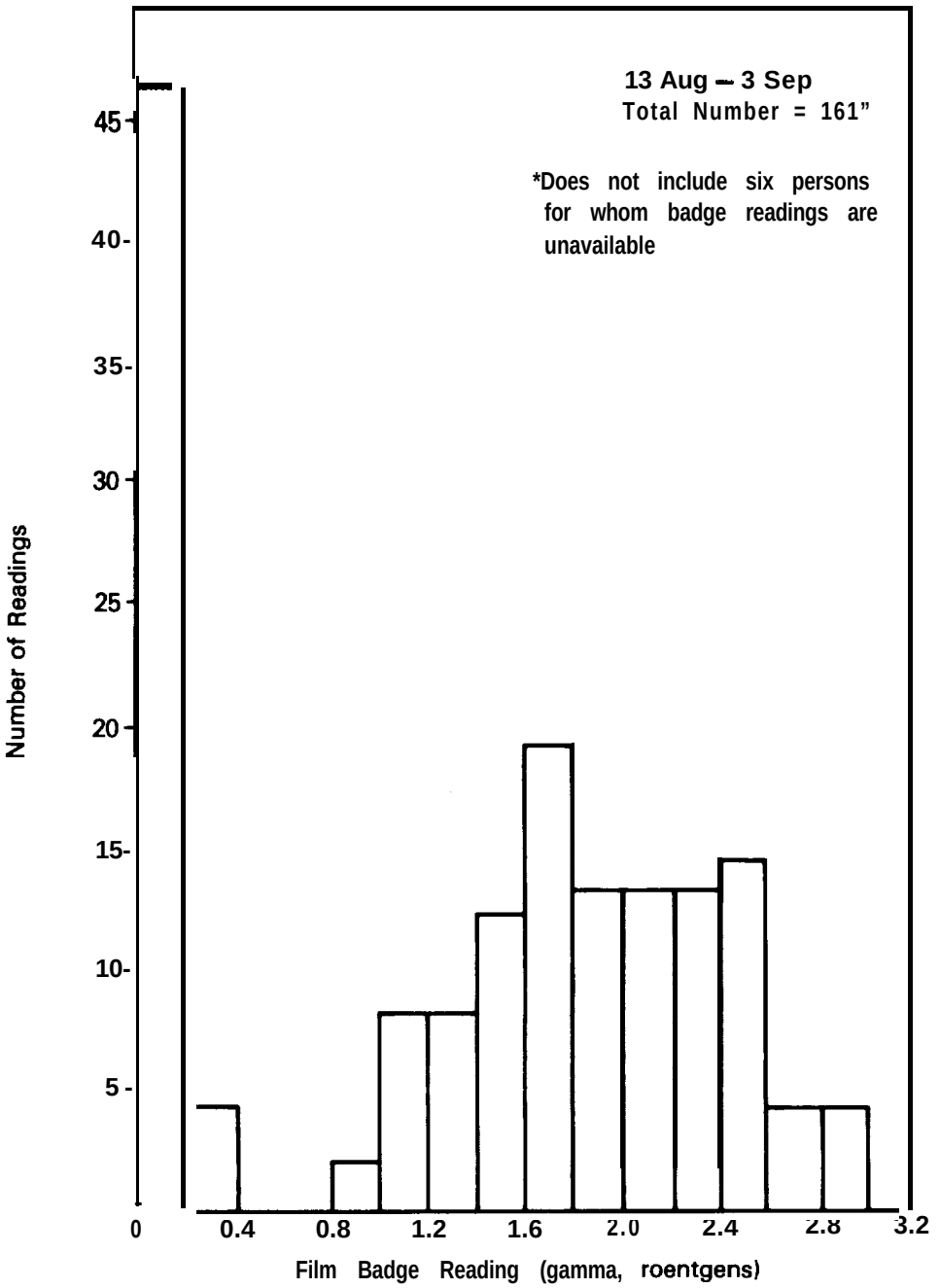

Figure 4-I: TASK FORCE BIG BANG, DISTRIBUTION OF FILM BADGE READINGS

As mentioned in chapter 2, film-badge readings indicate that only 110 of the 167 men originally assigned to Task Force BIG BANG actually participated in the exercise on 2 September. These two groups (participants and nonparticipants) are represented in the distribution of film-badge readings shown in figure 4-l. The 51 readings under 0.4 roentgens represent nonparticipants; however, because gamma radiation is recorded for some of the men, these men probably attended the documented rehearsals that were held prior to the detonation of GALILEO (15; 23). The higher group of readings, 0.8 to 3.2 roentgens, indicates the 110 men who participated in the troop test at Shot GALILEO.

The mean gamma reading for Task Force BIG BANG participants is 1.9 roentgens (standard deviation = 0.49 roentgens). Among those individuals who probably participated in the exercise, the monitors received the highest exposures. Nine of the ten documented participating civilian and military monitors recorded from 2.5 to 3.2 roentgens; in contrast, only one of the test troops exceeded 2.6 roentgens (6; 15; 23). Since the monitors' duties were such that their time in radioactive areas probably exceeded that of others, higher readings are to be expected for them (15; 23).

