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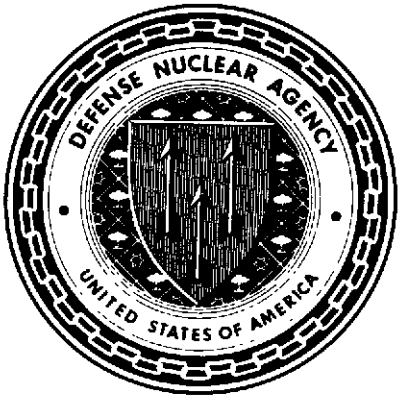
OPERATION TUMBLER-SNAPPER 1952



United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

HRE-0666

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This report describes the activities of an estimated 10,600 DOD personnel, both military and civilian, in Operation TUMBLER-SNAPPER, the third nuclear weapons testing series conducted at the Nevada Proving Ground. TUMBLER-SNAPPER consisted of eight nuclear tests conducted from 1 April to 5 June 1952. Activities engaging DOD personnel included Exercise Desert Rock IV programs, scientific experiments, and DOD support activities. Radiological safety criteria and procedures were established and implemented during Operation TUMBLER-SNAPPER to minimize participants' exposure to radioactivity.

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20. ABSTRACT (Continued)

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

Fact Sheet

dna

Defense Nuclear Agency
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Washington, D C 20305

Subject: Operation TUMBLER-SNAPPER

Operation TUMBLER-SNAPPER, a series of atmospheric nuclear weapons tests, was conducted by the Atomic Energy Commission (AEC) at the Nevada Proving Ground (NPG) from 1 April to 5 June 1952. The operation consisted of eight nuclear detonations in two phases. The TUMBLER phase, of primary concern to the Department of Defense (DOD), consisted of four weapons effects tests, Shots ABLE, BAKER, CHARLIE, and DOG. These airdropped devices were detonated to collect information on the effect of the height of burst on overpressure. Shots CHARLIE and DOG were also part of the SNAPPER phase, of primary concern to the AEC and the Los Alamos Scientific Laboratory. The other weapons development tests in the SNAPPER phase were Shots EASY, FOX, GEORGE, and HOW. The primary purpose of these four tower shots was to gather information on nuclear phenomena to improve the design of nuclear weapons.

Department of Defense Involvement

About 7,350 of the estimated 10,600 DOD participants in Operation TUMBLER-SNAPPER took part in Exercise Desert Rock IV. The remaining DOD personnel assisted in scientific experiments, air support activities, or administration and support activities at the NPG.

Exercise Desert Rock IV, an Army training program involving personnel from the armed services, included observer programs and tactical maneuvers. Observer programs, conducted at Shots CHARLIE, DOG, FOX, and GEORGE, generally involved briefings on the effects of nuclear weapons, observation of a nuclear detonation, and a subsequent tour of a display of military equipment exposed to the detonation. Tactical maneuvers, conducted after Shots CHARLIE, DOG, and GEORGE, were designed both to train troops and to test military tactics. Psychological tests were conducted at Shots CHARLIE, FOX, and GEORGE to determine the troops' reactions to witnessing a nuclear detonation.

Soldiers from various Sixth Army units provided support for the Exercise Desert Rock IV programs. They maintained and operated Camp Desert Rock, a Sixth Army installation located three kilometers south of the NPG. These soldiers provided essential services such as food, housing, transportation, communications, construction, and security. Some of the Desert Rock support troops worked in the forward areas of the NPG to construct

observer trenches, lay communication lines, provide transportation, and assist with other preparations for Desert Rock IV activities. Many of the Camp Desert Rock support personnel observed at least one detonation during Operation TUMBLER-SNAPPER, and some were called upon to perform support or staff duties in the test areas during nuclear detonations.

