

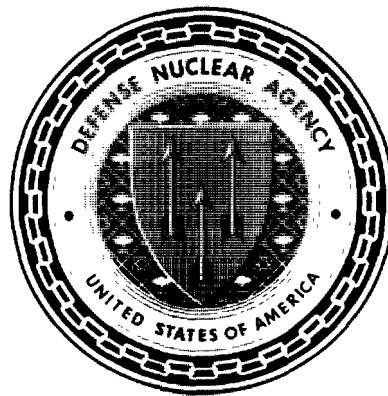
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SHOTS

WHEELER TO MORGAN

The Final Eight Tests of the PLUMBBOB Series

6 SEPTEMBER - 7 OCTOBER 1957



United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

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to ionizing radiation while allowing participants to accomplish their objectives. Desert Rock personnel were limited to five roentgens of whole-body gamma radiation during any six-month period. The radiation protection procedures of Exercise Desert Rock included provisions for (32; 33):

- Maintaining minimum safe distances from nuclear detonations
- Enforcing protective procedures for personnel observing the detonations
- Controlling access to radiation areas
- Film-badging and monitoring the cumulative exposures of Desert Rock personnel
- Decontaminating all equipment and personnel leaving the shot area after each detonation
- Preparing emergency evacuation plans for personnel in the forward area.

1.3 DOSIMETRY FOR PLUMBBOB PARTICIPANTS

For Operation PLUMBBOB, REECO maintained cumulative exposure lists of NTO and AFSWC personnel. The lists provided the shot-specific dosimetry information described in the radiological safety sections of the following chapters. For example, lists were developed that showed the personnel who had, during a shot-specific period, exceeded a cumulative dose of two roentgens. A few surviving disposition forms, specifying personnel exposures exceeding three roentgens, indicate that Exercise Desert Rock similarly monitored cumulative exposures. Personnel whose exposures reached five roentgens were prohibited from further entry into the shot area. The Operation PLUMBBOB volume summarizes dosimetry totals and overexposure information for PLUMBBOB participants.

SHOT WHEELER SYNOPSIS

AEC TEST SERIES: PLUMBBOB
DOD EXERCISE: Desert Rock VII and VIII
DATE/TIME: 6 September 1957, 0545 hours
YIELD: 0.197 kilotons
HEIGHT OF BURST: 500 feet (balloon shot)

Objectives: (1) To evaluate newly designed devices for possible inclusion in the nuclear arsenal
(2) To evaluate the nuclear yield and the blast, thermal, and radiation phenomena produced by these nuclear devices
(3) To evaluate the ability of military personnel and equipment to locate and detect nuclear detonations.

Weather: At shot-time, the temperature was 15°C, and surface winds were calm. Winds were 11 knots from the east-southeast at 10,000 feet and 17 knots from the east-southeast at 15,000 feet.

Radiation Data: The initial survey, mid-time of 0652 hours, determined that radiation intensities greater than 0.1 R/h were limited to within about 750 meters from ground zero except to the north, where the residual radiation field from a previous shot was encountered.

Participants: Exercise Desert Rock troops, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, University of California Radiation Laboratory, other contractors.

CHAPTER 2

SHOT WHEELER

Shot WHEELER, the seventeenth nuclear weapons test of Operation PLUMBBOB, was detonated at 0545 hours Pacific Daylight Time on 6 September 1957. The device, which had a yield of 0.197 kiloton, was suspended from a balloon and fired 500 feet above the ground in Area 9 of the Nevada Test Site. The cloud top reached 17,000 feet and traveled west-northwest (29).

2.1 EXERCISE DESERT ROCK VII AND VIII OPERATIONS AT SHOT WHEELER

Two technical service projects were conducted at Shot WHEELER: Project 50.3, Evaluation of Medium Range Detonation-detection and Cloud Tracking Systems, and Project 50.8, Detection of Atomic Burst and Radioactive Fallout. These two projects involved 128 Desert Rock participants. In addition, 12 Desert Rock support troops witnessed the detonation from a location near News Nob, approximately 21 kilometers south of ground zero. The 12 observers probably returned to Camp Desert Rock after the detonation (33).

Project 50.3, Evaluation of Medium Range Detonation-detection and Cloud Tracking Systems, was fielded by a detachment from the Army Signal Research and Development Laboratories, Fort Monmouth, New Jersey; personnel from Fort Meade, Maryland; and personnel from Fort Huachuca, Arizona. The project had two purposes: to test the capacity of Army radar equipment in detecting the nuclear detonation and tracking the radioactive cloud, and to examine Army fallout prediction methods. Participants were divided into a radar section and two fallout prediction teams. The radar section detected and tracked the cloud, recorded fireball growth, and determined the rate of rise

of the cloud, the height of burst, and the yield. In addition, the radar section collected data to evaluate the capability of radar equipment in cloud detection. Three radar sets were used: one about 180 kilometers southeast of ground zero at Boulder City, Nevada, and the other two about 13 kilometers west of ground zero at UTM coordinates 766106. All three sets were manned at the time of the detonation (19; 32; 52).