4.2 NEVADA TEST ORGANIZATION RADIATION PROTECTION ACTIVITIES

The following subsections indicate specific data concerning radiation protection activities performed by NTO at Shot GALILEO.

Dosimetry Records for GALILEO

From 2 September to 4 September 1957, including the 2 September detonation of GALILEO, the Personnel Dosimetry Branch issued 3,515 film badges and 448 pocket dosimeters (20; 25). Dosimetry data indicates taht eight DOD participants received a gamma exposure exceeding 2.0 roentgens during GALILEO. None of these exceeded the limit of 3.9 roentgens (20).

Logistical Information for Radiological Safety Equipment

For Shot GALILEO, the Logistics Branch issued 1,208 pieces of protective clothing, 190 respirators, and 3,127 pieces of miscellaneous equipment (20; 25).

Monitoring Procedures and Support at GALILEO

Ten minutes after the detonation of Shot GALILEO, a total of 11 monitors traveling in seven vehicles started the initial ground survey, which had a mid-time of 0726 hours. Completion of the survey was delayed because the cloud remained in the area for a considerable time, causing fallout and changing radiation intensities at ground level. Resurveys were made at a mid-time of 1150 hours on shot-day, and again on 3, 4, and 5 September 1957.

The initial aerial survey team departed from the Control Point helicopter pad at 0810, 2 1/2 hours after the detonation. The aerial survey team resurveyed the area around the GALILEO ground zero on 3 September and on 4 September. The maximum intensity that the aerial survey team measured was 52 R/h, 100 feet above ground zero on 3 September, the day after the GALILEO detonation. The highest reading taken on the day of detonation was 50 H/h, 500 feet above ground zero, about 2 1/2 hours after detonation (20; 25).

Plotting and Briefing at GALILEO

Using information from the initial surveys, the Plotting and Briefing Branch developed isointensity contour maps. A copy of the initial contour map, with a mid-time for measurements of 0726 hours, is shown in figure 4-2. Figures 4-3 through 4-6 show copies of the isointensity contours generated from the resurveys conducted from 2 September to 5 September 1957.

Information from the ground surveys allowed the Plotting and Briefing Branch to establish Full and Limited Radiological

