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Fact Sheet for the Chairman, Committee on Governmental Affairs, U.S. Senate

November 1993

NUCLEAR HEALTH AND SAFETY

Examples of Post World War II Radiation Releases at U.S. Nuclear Sites

GAO/RCED-94-51FS

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-253483

November 24, 1993

The Honorable John Glenn
Chairman, Committee on
Governmental Affairs
United States Senate

Dear Mr. Chairman:

In response to your request, this fact sheet provides information on several planned radioactive releases that were conducted at U.S. nuclear sites in the post World War II years, including a release at Hanford, Washington, in December 1949. The Hanford event, referred to as the Green Run test, has been the subject of public attention in the Pacific Northwest since the late 1980s. Public concern has been heightened by the longtime secrecy surrounding the event and the fact that some test details still remain classified. As agreed with your office, we are presenting information on (1) the Green Run test and (2) several other tests at U.S. sites in the late 1940s and early 1950s that involved radioactive releases.[1]

In summary, the Green Run test was an atmospheric radioactivity-monitoring experiment conducted by the military and the former Atomic Energy Commission (AEC). A premise of the test was that aerial monitoring and sampling of a radioactive cloud, even far from the source, could give evidence of nuclear materials. Conducted on December 2-3, 1949, the test released a recorded total of almost 28,000 curies of radioactive material from a special spent fuel reprocessing operation into the atmosphere over southeast Washington and Oregon.[2] (See fig. 1.1.)

For the test, some of the plant's usual radiation safety procedures were intentionally relaxed, resulting in a larger than normal radioactive release. Test participants did not consider the test to be unsafe at the time, and the radiation doses that the off-site populace might have received as a result of the test were not estimated at the time (based on the historical test documentation available to us). However, according to the AEC, in some locations, the release exceeded then-existing local Hanford limits for deposition in vegetation and animal tissue, and it may not have been permissible under today's more stringent safety standards for U.S. nuclear sites. Presently, to better understand the health effects of the test and

[1]An identically titled classified version of this fact sheet (C-GAO/RCED-93-1FS) was issued to you on June 30, 1993.

[2]A curie is a basic unit of radioactivity that is equal to 3.7×10^{10} radioactive disintegrations per second.

other Hanford iodine releases during the middle to late 1940s, a study of historical Hanford doses is under way, directed by the Centers for Disease Control.

In addition, we documented 12 other planned radioactive releases that occurred at three U.S. nuclear sites during 1948-52. These releases, or tests, were part of the U.S. nuclear weapons research and development effort, and they were conducted by the military and the AEC. The releases were of two types, radiation warfare tests[3] and atmospheric radiation-tracking tests. The radiation warfare tests were conducted at the AEC's Oak Ridge, Tennessee, site and the military's Dugway, Utah, site in order to develop an air-dropped radioactive munition. The atmospheric radiation-tracking tests were conducted at the AEC's Los Alamos, New Mexico, site in order to analyze the diffusion of radioactive gases and fallout effects. Two of the Los Alamos tests—conducted in 1950, involving unspecified kilocurie amounts—resulted in the detection of atmospheric radiation off-site over populated areas. We found no documentation of potential health effects from these tests.

To develop this fact sheet, we used diverse sources of information because of the lack of complete, definitive government records on radiation releases at nuclear sites. As a result, our results are based on—and limited to—available information drawn from government and private archives, agencies' files, and interviews with knowledgeable individuals. Other releases not documented in this fact sheet may have occurred at U.S. nuclear sites in the post World War II years.

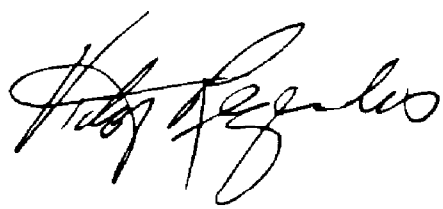
We discussed information in this fact sheet with officials of the Department of Energy's Divisions of History and Air, Water, and Radiation, who generally agreed with the facts as presented. On the basis of their suggestions, minor technical changes were made where appropriate. However, as requested, we did not obtain written agency comments on this fact sheet.

As arranged with your office, unless you publicly release its contents earlier, we plan no further distribution of this fact sheet until 30 days after the date of this letter. At that time, we will send copies of this fact sheet to the Secretaries of Defense and Energy. We will make copies available to others on request.