One of the fallout prediction teams used upper wind data to test an Army Signal Research and Development Laboratories technique for predicting fallout patterns. The fallout team consisted of personnel from the Meteorological Division, Army Signal Research and Development Laboratories. This team operated out of an M-109 mobile van, which contained the teletype and recording equipment necessary for obtaining meteorological data for plotting fallout. The mobile van, manned at the time of the detonation, was located next to the weather station at Camp Mercury. A second fallout prediction team, with personnel from the Army Electronic Proving Ground, Fort Huachuca, operated near Alamo, Nevada, 92 kilometers northeast of the Control Point. Project activities involved an estimated 23 DOD personnel (19; 32; 52).

Project 50.8, Detection of Atomic Burst and Radioactive Fallout, was conducted by the Army Air Defense Board, supported by the 495th Antiaircraft Artillery Missile Battalion. The project, which involved an estimated 105 DOD personnel, was designed to determine how well equipment found in a typical Army unit could (57; 58; 59):

- Determine the location, height of burst, and yield of a detonation
- Track targets and guided missiles through a radioactive cloud or fireball.

During the detonation, personnel operated three radar sets about 20 kilometers from ground zero and a fourth radar set approximately 70 kilometers from ground zero. In addition, participants

manned a project control point southeast of ground zero, at UTM coordinates 832962 (32).

2.2 DEPARTMENT OF DEFENSE PARTICIPATION IN TEST GROUP, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT WHEELER

Besides participating in Exercise Desert Rock activities, Department of Defense personnel took part in other test activities during Shot WHEELER that required them to enter the forward area. Table 2-1 identifies the test group projects involving DOD participants. The Air Force also sponsored one operational training project. In addition to the test group projects and the operational training project, support activities accounted for a number of DOD participants. The Air Force Special Weapons Center supported one test group project and flew routine air missions for the Test Manager.

Table 2-1: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT WHEELER

Project	Title	Participants	Estimated DOD Personnel
Weapons Effects Test Group			
6 4	Accuracy and Reliability of the Short-baseline NAROL System	Air Force Cambridge Research Center	*
91	Support Photography	AFSWP, EG and G	12
University of California Radiation Laboratory Test Group			
21 2	Radiochemistry Sampling	University of California Radiation Laboratory; 4926th Test Squadron (Sampling), Air Force Special Weapons Center	8

* Unknown

2.2.1 AFSWP Field Command Weapons Effects Test Group Projects

The Weapons Effects Test Group conducted two projects during Shot WHEELER. In identifying these projects, table 2-1 lists the

estimated numbers of DOD personnel. These estimates, as well as DOD personnel estimates in the project tables of the following chapters, reflect the minimum number of project participants in an experiment as given in the schedule of events for the shot or in the weapons test reports.

Project 6.4, Accuracy of the Reliability of the Short-baseline NAROL System, used the Long Range Aids to Navigation (LORAN) system in an inverse fashion to determine the electromagnetic pulse from the nuclear burst in order to detect the position and measure the yield of that burst. The Indirect Bomb Damage Assessment NAROL system tested in this operation consisted of nets located in Albuquerque, New Mexico; Vale, Oregon; and Rapid City, South Dakota. Each NAROL net had two unmanned slave stations and one manned station (34).

Project 9.1, Support Photography, was sponsored by AFSWP to provide the following support services:

- Technical photographic support of the military effects program
- Documentation of the overall military effects program and production of an effects motion picture
- Documentation of the detonation for release through the Joint Office of Test Information and for historical purposes
- General photographic support to Department of Defense projects.

Nine personnel established and then manned a photography station at the BJY from five hours before to 30 minutes after the detonation (10). In addition, Edgerton, Germeshausen, and Grier (EG and G) personnel provided technical photographic support to AFSWP and the AEC, operating camera stations to record fireball and cloud growth. After the detonation, three EG and G participants spent about 90 minutes in the shot area recovering film from the stations. Although Project 9.1 also included

aerial photography at other shots, no data are available concerning an air photographic mission at WHEELER (10; 24).

2.2.2 Department of Defense Participation in University of California Radiation Laboratory Test Group Projects

Of the ten projects conducted by the University of California Radiation Laboratory Test Group at WHEELER, only Project 21.2, Radiochemistry Sampling, involved DOD participants, as shown in table 2-1. The project required cloud sampling, discussed in section 2.2.4.

2.2.3 Department of Defense Operational Training Project

The one operational training project conducted by the Air Force at Shot WHEELER was Project 53.1, Aerial Sampling Missions. This project was designed to train Air National Guard units in cloud sampling. Two F-33A aircraft, each with a crew of two from the Wisconsin Air National Guard, participated in the activity (27). It is probable that the project involved cloud sampling and was conducted in conjunction with UCRL Project 21.2, Radiochemistry Sampling.

2.2.4 Air Force Special Weapons Center Activities

Air Force Special Weapons Center support to the Test Manager and the test groups at Shot WHEELER consisted of cloud-sampling and sample courier missions in support of Project 21.2, cloud-tracking missions, security sweeps, and aerial surveys.