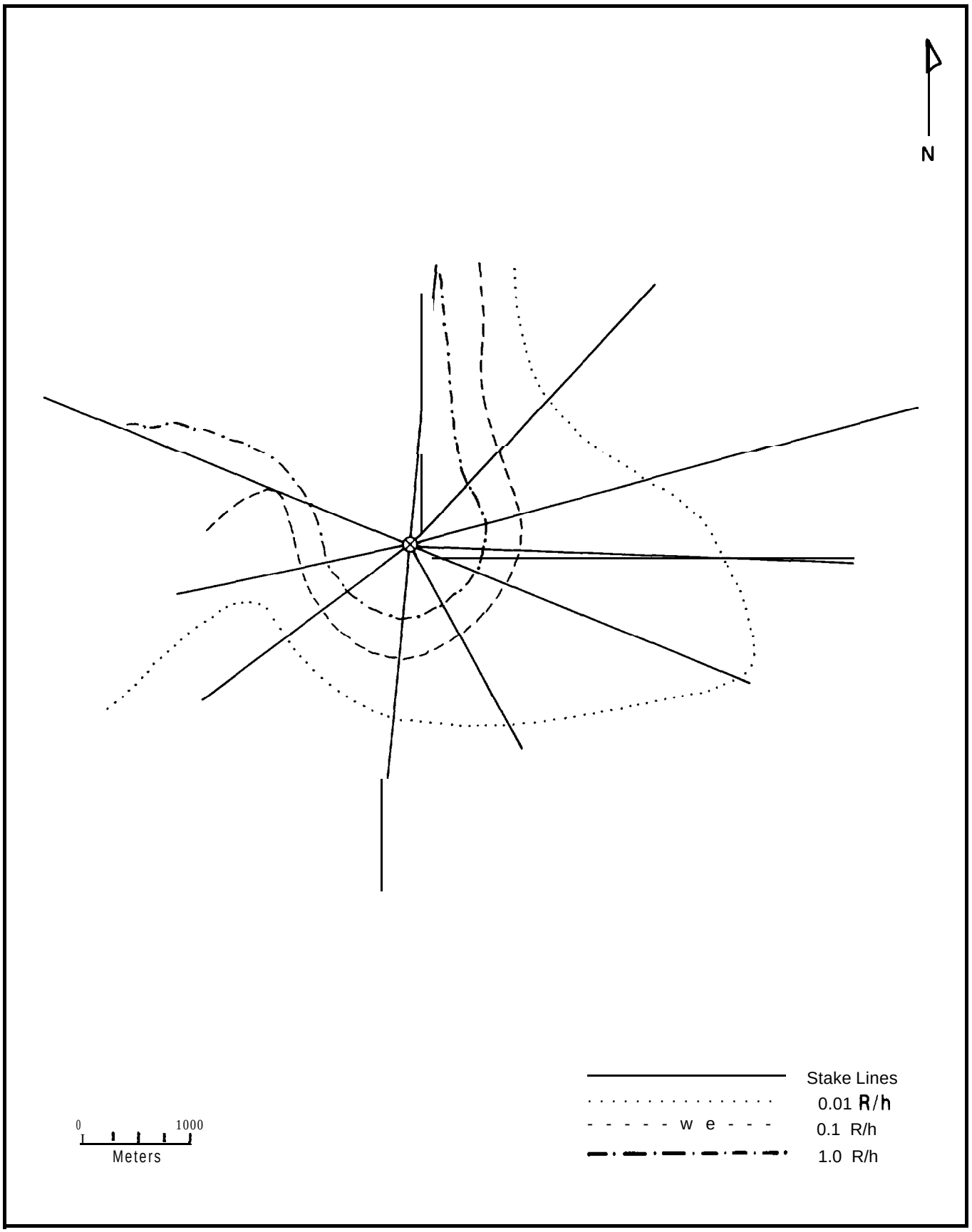

Figure 4-2: INITIAL SURVEY FOR SHOT GALILEO, 2 SEPTEMBER 1957, MID-TIME 0726

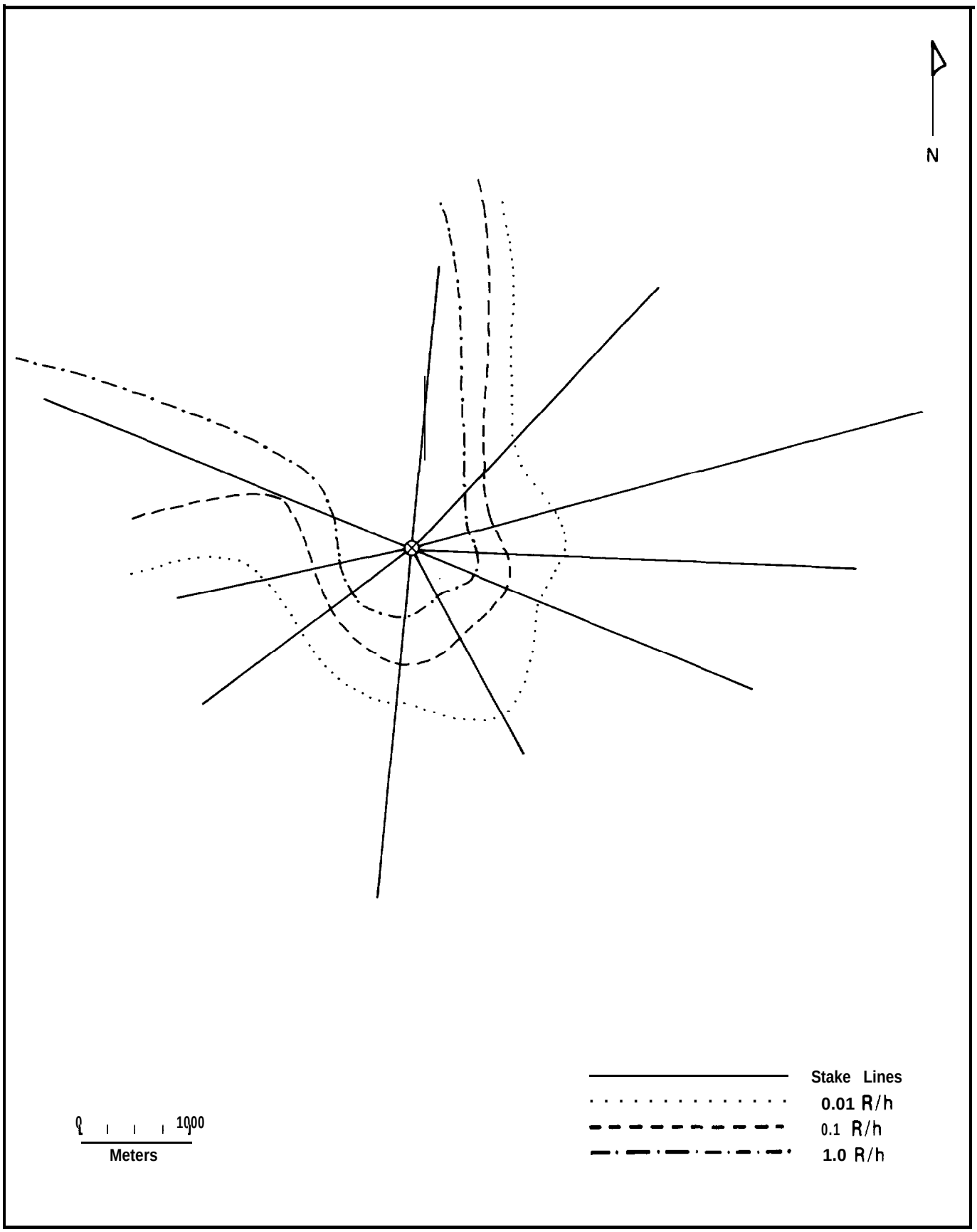

Figure 4-3: RESURVEY FOR SHOT GALILEO, 2 SEPTEMBER 1957, MID-TIME 1150

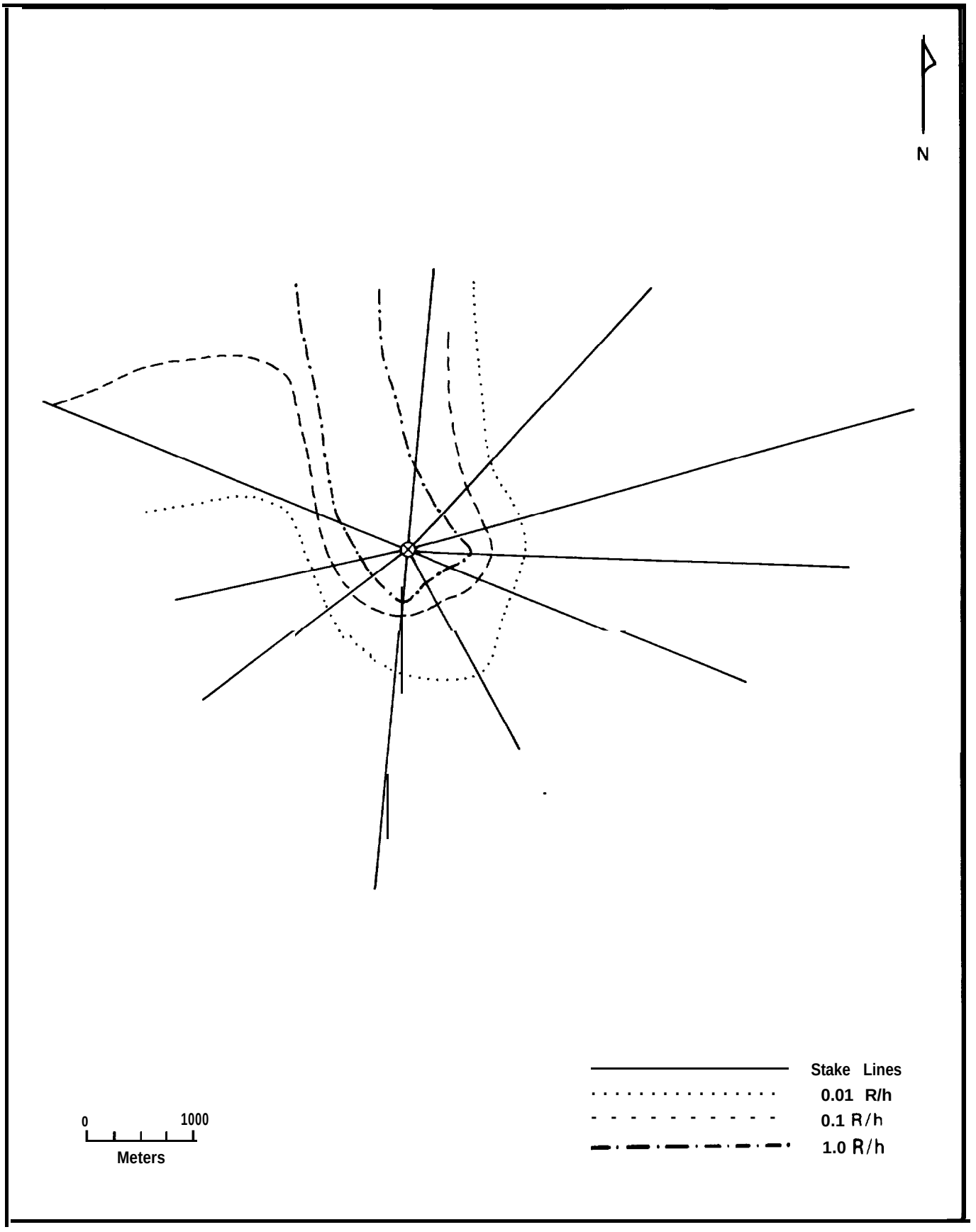

Figure 4-4: RESURVEY FOR SHOT GALILEO, 3 SEPTEMBER 1857, MID-TIME 0828

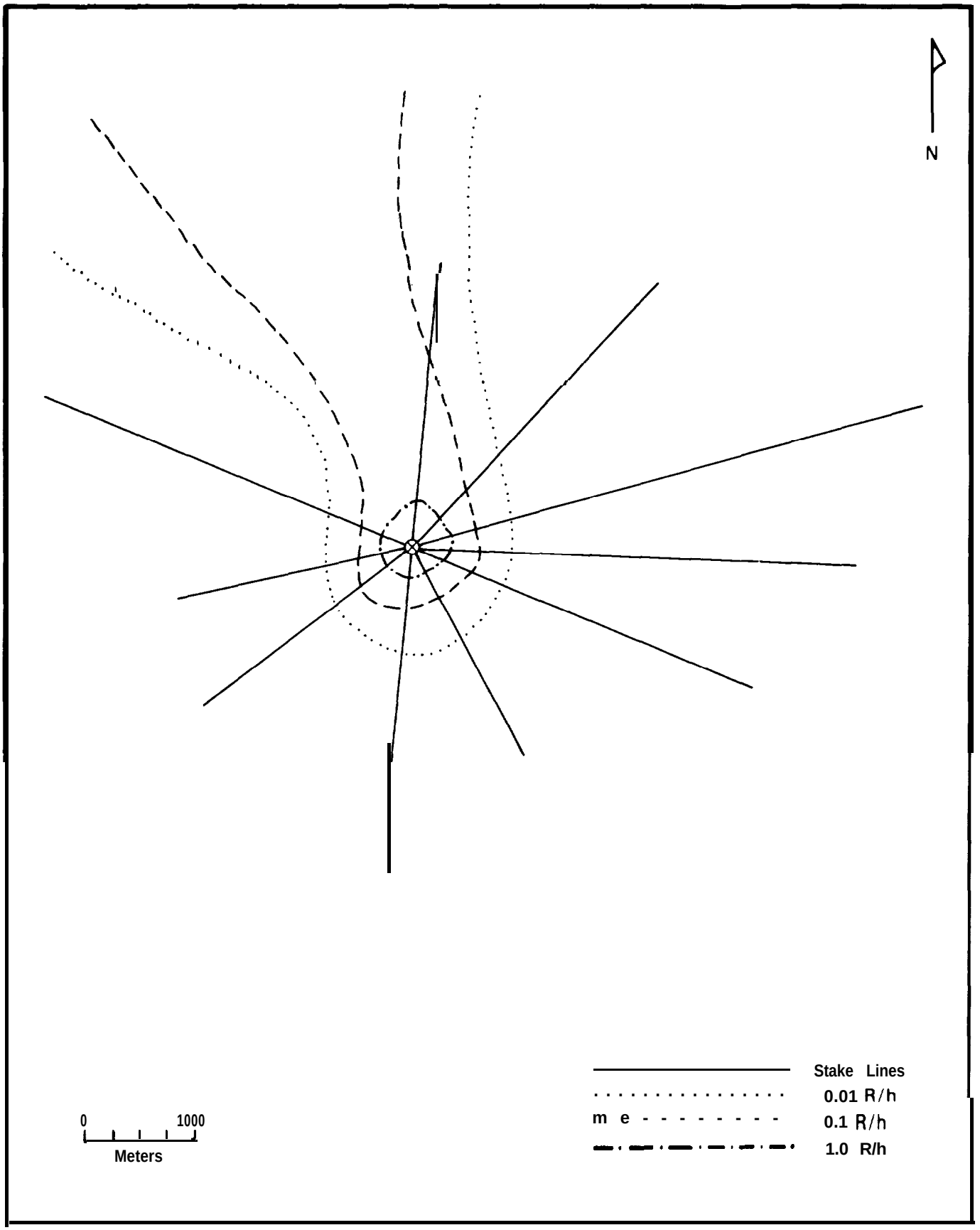

**Figure 4-5: RESURVEY FOR SHOT GALILEO,
4 SEPTEMBER 1957, MID-TIME 0616**

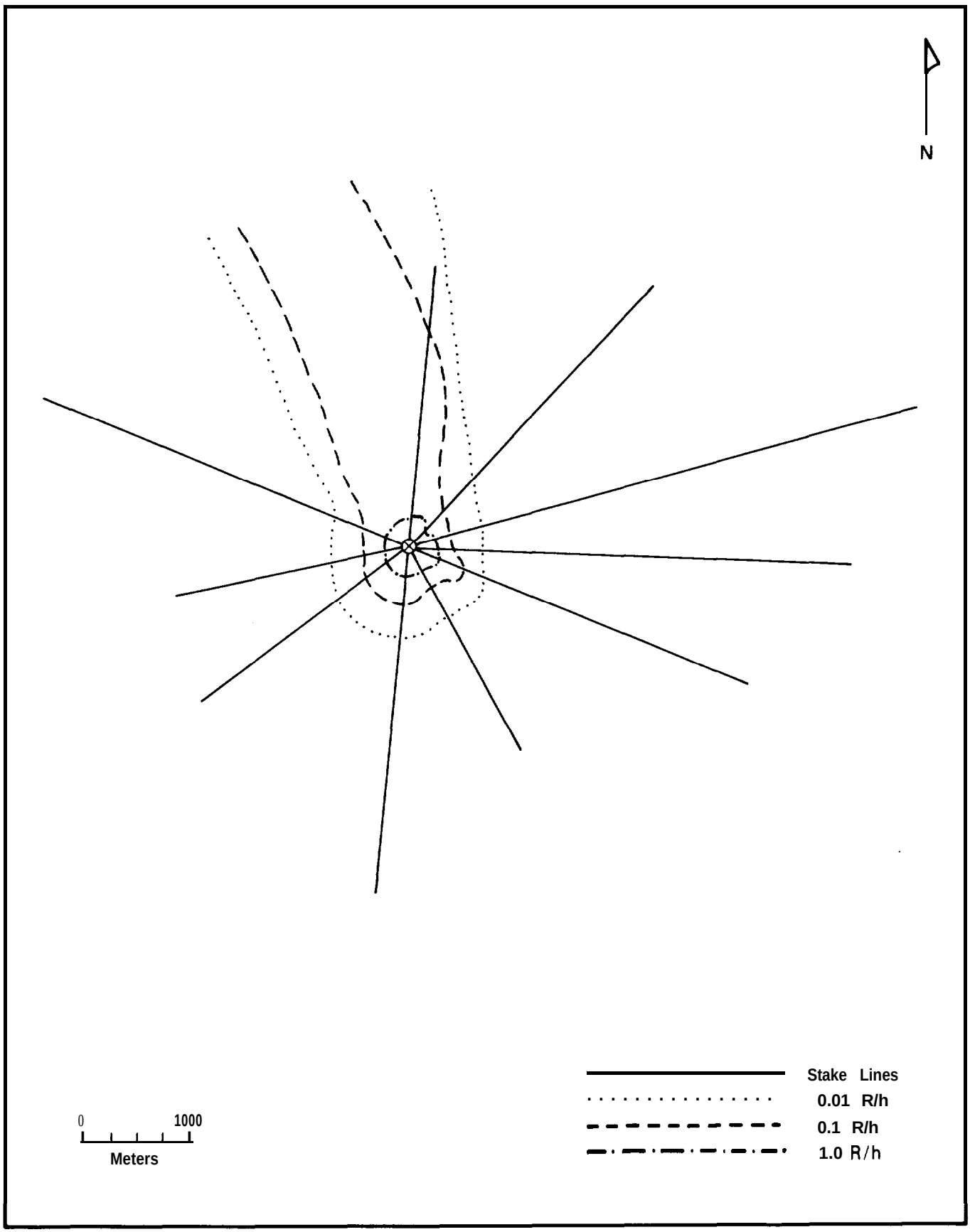

Figure 4-6: RESURVEY FOR SHOT GALILEO, 5 SEPTEMRER 1957, MID-TIME 6626

Exclusion (RADEX) Areas. The Plotting and Briefing Branch also issued the access permits required for