DOD personnel also participated in scientific experiments conducted by two test groups at Operation TUMBLER-SNAPPER: the Military Effects Test Group and the Weapons Development Test Group. The Military Effects Test Group was sponsored by Test Command, Armed Forces Special Weapons Project (AFSWP), and involved more DOD participants than did the AEC Weapons Development Test Group. The Los Alamos Scientific Laboratory conducted most of the Weapons Development Test Group activities, but DOD personnel were sometimes involved. Test group participants placed instruments and equipment around ground zero in the days and weeks before the scheduled nuclear test. At shot-time, these personnel were generally positioned at designated observer locations or were working at substantial distances from ground zero. After each detonation, when it was determined that the area was radiologically safe for limited access, these participants returned to the test area to recover equipment and gather data.

DOD personnel also provided air support to Operation TUMBLER-SNAPPER. The Air Force Special Weapons Center (AFSWC), from Kirtland Air Force Base, had primary responsibility for cloud sampling, courier missions, cloud tracking, aerial surveys of the terrain, and other air support as requested. AFSWC consisted of units of the 4925th Test Group and 4901st Support Wing, which staged out of Indian Springs Air Force Base.

Although the AEC Test Manager was responsible for planning, coordinating, and executing Operation TUMBLER-SNAPPER programs and activities, DOD personnel assisted in these duties. They were responsible for overseeing the DOD technical and military operations at the tests.

Summaries of TUMBLER-SNAPPER Nuclear Events

The eight TUMBLER-SNAPPER events are summarized in the accompanying table. The accompanying map shows the ground zeros of these shots.

Shot ABLE, an airdropped nuclear device, was detonated at 0900 hours on 1 April 1952, 793 feet over Area 5 of Frenchman Flat. ABLE had a yield of one kiloton. The event was a weapons effects test and involved DOD personnel from the Military Effects Test Group and the Weapons Development Test Group in about 30 scientific and diagnostic experiments. AFSWC activities included the airdrop, cloud sampling, courier service, cloud tracking, and aerial surveys. In addition, over 150 personnel from the

Strategic Air Command observed the detonation from B-50 aircraft flying over the test area. No formal military training exercises were conducted at this shot, although 15 members of the Camp Desert Rock support staff witnessed the shot. Onsite radiation intensities were characterized by small areas of low-level radioactivity surrounding ground zero. Six hours after the shot, the 0.01 R/h* radiation intensity line was at a radius of about 600 meters from ground zero.

Shot BAKER, an airdropped nuclear device, was detonated at 0930 hours on 15 April 1952, 1,109 feet over Area 7 of Yucca Flat. The BAKER device had a yield of one kiloton. BAKER was also a weapons effects test and involved DOD personnel from the test groups in 45 experiments. AFSWC activities included the airdrop, cloud sampling, courier service, cloud tracking, and aerial surveys. About 170 Strategic Air Command observers flying in B-50 aircraft witnessed the detonation. No formal military training exercises were conducted, but ten members of the Camp Desert Rock staff did witness the shot. Onsite radioactivity was characterized by small areas of radiation around ground zero. About one hour after the shot, the initial radiological survey team found a radiation intensity of 1.2 R/h at ground zero, decreasing to 0.01 R/h 750 meters south of ground zero.

Shot CHARLIE, an airdropped nuclear device, was detonated with a yield of 31 kilotons at 0930 hours on 22 April 1952 about 3,500 feet over Area 7 of Yucca Flat. About one hour after the shot, the initial survey showed that radiation intensities of 0.01 R/h or more were confined within 1,000 meters of ground zero.

As part of Exercise Desert Rock IV, the armed services fielded a troop observer program with 535 participants and a tactical troop maneuver with about 1,675 participants. The tactical maneuver at Shot CHARLIE was conducted by the following units:

Army

- 2nd Battalion, 504th Airborne Infantry Regiment, 82nd Airborne Division, Fort Bragg, North Carolina
- Company B, 167th Infantry Regiment, 31st Infantry Division, Camp Atterbury, Indiana
- Company C, 135th Infantry Regiment, 47th Infantry Division, Fort Rucker, Alabama

*Roentgens per hour

- Tank Platoon, 11th Armored Cavalry Regiment, Camp Carson, Colorado

- Engineer Platoon, 369th Engineer Amphibious Support Regiment, Fort Worden, Washington

- Medical Detachment (augmented), Sixth Army, numerous Sixth Army posts.