Cloud Sampling

Six F-84 aircraft, with one pilot each, collected samples of the cloud for Project 21.2, Radiochemistry Sampling. A B-57 sampler control aircraft, manned by a pilot and a UCRL scientific

advisor, also participated. Pilots of the 4926th Test Squadron (Sampling) flew all seven aircraft (1; 2).

The B-57 sampler control aircraft, which guided the six sampler aircraft through the missions, left Indian Springs AFB at 0445 hours, one hour before the detonation. The aircraft reached an altitude of 35,000 feet and began a right-hand holding pattern about 50 nautical miles east of ground zero at 0550 hours (1; 2).

The six sampler aircraft proceeded as follows. At 0605 hours, 15 minutes after the sampler control aircraft began its orbit, the first F-84 entered the vicinity of the burst at 35,000 feet and established visual contact with the control aircraft. After the detonation, the control aircraft left its orbit to view the cloud from all sides. The scientific advisor in the B-57 then directed the samplers to penetrate the cloud at the altitude necessary to acquire the samples. The first F-84 left the area 35 minutes later, landing at Indian Springs AFB at 0645 hours. The remaining five F-84 samplers followed the pattern set by the first sampler and entered the area of the cloud at altitudes of 35,000 feet at ten-minute intervals, between 0615 hours and 0655 hours. Each aircraft followed the same procedures as the first F-84, and remained in the area collecting samples for about 30 minutes. The final sampler aircraft landed at Indian Springs AFB at 0735 hours. The control aircraft ended its pattern at 0725 hours, after the six sampler aircraft had collected cloud samples, and landed at Indian Springs at 0736 hours (1; 2).

Upon landing, each sampler aircraft taxied to the strip farthest from base operations. There, ground personnel used long-handled poles to remove the samples and place them in metal containers to be sent by courier to UCRL. With the mission complete, the aircraft and the pilots were decontaminated, as described in the Operation PLUMBBOB volume (1; 2).

Courier Missions

The 4900th Air Base Group from Kirtland AFB flew the courier sample return missions. Two C-47 aircraft, each with a minimum crew of three, flew samples out of Indian Springs AFB to UCRL for analysis (1; 2).

Cloud Tracking

Five minutes after the WHEELER detonation, two B-25 aircraft, each with an estimated crew of four, left Indian Springs AFB and flew over and beyond the NTS at 15,000 feet. The purpose of the mission was to determine the direction the cloud traveled and to keep the airways clear of any aircraft unrelated to the test projects (1; 2).

Security Sweep

The evening before the detonation, one L-20 aircraft, with at least two people aboard, left the airstrip near Camp Mercury and flew a security sweep mission over the NTS to ensure that no unauthorized personnel remained in the shot area (1; 2).

Helicopter Surveys

Ninety minutes after the detonation, one H-21 helicopter, with two AFSWC crewmen and two radiological safety monitors, left the airstrip near Camp Mercury and flew a survey mission over the WHEELER shot area and other designated points to record radiation intensities. The survey took an estimated 40 minutes. Crew members wore anticontamination clothing and respirators during the flight. After the mission, the helicopter returned to the helicopter area at Camp Mercury, where aircraft and crew were monitored and decontaminated as required. Subsequent surveys were canceled, as discussed in section 2.3. A survey to assess detonation damage, planned for about two hours after the shot, was also canceled (1; 2; 44).

2.3 RADIATION PROTECTION AT SHOT WHEELER

The purpose of the radiation protection procedures developed for Operation PLUMBBOB was to ensure that individuals would avoid unnecessary exposure to ionizing radiation while accomplishing their missions. Some of the procedures described in the Operation PLUMBBOB volume resulted in records that enabled the Nevada Test Organization to evaluate the effectiveness of its radiation protection programs. The available information includes NTO isointensity contour maps, monitoring data, and some NTO personnel dosimetry data. Radiological safety procedures and dosimetry information for Desert Rock and AFSWC personnel are described in the Operation PLUMBBOB volume.

Dosimetry Records

Film badge records turned in on the WHEELER shot-day indicate that four Desert Rock participants reached or exceeded two roentgens of cumulative gamma exposure. Three of these personnel were from the 232nd Signal Company and had film badge readings of 4.35, 9.5, and 10.2 roentgens. The latter two readings, which exceeded the Desert Rock limit of five roentgens, represented the greatest exposures for any Operation PLUMBBOB participants. The fourth individual, a member of the Desert Rock Instructor Group, received two roentgens, according to a film badge worn over a four-day period. The shots with which this exposure and the others are associated are not known (39; 44; 54; 60).

On 5 and 6 September 1957, including the 6 September detonation of WHEELER, the NTO Personnel Dosimetry Branch issued 516 film badges and 272 pocket dosimeters (60). One DOD participant, from the Ballistic Research Laboratories, received a cumulative gamma exposure of 2.12 roentgens. The Desert Rock Radiological Safety Officer, listed among the NTO participants, received a cumulative gamma exposure of 2.23 roentgens. It is not known why he wore an NTO film badge in addition to his Desert

Rock film badge. If no duplication occurred, his cumulative exposure was 6.9 roentgens, in excess of the five roentgen limit (39; 44; 60).