entry into these areas. During the period 2 September through 4 September, access permits were issued to a total of 735 individuals involved in 41 projects (20; 25).

Decontamination Activities at GALILEO

During the period covering Shot GALILEO, 2 through 4 September 1957, the Decontamination Section decontaminated 64 vehicles and two recorders (20; 25).

AVAILABILITY INFORMATION

An availability statement has been included at the end of the reference citation for those readers who wish to read or obtain copies of source documents. The following addresses are being provided for that purpose.

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

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ATTN: Gov Docs

Central State University
ATTN: Lib Docs Dept

Central Washington University
ATTN: Lib Docs Sec

Central Wyoming College Library
ATTN: Librn

Charleston County Library
ATTN: Librn

Charlotte & Mechlenburg 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

DEPARTMENT OF DEFENSE CONTRACTORS (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

DEPARTMENT OF DEFENSE CONTRACTORS (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

University of Delaware
ATTN: Dir of Libraries

Delta College Library
ATTN: Libm

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

DEPARTMENT OF DEFENSE CONTRACTORS (Continued1

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

East Tennessee State University Sherrod Library
ATTN: Docs Dept

East Texas State University
ATTN: Library

Monmouth County Library Eastern Branch
ATTN: Librn

Eastern Illinois University
ATTN: Librn

Eastern Kentucky University
ATTN: Librn

Eastern Michigan University Library
ATTN: Library

Eastern Montana College
ATTN: Lib Docs

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

Elmire College
ATTN: Librn

Elon College Library
ATTN: Librn

Enoch Pratt Free Library
ATTN: oocs Ofc

Enory 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

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Florida Institute of Technology
ATTN: Library