Air Force

- 140th Fighter-Bomber Group (Provisional)
  - 140th Fighter-Bomber Wing, Clovis Air Force Base, New Mexico

The CHARLIE tactical maneuver consisted of five activities:

- Observation of the shot
- Psychological testing
- Movement to objective
- Inspection of an equipment display
- Airborne exercise.

After observing the shot from trenches approximately 6,400 meters south of ground zero, the troops were tested by the Human Resources Research Office and the Operations Research Office to determine their reactions to the detonation. The troops then toured the display area and approached as close as 160 meters to ground zero, where they encountered radiation intensities of up to 0.01 R/h. While ground troops were taking part in these activities, Army paratroopers landed in a drop zone north of ground zero. Some of the paratroopers, however, jumped prematurely and missed the drop zone by as much as 13 kilometers. Five paratroopers were slightly injured on landing. Despite this problem, the exercise was completed as planned.

In addition to Exercise Desert Rock activities, DOD personnel participated in about 50 scientific projects, approximately 190 Strategic Air Command observers witnessed the shot from aircraft flying in the vicinity of the NPG, and AFSWC personnel provided air support, including the bomb drop.

Shot DOG, another airdropped nuclear device, was detonated with a yield of 19 kilotons at 0830 hours on 1 May 1952. Ground zero for DOG, which was detonated more than 1,000 feet above Area 7, was the same as that for Shots BAKER and CHARLIE. The initial radiation survey, taken about one hour after the shot, showed that radiation intensities of 0.01 R/h extended approximately 1,600 meters from ground zero.

The Navy and Marine Corps conducted a troop observer program and a tactical troop maneuver at Shot DOG as part of Exercise Desert Rock IV. The observer program involved approximately 350 Navy and Marine participants. Desert Rock participants observed the shot from trenches 6,400 meters south of ground zero. The tactical maneuver was conducted by about 1,950 Marines from the Marine Corps Provisional Atomic Exercise Unit. This unit consisted of officers and enlisted men from the 1st Provisional Marine Battalion of Camp Pendleton and the 2d Provisional Marine Battalion of Camp Lejeune. The DOG tactical maneuver was the first maneuver conducted by the Marine Corps during continental nuclear weapons testing. As at Shot CHARLIE, troops observed the shot, took psychological tests, and toured display areas. In addition, some participants accompanied AFSWP and Desert Rock monitoring teams on their initial survey of the ground zero area in order to learn radiological monitoring techniques. At Shot DOG, three display areas were established between 270 and 1,600 meters from ground zero. The Marines stopped their tour of the displays at 820 meters from ground zero because of the radiation intensities they encountered.

In addition to Desert Rock activities, DOD personnel participated in about 50 of the scientific experiments conducted by the test groups, about 180 observers from the Strategic Air Command watched the detonation from aircraft flying in the vicinity of the NPG, and AFSWC personnel provided air support, including the bomb drop.

Shot EASY was detonated from a 300-foot tower at 0415 hours on 7 May 1952 in Area 1 of Yucca Flat. The device had a yield of 12 kilotons. DOD participants were involved in approximately 30 of the test group experiments, and AFSWC personnel provided air support. No formal Desert Rock IV training exercises were conducted. However, 1,000 personnel from Camp Desert Rock support units witnessed the shot from the Control Point at Yucca Pass. Onsite residual radioactivity was heaviest around and to the north of ground zero. The initial radiological survey team was unable to complete the survey on shot-day because of the large radiation area and rough terrain. On the day after the shot, the 0.01 R/h line was 900 to 1,000 meters east, south, and west of ground zero but extended about six kilometers north of the shot-tower.

Shot FOX, a 300-foot tower detonation, was fired in Area 4 of Yucca Flat with a yield of 11 kilotons at 0400 hours on 25 May 1952. Most onsite fallout occurred to the northeast of ground zero, overlapping residual radiation from Shot EASY. Ninety minutes after the shot, the 0.01 R/h line extended farther than 6.5 kilometers to the east. High radiation levels to the northeast prevented completion of the initial radiological survey on shot-day. Three days after the shot, the 1.0 R/h line extended less than 500 meters from ground zero, except to the northeast where it reached nearly two kilometers.