[3]The term radiation warfare has different meanings, but in this fact sheet it refers to the use of non-bomb radioactive agents for offensive military purposes.

Please call me at (202) 512-3841 if you or your staff have any questions. Major contributors to this fact sheet are listed in appendix II.

Sincerely yours,



Victor S. Rezendes
Director, Energy and Science Issues

Contents

Abbreviations

AEC	Atomic Energy Commission
DOE	Department of Energy

The Green Run Test and Its Safety and Health Implications

Details of the Green Run test and its historical context indicate that it was an atomic energy intelligence collection experiment. The test occurred during a period of heightened interest in Soviet nuclear capabilities, shortly after the first Soviet nuclear bomb detonation. The test was not considered unsafe at the time, when radiation protection standards were generally less stringent than they are today. However, at some locations, the release exceeded then-existing local Hanford, Washington, tolerances for deposition in vegetation and animal tissue, and it may not have been permissible under today's nuclear safety standards. Presently, potential health effects from the test and other iodine releases at Hanford during the 1940s are being addressed in an ongoing dose reconstruction study.

A classified report on the test was issued in May 1950 by the former Atomic Energy Commission (AEC), but the report remained classified in its entirety—and the test remained undisclosed—for almost four decades. Details of the test and concerns about its potential health and safety effects first surfaced in the latter part of the 1980s. When references to the test appeared in other AEC documents that were declassified over the years, several Green Run-related Freedom of Information Act requests and appeals were filed. As a result, the test report was largely declassified in 1989. (Several passages in the report remain classified by determination of the Air Force, on the basis that further declassification of the report could compromise Air Force missions and thereby damage the national security.)

Test Purpose and Historical Context

The Green Run test was a special test of detectability as well as a research experiment into the atmospheric diffusion of radioactive gases. As such, it was related to postwar classified AEC/military research into the nature and effects of radioactive fallout and bomb debris.