Logistics

For Shot WHEELER, the General Supply Section issued protective supplies to 613 personnel. These supplies consisted of coveralls, shoe covers, respirators, and other protective equipment (44; 60).

Monitoring Procedures and Support

Five minutes after the detonation, a total of 11 monitors traveling in eight vehicles proceeded into the shot area and performed the initial ground radiological survey of the shot area. The survey took about an hour to complete. Resurveys were made about six hours after the detonation and again on 7, 8, and 9 September (44; 60).

The initial aerial survey team, consisting of two radiological monitors and two AFSWC crewmen, departed from the Control Point helicopter pad at 0715 hours, 90 minutes after the detonation. The highest radiation intensity in the shot area was 4.8 R/h, encountered 25 feet above ground zero about two hours after the detonation. Outside the shot area, the highest intensity was 7.5 R/h, detected 25 feet above the ground zero of Shot GALILEO, fired five days earlier. Aerial resurveys were canceled for Shot WHEELER because ground resurveys supplied sufficient information (44; 60).

Plotting and Briefing

Using information from the initial surveys, the Plotting and Briefing Branch developed isointensity contour maps. Figure 2-1 shows a copy of the initial contour map, with a mid-time of 0652 hours. Figure 2-2 presents copies of the isointensity maps

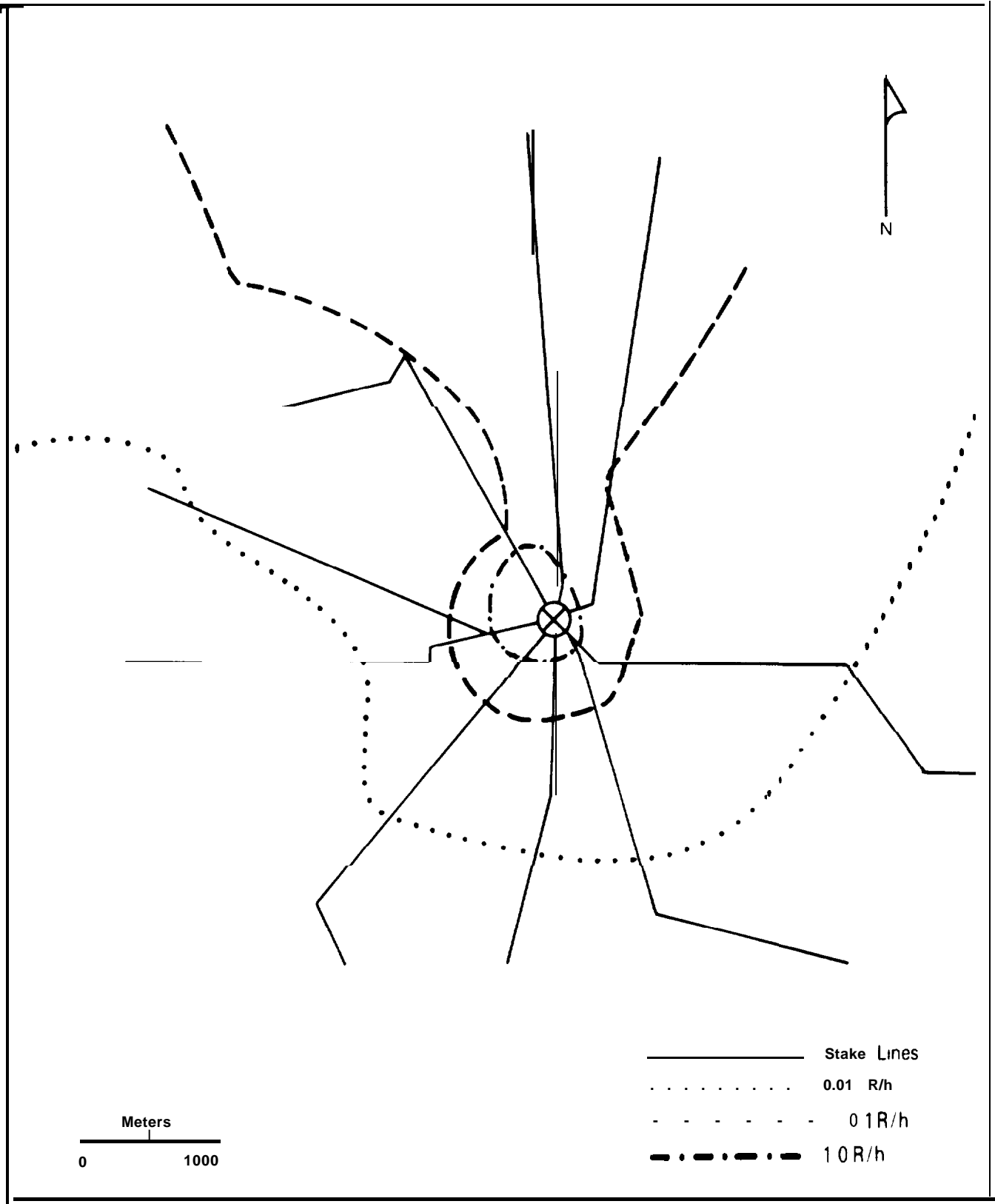
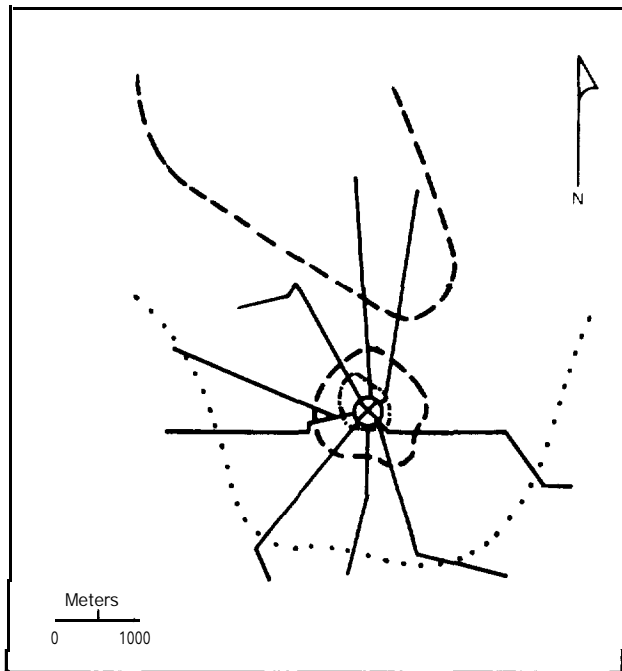
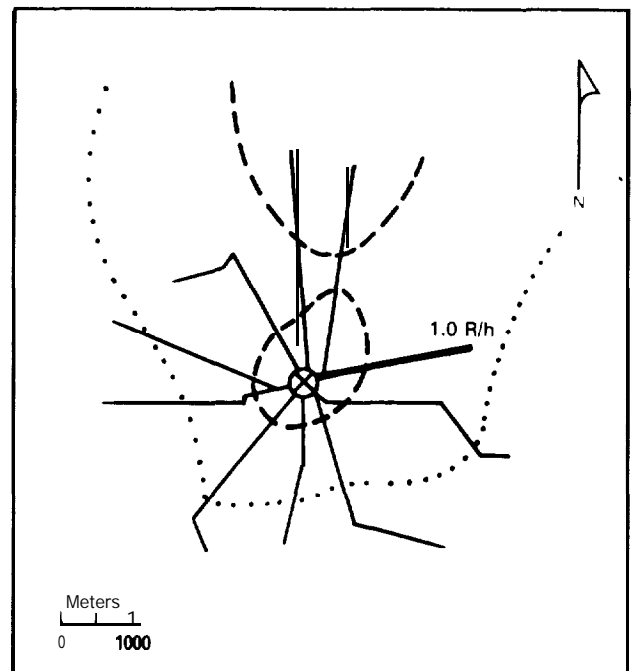