During Shot FOX, the largest single activity was the Army troop observer program, part of Exercise Desert Rock IV. Approximately 950 exercise troops from the 701st Armored Infantry Battalion, 1st Armored Division, Fort Hood, Texas, witnessed the shot from trenches 6,400 meters southeast of ground zero. An additional 500 observers from the six continental armies and the service schools also witnessed the shot. The observer program included psychological testing before and after the shot and a tour of the equipment display area.

In addition, DOD personnel were involved in 27 test group experiments. AFSWC personnel provided air support, and about 100 observers from the Strategic Air Command witnessed the shot from aircraft flying in the vicinity of the NPG.

Shot GEORGE, a 300-foot tower detonation, was fired with a yield of 15 kilotons at 0355 hours on 1 June 1952. GEORGE was detonated in Area 3. The initial radiation survey established the 0.01 R/h line at about 1,300 meters to the west, south, and east of ground zero. The area north of the shot-tower could not be surveyed on shot-day because of radiation levels in excess of 10.0 R/h.

The Desert Rock troop observer program and tactical troop maneuver at Shot GEORGE involved approximately 1,800 Army troops. Immediately after they observed the shot from trenches about 6,400 meters south of ground zero, about 500 soldiers toured the equipment display area, located about 500 to 2,500 meters southwest of ground zero. The remaining 1,300 soldiers took part in the tactical troop maneuver, a ground assault on an objective south of ground zero. Immediately after the shot, the troops, accompanied by five tanks, advanced from the trench area toward the objective. When Army monitors preceding the assault detected radiation intensities of 0.5 R/h at about 460 meters from ground zero, the attack was halted. Troops then proceeded to the equipment display areas. The following Army units took part in this maneuver:

- 23rd Transportation Truck Company, Camp Roberts, California
- 31st Transportation Truck Company, Fort Ord, California
- Tank Platoon of the 1st Armored Division, Fort Hood, Texas
- 369th Engineer Amphibious Support Regiment, Fort Worden, Washington.

In addition to these Desert Rock activities, DOD personnel participated in 25 of the test group experiments, AFSWC personnel performed air support missions, and 24 observers from the Strategic Air Command watched the detonation from two B-50s flying in the vicinity of the NPG.

Shot HOW was detonated from a 300-foot tower, located in Area 2 of Yucca Flat, on 5 June 1952 at 0355 hours. Shot HOW, the last weapons test of Operation TUMBLER-SNAPPER, had a yield of 14 kilotons. No Exercise Desert Rock programs were conducted, but DOD personnel did participate in about 30 of the test group projects. The onsite fallout pattern extended to the north and northwest of ground zero, but the initial radiological survey team did not monitor that area because no recovery operations were necessary there. The survey team did measure intensities of 0.01 R/h as far as two kilometers to the west of ground zero.

Safety Standards and Procedures

The Atomic Energy Commission established safety criteria to minimize the exposure of participants to ionizing radiation while allowing them to accomplish their missions. The AEC established a limit of 3.0 roentgens of gamma exposure per 13-week period for Exercise Desert Rock, the joint AEC-DOD organization, and most of AFSWC. AFSWC sampling pilots were authorized to receive up to 3.9 roentgens during the TUMBLER-SNAPPER operation because their mission required them to penetrate the clouds formed by the detonations.

The Test Manager was ultimately responsible for the safety of participants in Exercise Desert Rock IV, of the personnel in the joint AEC-DOD organization, and of individuals residing within 320 kilometers of the NPG. Most onsite and offsite radiological safety procedures were performed by the AFSWP Radiological Safety Group, composed of personnel from the Army, Navy, and Air Force. An officer appointed by Test Command, AFSWP, headed the group.

The Desert Rock Exercise Director was responsible for conducting Exercise Desert Rock IV in compliance with the AEC radiological safety policies. The Desert Rock Radiological Safety Group was usually supervised and assisted by the AFSWP Radiological Safety Group. The AFSWP group was also responsible for processing the film badges worn by Desert Rock participants.