Florida International University Library
ATTN: Docs Sec

Florida State Library
ATTN: Docs Sec

Florida State University
ATTN: Librn

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

Fond Du Lac Public Library
ATTN: Librn

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

Ft Worth Public Library
ATTN: Librn

Free Public Library of Elizabeth
ATTN: Librn

Free Public Library
ATTN: Librn

Freeport Public Library
ATTN: Librn

Fresno Cty Free Library
ATTN: Librn

Gadsden Public Library
ATTN: Librn

Garden Public Library
ATTN: Librn

Gardner Webb College
ATTN: Docs Library

Gary Public Library
ATTN: Librn

Geauga Cty Public Library
ATTN: Librn

Georgetown University Library
ATTN: Gov Docs Room

Georgia Institute of Technology
ATTN: Librn

Georgia Southern College
ATTN: Librn

Georgia Southwestern College
ATTN: Dir of Libraries

Georgia State University Library
ATTN: Librn

DEPARTMENT OF DEFENSE CONTRACTORS (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 Monoa
ATTN: Dif 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

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Herbert H. Lehman College
ATTN: Lib Docs Div

Hofstra University Library
ATTN: Docs Dept

Hollins College
ATTN: Librn

Hopkinsville Comnunity College
ATTN: Librn

Wagner College
ATTN: Librn

University of Houston Library
ATTN: Docs Div

Houston Public Library
ATTN: Librn

Tulane University
ATTN: Docs Dept

Hoyt Public Library
ATTN: Librn

Humboldt State College Library
ATTN: Docs Dept

Huntington Park Library
ATTN: Librn

Hutchinson Public Library
ATTN: Librn

Idaho Public Library & Information Center
ATTN: Librn

Idaho State Library
ATTN: Librn

Idaho State University Library
ATTN: Docs Dept

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

University of Illinois Library
ATTN: Docs Sec

Illinois State Library (Reg)
ATTN: Gov Docs Br

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

Illinois Valley Community College
ATTN: Library

Illinois State University
ATTN: Librn

Indiana State Library (Reg)
ATTN: Serial Sec

Indiana State University
ATTN: Docs Library

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Indiana University Library
ATTN: Docs Dept

Indianapolis Marion County Public Library
ATTN: Social Science Oiv

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

JAYCOR
2 cy ATTN: Health & Environment Oiv

Jefferson County Public Library
Lakewood Regional Library
ATTN: Librn

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

John Hopkins University
ATTN: Docs Library

La Roche College
ATTN: Librn

Johnson Free Public Library
ATTN: Librn

JRB Associates
10 cy ATTN: L. Novotney

Kalamazoo Public Library
ATTN: Librn

Kaman Tempo
ATTN: DASIAC
ATTN: E. Martin

Kaman Tempo
ATTN: R. Miller

Kaman Tempo
ATTN: C. Jones

Kansas City Public Library
ATTN: Docs Oiv

Kansas State Library
ATTN: Librn

Kansas State University Library
ATTN: Oocs Dept

University of Kansas
ATTN: Dir of Library (Reg)

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Kent State University Library
ATTN: Oocs Oiv

Kentucky Oept of Library & Archives
ATTN: Docs Sec

University of Kentucky
ATTN: Gov Pub Oept
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 Oept

Brigham Young University
ATTN: Oocs & 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 Oiv U.S. Oocs

Louisiana State University
ATTN: Gov Ooc Oept
ATTN: Dir of Libraries (Reg)

Louisville Free Public Library
ATTN: Librn

Louisville University Library
ATTN: Librn

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

Maine Maritime Academy
ATTN: Librn

University of Maine
ATTN: Librn

DEPARTMENT OF DEFENSE CONTRACTORS (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
Kahuley Branch
ATTN: Librn

McNeese State University
ATTN: Librn

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

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

Memphis State University
ATTN: Librn

Mercer University
ATTN: Librn

Mesa County Public Library
ATTN: Librn

Miami Dade Community College
ATTN: Librn

University of Miami Library
ATTN: Gov Pubs

Miami Public Library
ATTN: Docs Div

Miami University Library
ATTN: Docs Dept

University of Santa Clara
ATTN: Docs Div

Michigan State Library
ATTN: Librn

Michigan State University Library
ATTN: Librn

DEPARTMENT OF DEFENSE CONTRACTORS (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

Morhead State College
ATTN: Library

Mt Prospect Public Library
ATTN: Gov't Info Ctr

Murray State University Library
ATTN: Lib

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Nassau Library System
ATTN: Librn

National Academy of Sciences
ATTN: C. Robinette
ATTN: Medical Follow-Up Agency
ATTN: Natl Materials Advisory Board

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 City Memorial Library at Cortland
ATTN: Librn

State University of New York
ATTN: Lib Docs Sec

DEPARTMENT OF DEFENSE CONTRACTORS (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 at Wilmington
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

University of North Dakota
ATTN: Dir of Libraries

North Georgia College
ATTN: Librn

North Texas State University Library
ATTN: Librn

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Northeast Missouri State Univeristy
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

DEPARTMENT OF DEFENSE CONTRACTORS (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

Pacific-Sierra Research Corp
ATTN: H. Brode

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

DEPARTMENT OF DEFENSE CONTRACTORS (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