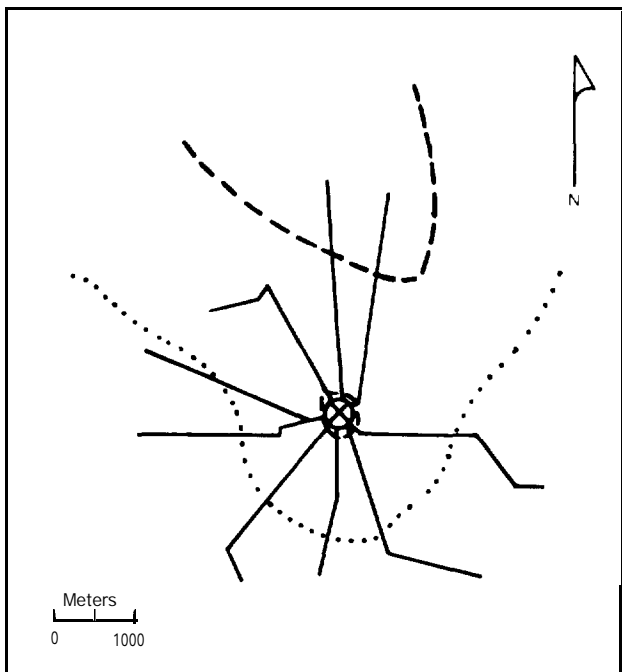
Figure 2-1: INITIAL SURVEY FOR SHOT WHEELER,
6 SEPTEMBER 1957, MID-TIME 0662