The 4925th Test Group (Atomic) implemented radiological safety procedures for AFSWC personnel at Indian Springs Air Force Base. For AFSWC personnel at Kirtland Air Force Base, the 4901st Support Wing (Atomic) carried out these procedures.

Although the missions and activities of each organization were different, the general radiological safety procedures followed by all groups were similar:

- Orientation and training - preparing radiological monitors for their work and familiarizing participants with radiological safety procedures
- Personnel dosimetry - issuing and developing film badges and evaluating gamma radiation exposures recorded on film badges

- Use of protective equipment - providing clothing, respirators, and other protective equipment

- Monitoring - performing radiological surveys and controlling access to radiation areas

- Briefing - informing observers and project personnel of radiological hazards and the radiological conditions in the test area

- Decontamination - detecting and removing contamination from personnel and equipment.

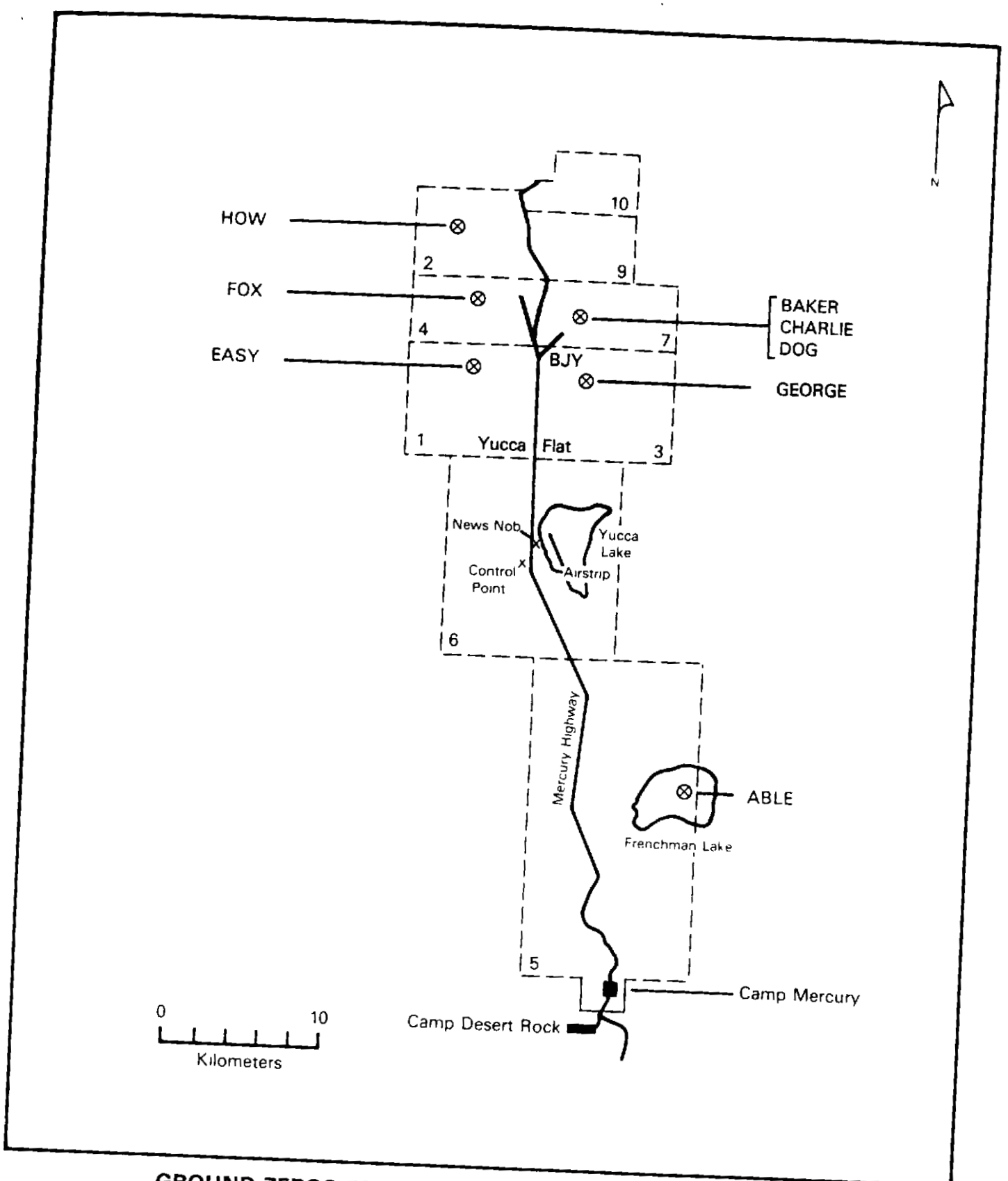
Radiation Exposures at TUMBLER-SNAPPER

As of June 1982, the military services had identified by name 5,064 participants in TUMBLER-SNAPPER. Film badge data are available for 1,803 of these participants, as shown in the "Summary of Dosimetry for Operation TUMBLER-SNAPPER" table. Forty-two DOD participants who were subject to the joint AEC-DOD organization limit of 3.0 roentgens exceeded it, and eight individuals subject to the 3.9 roentgen AFSWC limit received exposures in excess of the stipulated level.

SUMMARY OF OPERATION TUMBLER-SNAPPER EVENTS (1952)

Shot	ABLE	BAKER	CHARLIE	DOG	EASY	FOX	GEORGE	HOW
Sponsor	DOD-LASL	DOD-LASL	DOD-LASL	DOD-LASL	LASL	LASL	LASL	LASL
Planned Date	1 April	15 April	22 April	29 April	6 May	13 May	20 May	27 May
Actual Date	1 April	15 April	22 April	1 May	7 May	25 May	1 June	5 June
Time*	0900	0930	0930	0830	0415	0400	0355	0355