DEPARTMENT OF DEFENSE CONTRACTORS (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

Science Applications, Inc
ATTN: Tech Library

Scottsbluff Public Librarv
ATTN: Librn

Scranton Public Library
ATTN: Librn

Seattle Public Librarv
ATTN: Ref Docs Asst

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Selby Public Library
ATTN: Librn

Shawnee Library System
ATTN: Librn

Shreve Memorial Library
ATTN: Librn

Silas Bronson Public Library
ATTN: Librn

Sioux City Public Library
ATTN: Librn

Skidmore College
ATTN: Librn

Slippery Rock State College Library
ATTN: Librn

South Carolina State Library
ATTN: Librn

University of South Carolina
ATTN: Librn

University of South Carolina
ATTN: Gov Docs

South Dakota School of Mines & Technical Library
ATTN: Librn

South Dakota State Library
ATTN: Fed Docs Dept

University of South Dakota
ATTN: Docs Librn

South Florida University Library
ATTN: Librn

Southeast Missouri State University
ATTN: Librn

Southeastern Massachusetts University Library
ATTN: Docs Sec

University of Southern Alabama
ATTN: Librn

Southern California University Library
ATTN: Docs Dept

Southern Connecticut State College
ATTN: Library

Southern Illinois University
ATTN: Librn

Southern Illinois University
ATTN: Docs Ctr

Southern Methodist University
ATTN: Librn

University of Southern Mississippi
ATTN: Library

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Southern Oregon College
ATTN: Library

Southern University in New Orleans Library
ATTN: Librn

Southern Utah State College Library
ATTN: Docs Dept

Southwest Missouri State College
ATTN: Library

University of Southwestern Louisiana Libraries
ATTN: Librn

Southwestern University
ATTN: Librn

Spokane Public Library
ATTN: Ref Dept

Springfield City Library
ATTN: Docs Sec

St Bonaventure University
ATTN: Librn

St Johns River Junior College
ATTN: Library

St Joseph Public Library
ATTN: Librn

St Lawrence University
ATTN: Librn

St Louis Public Library
ATTN: Librn

St Paul Public Library
ATTN: Librn

Stanford University Library
ATTN: Gov Docs Dept

State Historical Soc Library
ATTN: Docs Serials Sec

State Library of Massachusetts
ATTN: Librn

State University of New York
ATTN: Librn

Stetson University
ATTN: Librn

University of Steubenville
ATTN: Librn

Stockton & San Joaquin Public Library
ATTN: Librn

Stockton State College Library
ATTN: Librn

Albion College
ATTN: Gov Docs Librn

DEPARTMENT OF DEFENSE CONTRACTORS (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

DEPARTMENT OF DEFENSE CONTRACTORS (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 Oreno
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

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Washington State Library
ATTN: Docs Sec

Washington State University
ATTN: Lib Docs Sec

Washington University Libraries
ATTN: Dir of Lib

University of Washington
ATTN: Docs Div

Wayne State University Library
ATTN: Librn

Wayne State University Law Library
ATTN: Docs Dept

Weber State College Library
ATTN: Librn

Wesleyan University
ATTN: Docs Librn

West Chester State College
ATTN: Docs Dept

West Covina Library
ATTN: Librn

Univeristy of West Florida
ATTN: Librn

West Georgia College
ATTN: Librn

West Hills Community College
ATTN: Library

West Texas State University
ATTN: Library

West Virginia College of Grad Studies Library
ATTN: Librn

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

Westerly Public Library
ATTN: Librn

Western Carolina University
ATTN: Librn

Western Illinois University Library
ATTN: Librn

Western Washington University
ATTN: Librn

Western Wyoming Comnunity College Library
ATTN: Librn

Westmoreland City Community College
ATTN: Learning Resource Ctr

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Whitman College
ATTN: Librn

Wichita State University Library
ATTN: Librn

Williams & Mary College
ATTN: Docs Dept

Emporia Kansas State College
ATTN: Gov Docs Div

William College Library
ATTN: Librn

Williamantic Public Library
ATTN: Librn

Winthrop College
ATTN: Docs Dept

University of Wisconsin at Whitewater
ATTN: Gov Docs Lib

University of Wisconsin at Milwaukee
ATTN: Lib Docs

University of Wisconsin at Oshkosh
ATTN: Librn

University of Wisconsin at Platteville
ATTN: Doc Unit Lib

University of Wisconsin at Stevens Point
ATTN: Docs Sec

University of Wisconsin
ATTN: Gov Pubs Dept

University of Wisconsin
ATTN: Acquisitions Dept

Worcester Public Library
ATTN: Librn

Wright State University Library
ATTN: Gov Docs Librn

Wyoming State Library
ATTN: Librn

University of Wyoming
ATTN: Docs Div

Yale University
ATTN: Dir of Libraries

Yeshiva University
ATTN: Librn

Yuma City County Library
ATTN: Librn