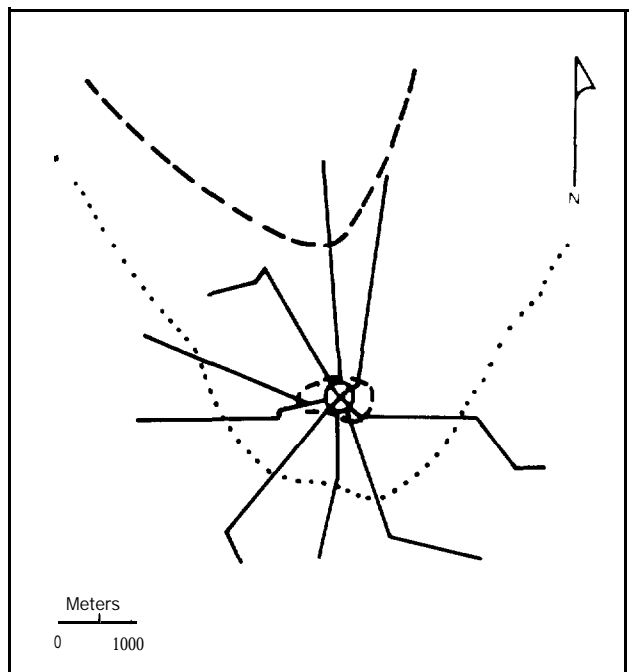
6 September 1957, Mid-Time: 1206



7 September 1957, Mid-Time: 0745



8 September 1957, Mid-Time: 0804



9 September 1957, Mid-Time: 0845



Figure 2-2: SUBSEQUENT SURVEYS FOR SHOT WHEELER

developed from 6 to 9 September. Most of the radiation field, except for within about one kilometer of ground zero, was residual from Shot SMOKY, fired on 31 August (60).

Information from the ground surveys allowed the Plotting and Briefing Branch to establish Full and Limited Radiological Exclusion Areas, described in the Operation PLUMBBOB volume. The Plotting and Briefing Branch also issued the access permits required for entry into these areas. During the period of 5 and 6 September, access permits were issued to 443 individuals involved in 26 projects (60).

Decontamination Activities

During the period covering Shot WHEELER, personnel of the Decontamination Branch decontaminated 58 vehicles (60). In addition, personnel decontaminated the area within a 90-meter radius of the WHEELER balloon site in Area 9, contaminated by radioactive fallout from Shot SMOKY. Decontamination operations began on 3 September 1957, as participants scraped the surface soil with a bulldozer, removed contaminated soil from the area by trucks, and backfilled the area with uncontaminated soil. Radiation readings were taken after each phase of activity to determine its effectiveness (60).

SHOT LAPLACE SYNOPSIS

AEC TEST SERIES: PLUMBBOB
DOD EXERCISE: Desert Rock VII and VIII
DATE/TIME: 8 September 1957, 0600 hours
YIELD: 1 kiloton
HEIGHT OF BURST: 750 feet (balloon shot)

Objectives: (1) To evaluate newly designed devices for possible inclusion in the nuclear arsenal
(2) To evaluate the nuclear yield and the blast, thermal, and radiation phenomena produced by these nuclear devices
(3) To evaluate the effects of nuclear radiation for civil defense purposes.

Weather: At shot-time, the temperature was 19°C, and surface winds were calm. Winds were ten knots from the west-northwest at 10,000 feet and four knots from the east-southeast at 20,000 feet.

Radiation Data: The initial survey, mid-time of 0712 hours, determined that radiation intensities greater than 0.1 R/h were confined to within 950 meters of ground zero.

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

CHAPTER 3

SHOT LAPLACE

Shot **LAPLACE** was conducted with a yield of one kiloton at 0600 hours Pacific Daylight Time on 8 September 1957. The device was suspended from a balloon and fired 750 feet above the ground in Area 7 of the Nevada Test Site. The top of the cloud resulting from the detonation reached a height of 20,000 feet (29).

3.1 EXERCISE DESERT ROCK VII AND VIII OPERATIONS AT SHOT **LAPLACE**

Two technical service projects were conducted at Shot **LAPLACE**: 50.3, Evaluation of Medium Range Detonation-detection and Cloud Tracking Systems, and 50.8, Detection of Atomic Hurst and Radioactive Fallout. These projects involved an estimated 128 Desert Rock participants. In addition, seven Desert Rock support troops witnessed the detonation from a location near News Nob, 16 kilometers south of ground zero. The seven observers probably returned to Camp Desert Rock following the detonation without going into the forward testing area (33).

Project 50.3, Evaluation of Medium Range Detonation-detection and Cloud Tracking Systems, was fielded by a detachment from the Army Signal Research and Development Laboratories, Fort Monmouth, New Jersey; personnel from Fort Meade, Maryland; and personnel from Fort Huachuca, Arizona. The project had two purposes: to test the capacity of Army radar equipment in detecting the nuclear detonation and tracking the radioactive cloud, and to examine Army fallout prediction methods. The activities involved an estimated 23 DOD participants, who were divided into a radar section and two fallout prediction teams. The radar section detected and tracked the nuclear cloud,

recorded fireball growth, and determined the rate of rise of the cloud, the height of burst, and the yield. In addition, the radar section collected data to determine the use of radar equipment in cloud detection. Four radar sets were used: one was about 180 kilometers southeast of ground zero, one was approximately 90 kilometers south of ground zero at Angel's Peak, and two were about 12 kilometers west of ground zero, at UTM coordinates 766106. The 865th Aircraft Control and Warning Squadron operated the Angel's Peak radar unit. All sets were manned at the time of the detonation (19; 32; 52).