NPG Location	Frenchman Lake (Area 5)	Area 7	Area 7	Area 7	Area 1	Area 4	Area 3	Area 2
Type of Detonation	Airdrop	Airdrop	Airdrop	Airdrop	Tower	Tower	Tower	Tower
Height of Burst (Feet)	793	1,109	3,447	1,040	300	300	300	300
Yield (Kilotons)	1	1	31	19	12	11	15	14

* Pacific Standard Time



GROUND ZEROS FOR OPERATION TUMBLER-SNAPPER AT THE NEVADA PROVING GROUND

SUMMARY OF DOSIMETRY FOR OPERATION TUMBLER-SNAPPER AS OF JUNE 1982

Service	Personnel Identified by Name	Personnel Identified by Name and by Film Badge	Gamma Exposure (Roentgens)					Number of Personnel with Zero Gamma Exposure*	Average Gamma Exposure (Roentgens)	Maximum Gamma Exposure (Roentgens)
			<.1	.1-1.0	1.0-3.0	3.0-5.0	5.0+			
Army	1786	843	295	463	61	17	7	216	.396	10.8
Navy	493	130	51	51	26	2	0	13	.594	4.2
Marine Corps	1980	25	22	2	1	0	0	21	.070	1.5
Air Force	416	416	177	184	36	17	2	59	.497	7 6
Scientific Personnel, Contractors, and Affiliates	389	389	206	98	72	12	1	118	.575	6.1
TOTAL	5064	1803	751	798	196	48	10	427	.468	

* The number of personnel in this column is also represented in the <.1 Gamma Exposure column.

PREFACE

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

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

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

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

*Renamed the Nevada Test Site in 1955.

+The Center for Disease Control is part of the U.S. Department of Health and Human Services (formerly the U.S. Department of Health, Education, and Welfare).

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

METHODS AND SOURCES USED TO PREPARE THIS VOLUME

This report on Operation TUMBLER-SNAPPER is based on the military and technical documents associated with these atmospheric nuclear weapons tests. Many of the documents pertaining specifically to DOD involvement in TUMBLER-SNAPPER were found in the Modern Military Branch of the National Archives, the Defense Nuclear Agency Technical Library, and the Office of Air Force History.