One of the fallout prediction teams used upper wind data to test a Signal Research and Development Laboratory technique for predicting fallout patterns. The team included personnel from the Meteorological Division, Army Signal Research and Development Laboratories. This team operated out of an M-109 mobile van, which contained the teletype and recording equipment necessary for obtaining meteorological data for plotting fallout. The mobile van, manned at the time of the detonation, was next to the weather station at Camp Mercury. A second fallout prediction team, with personnel from the Army Electronic Proving Ground, Fort Huachuca, operated near Alamo, Nevada, 92 kilometers northeast of the Control Point (19; 39; 52).

During the shot, a DOD civilian, while obtaining meteorological data about 18 kilometers from ground zero, may have developed mild conjunctivitis from the flash. He was examined by the Deputy Surgeon of Field Command, who found no evidence of retinal injury.

Project 50.8, Detection of Atomic Burst and Radioactive Fallout, was conducted by the Army Air Defense Board, supported by the 495th Antiaircraft Missile Battalion. The project, which involved an estimated 105 DOD personnel, was designed to

determine how well equipment found in a typical Army unit could (32; 39; 57-60):

- Determine the location, height of burst, and yield of a nuclear detonation
- Track targets and guided missiles through a radioactive cloud or fireball.

Personnel operated radar sets about 70, 19, and 17 kilometers from the NTS. In addition, participants manned a project control point southeast of ground zero, at LJTM coordinates 832962 (11; 57-59).

3.2 DEPARTMENT OF DEFENSE PARTICIPATION IN TEST GROUP, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT LAPLACE

In addition to participating in Exercise Desert Rock activities, Department of Defense personnel took part in other test activities during Shot LAPLACE that required them to enter the forward area. Table 3-1, given on the next page, identifies the test group projects involving DOD participants. The Air Force also sponsored one operational training project at the shot. In addition to the test group projects and the operational training project, AFSWC and other support activities accounted for a number of other DOD participants. The Air Force Special Weapons Center supported LASL Project 11.2 and flew four routine air missions for the Test Manager.

3.2.1 AFSWP Field Command Weapons Effects Test Group Projects

The Weapons Effects Test Group conducted three projects during Shot LAPLACE.

Project 2.0, Neutron and Gamma Radiation from Shot LAPLACE, was fielded by personnel from the Naval Radiological Defense Laboratory, the Army Chemical Warfare Laboratories, and other

PLUMBBOB participants outside of the Weapons Effects Test Group. The personnel fielding this project included the same individuals participating in Projects 2.2, 2.3, and 2.10 at other shots, plus other members of the Program 2 staff (11; 21). The primary objective of this project was to obtain information correlating neutron-flux with radioactivity induced in surface soils. Shot LAPLACE was chosen for this activity because it was to be an event of reasonably predictable neutron flux (11; 21).

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

Project	Title	Participants	Estimated DOD Personnel
Weapons Effects Test Group			
2 0	Neutron and Gamma Radiation from Shot LAPLACE	Naval Radiological Defense Laboratory; Army Chemical Warfare Laboratories	6
6 4	Accuracy and Reliability of the Short-baseline NAROL System	Air Force Cambridge Research Center	*
9 1	Support Photography	AFSWP; EC and G	8
Los Alamos Scientific Laboratory Test Group			
11 2	Radiochemistry Sampling	Los Alamos Scientific Laboratory, 4926th Test Squadron (Sampling), Air Force Special Weapons Center	7
Civil Effects Test Group			
39 1	Radiation Measurements Utilizing the Air Force Chemical Dosimeters	Air Force School of Aviation Medicine	24

* Unknown

Personnel placed neutron detectors, film badges, survey meters, and dosimeters in a line extending 90 to 2,740 meters from ground zero. They attached the neutron detectors to a cable at 90-meter intervals from about 90 to 1,000 meters from ground zero. One hour after the detonation, three Project 2.10

personnel recovered the neutron detectors by towing the cable on which the detectors were attached out of the radiation field. Three Project 2.3 participants entered the shot area two, three, four, seven, eight, 14, and 15 hours after the detonation to monitor instruments 730 meters northwest of ground zero (11; 21; 45).

Another part of the **study** involved using chemical dosimeters to measure gamma radiation from the detonation. This experiment, discussed in section 3.2.3, was performed by personnel from the Civil Effects Test Group in conjunction with Project 39.1, Radiation Measurements Utilizing the Air Force Chemical Dosimeters.

Project 6.4, Accuracy and Reliability of the Short-baseline NAROL System, used the Long Range Aids to Navigation (LORAN) system in an inverse fashion to detect the electromagnetic pulse from the nuclear burst in order to determine the position and measure the yield of that burst. The Indirect Bomb Damage Assessment NAROL system had nets in Albuquerque, New Mexico; Vale, Oregon; and Rapid City, South Dakota. Each NAROL net consisted of two unmanned slave stations and one manned station (34).

Project 9.1, Support Photography, was sponsored by AFSWP to provide the following support services:

- Technical photographic support of the military effects program
- Documentation of the overall military effects program and production of an effects motion picture
- Documentation of the detonation for release through the Joint Office of Test Information and for historical purposes
- General photographic support to Department of Defense projects.

Eight personnel established and then manned a photography station at UTM coordinates 852975 from five hours before to 30 minutes

after the detonation (11). In addition, EG and G personnel provided technical photographic support to AFSWP and the AEC, operating camera stations to record fireball and cloud growth. After the detonation, EG and G participants entered the shot area to recover the film (11; 24).

3.2.2 Department of Defense Participation in Los Alamos Scientific Laboratory Test Group Projects

Of the ten projects conducted **by** the LASL Test Group at **LAPLACE**, only Project 11.2, Radiochemistry Sampling, had DOD personnel participation. The project involved cloud-sampling missions, discussed in section 3.2.5.

3.2.3 Department of Defense Participation in Civil Effects Test Group Projects

The CETG conducted six projects at **LAPLACE**. Among these six, only Project 39.1, Radiation Measurements Utilizing the Air Force Chemical Dosimeters, involved DOD personnel. The objective of this project was to use film dosimetry techniques, particularly chemical dosimeters, to measure initial gamma radiation from a nuclear detonation. An estimated 24 military personnel from the Air Force School of Aviation Medicine, Randolph AFB, Texas, performed **pre-** and **postshot** exposure analyses (55). DOD personnel of Projects 2.3 and 2.10 placed dosimeters on the project's recovery cable in the forward area and helped retrieve the instruments after the detonation. Three Project 39.1 personnel recovered chemical dosimeters one hour after the shot from stations 270 to 1,830 meters from ground zero (11; 45; 55).

3.2.4 Department of Defense Operational Training Project

The one operational training project conducted by the Air Force at Shot **LAPLACE** was Project 53.5, Aircrew Indoctrination

(Early Cloud Penetration). Sponsored by the Air Defense Command, the project was to enable Air Defense Command aircrews to witness a nuclear detonation and to penetrate its cloud. One T-33 aircraft, with a crew of two, flew a left-hand pattern at 25,000 feet heading inbound so as to be approximately ten nautical miles north of ground zero at the time of the detonation (3; 27). The aircraft penetrated the cloud after given clearance by the sampler control aircraft, discussed in section 3.2.5.

In addition, two F-84 aircraft from Project 53.9, Photographic Reconnaissance Training, were scheduled to participate at LAPLACE. The aircraft, which were from the Tennessee National Guard, did not, however, take part as scheduled (3; 27).

3.2.5 Air Force Special Weapons Center Activities

AFSWC support at Shot LAPLACE consisted of cloud-sampling and sample courier missions in support of the LASL test group project, cloud-tracking missions, security sweeps, and aerial surveys (3).

Cloud Sampling

Five F-84 aircraft, with one pilot each, collected samples of the nuclear cloud for LASL Project 11.2, Radiochemistry Sampling. A B-57 sampler control aircraft, manned by a pilot and a LASL scientific advisor, also participated. Pilots of the 4926th Test Squadron (Sampling) flew all six aircraft (1; 3; 61).

The sampler control aircraft, which guided the other five sampler aircraft through their missions, left Indian Springs AFB at 0510 hours, 50 minutes before the detonation. The aircraft reached an altitude of 35,000 feet and began an orbit pattern at 0525 hours. After the detonation, the control aircraft left its orbit to view the cloud (3).

The five sampler aircraft proceeded as follows. At 0615, the first F-84 sampler aircraft entered the area of the cloud at 35,000 feet and established visual contact with the B-57 sampler control aircraft. The scientific advisor in the B-57 then directed the sampler to penetrate the cloud at the altitude necessary to acquire the samples. The F-84 left the area at 0650 hours and landed at Indian Springs AFB at 0655 hours. The next two F-84 samplers followed the first sampler aircraft and entered the area of the cloud at altitudes of 35,000 feet at 0630 hours and 0645 hours. The last two aircraft entered the area at 0700 hours. All four aircraft followed the same procedures as did the first F-84, and remained in the area of the cloud for about 35 minutes. The last two F-84 samplers landed at Indian Springs AFB at 0740 hours. The control aircraft ended its pattern at 0730 hours, after the sampler aircraft had completed their missions, and landed at Indian Springs AFB at 0741 hours (1; 3; 61).

Upon landing, each sampler aircraft taxied to the strip farthest from base operations. There, ground personnel used long-handled poles to remove the samples and place them in metal containers to be sent by courier aircraft to LASL. With the mission complete, the aircraft and pilots were decontaminated as described in the Operation PLUMBBOB volume (1; 3; 61).

Courier Missions

The 4900th Air Base Group from Kirtland AFB flew the courier sample return missions. Three C-47 aircraft flew samples out of Indian Springs AFB to LASL for analysis (1; 3; 61).

Cloud Tracking

At 0535 hours, one B-25 (serial number 118) left Indian Springs AFB and orbited at 15,000 feet over Mormon Mesa, 150 kilometers east of the NTS. The purpose of the mission was to determine the direction the cloud traveled and to keep the