In certain cases, the surviving historical documentation of activities conducted during Operation TUMBLER-SNAPPER addresses test specifications and technical information, rather than the personnel data critical to the study undertaken by the Department of Defense. Moreover, these documents sometimes have inconsistencies in vital facts. Efforts have been made to resolve these inconsistencies wherever possible or to bring them to the attention of the reader.

In addition to these inconsistencies in information, the documents describing projects of the Armed Forces Special Weapons Project (AFSWP) do not always present project titles and agencies consistently. To make this information as uniform as possible, the reports on TUMBLER-SNAPPER use weapons test report titles for each project. Information concerning the planned and actual dates and yields of the test detonations is taken from the Department of Energy, Announced United States Nuclear Tests, July 1945 through 1979 (NVO-209). Other facts, such as meteorological conditions and dimensions of the clouds formed by the detonations, are taken from DNA 1251-1, Compilation of Local Fallout Data from

Test Detonations 1945-1962, Volume 1, except in instances where more specific information is available elsewhere.

For several of the Exercise Desert Rock and test organization projects discussed in these volumes, the only available documents are the Sixth Army Desert Rock IV operation orders and the Test Director's schedule of events from "Operation Order 1-52." These sources detail the plans developed by DOD and AEC personnel during Operation TUMBLER-SNAPPER; they do not necessarily describe the projects as they were actually conducted. Although some of the after-action documents summarize the projects performed during the TUMBLER-SNAPPER Series, they do not always supply shot-specific information. In the absence of shot-specific after-action reports, projects are described according to the way they were planned. The references indicate whether the description of activities is based on the schedule of events, operation orders, or after-action reports.

ORGANIZATION AND CONTENT OF OPERATION TUMBLER-SNAPPER REPORTS

This volume details participation by DOD personnel in Operation TUMBLER-SNAPPER, the third atmospheric nuclear weapons testing series conducted at the Nevada Proving Ground. Two other publications address DOD activities during Operation TUMBLER-SNAPPER:

- Multi-shot volume: Shots ABLE, BAKER, CHARLIE, and DOG, the First Tests of the TUMBLER-SNAPPER Series
- Multi-shot volume: Shots EASY, FOX, GEORGE, and HOW, the Final Tests of the TUMBLER-SNAPPER Series.

The volumes addressing the test events of Operation TUMBLER-SNAPPER have been designed for use with one another. The series volume provides general information on Operation TUMBLER-SNAPPER that applies to the series as a whole, such as historical background, organizational relationships, and radiological safety

procedures. The two multi-shot volumes combine shot-specific descriptions for the eight TUMBLER-SNAPPER nuclear events. Descriptions of activities concerning any particular shot in Operation TUMBLER-SNAPPER may be supplemented by the general organizational and radiological safety information contained in this volume. In addition, this volume contains a bibliography of works consulted in the preparation of all three Operation TUMBLER-SNAPPER reports, while the multi-shot volumes contain a bibliography only of the sources referenced in each of those texts.

This volume is divided into six chapters. Chapter 1 gives the background of Operation TUMBLER-SNAPPER, including the historical context of the series, the layout of the Nevada Proving Ground, the eight events in the series, and the activities of DOD participants. Chapter 2 describes the joint AEC-DOD organization and Exercise Desert Rock, the two groups with major DOD participation at Operation TUMBLER-SNAPPER. This chapter defines the responsibilities of each group in planning, administering, and supporting the various nuclear test events and in conducting other activities in conjunction with those tests. Chapter 3 discusses the Exercise Desert Rock IV military maneuvers conducted during Operation TUMBLER-SNAPPER, and chapter 4 describes the scientific experiments and support activities engaging DOD personnel and coordinated by the joint AEC-DOD organization. These chapters define the objectives of the activities, describe the planned and actual procedures, and indicate at which shots the programs occurred. Chapter 5 describes the radiological criteria and procedures in effect during Operation TUMBLER-SNAPPER for each of the DOD groups with significant participation. Chapter 6 presents the results of the radiation protection program during Operation TUMBLER-SNAPPER, including an analysis of film badge readings for DOD personnel.

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

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