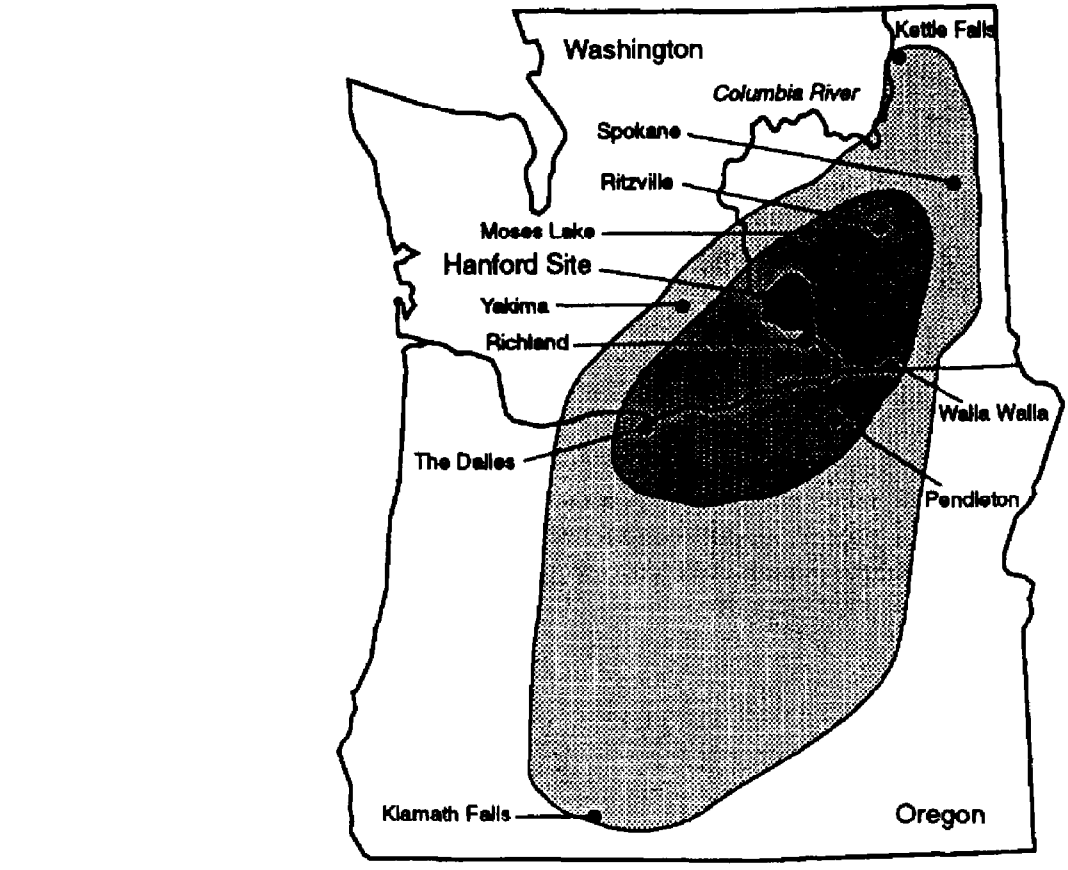
Test Purpose

The Green Run test was conducted at Hanford, Washington, on December 2-3, 1949, by the AEC and the Air Force. The test took place in a postwar climate of U.S. concern about Soviet nuclear capabilities following the first detected explosion of a Soviet nuclear weapon in August 1949. According to a test participant, a premise of the test was that aerial monitoring and sampling of a radioactive cloud, even long distances from the source, could give evidence of nuclear materials. The diffusion of the released gases was to be monitored in order to develop air, ground, and aquatic methods of collecting data on nuclear operations and weapons

tests. The radioactive cloud was generated by a special spent fuel reprocessing operation.

For the test, the plant's radiation emission control procedures were intentionally relaxed. The spent fuel used in the test was aged about 16 days instead of the usual longer period of up to 90 or more days, which accounts for the term "green" run (i.e., the test involved the reprocessing of "green" fuel). In addition, the plant's off-gas water scrubbers—used to minimize the release of radioactive off-gases from the stack—were not operated. According to the test report issued in May 1950, as a result of these steps, the test released about 27,800 curies of radioactive production off-gases, including about 7,800 curies of iodine and about 20,000 curies of less hazardous xenon, into the atmosphere in southeast Washington and Oregon. The total recorded iodine release was about twice the almost 4,000 curies predicted in pretest calculations. During the test, despite unexpected adverse weather patterns that developed and limited the range of diffusion, the radioactive cloud was detected by an aircraft over 100 miles northeast of the site. After the test, radioactive iodine was found on vegetation over large areas of southeast Washington and Oregon, as shown in figure 1.1.

Figure 1.1: Areas Where Radioactive Iodine Was Found on Vegetation Following the Green Run Test



Source: Hanford Environmental Dose Reconstruction Project Fact Sheet, Mar. 1992.

Historical Context

As a research experiment into atmospheric diffusion, the test was related to postwar classified AEC/military research into the nature and effects of radioactive fallout and bomb debris. Such research began as early as the Operation Crossroads test series in the Pacific Ocean in 1946—during which, fallout was monitored aerially by the Air Force and on the surface by naval vessels—and continued throughout succeeding

atmospheric-testing series. Effective instrumentation was an important aspect of research into radioactive effects, and at the time of the Green Run event the AEC and the military services were conducting several field instrument development programs to support their nuclear weapons research efforts. According to a test participant, the test was also generally related to research into the safety and health effects of nuclear detonations and nuclear production operations.

The Green Run test was preceded by other aerial radiation-monitoring tests that involved routine production releases of radioactive materials. The test was a follow-up to a series of aerial-monitoring tests conducted by the Air Force and the AEC during November 1948 to March 1949 at Oak Ridge, Tennessee, and at Hanford. For these tests, no special releases were conducted. The tests involved monitoring off-gases from routine production operations. At Oak Ridge, during 20 overflights by a C-47 aircraft between November 1948 and February 1949, reactor and separations off-gases were tracked up to 17 miles downwind. At Hanford in March, during three similar overflights, routine separations off-gases (with stack scrubbers in operation) were detectable for less than 2 miles—results considered so disappointing that further Hanford overflights were discontinued. In a report on the test series, the authors concluded that further use of similar Hanford operations as a source for aerial tracking was not practicable. Logically, the Green Run test—with Hanford scrubbers not operating—provided the needed stronger source.[1]

In addition, according to a former AEC official, monitoring overflights for the purpose of cloud tracking were conducted wherever sources of atmospheric radiation could be found in the United States, and probably at most or all AEC nuclear production sites. Routine close-in monitoring overflights at AEC sites began in the early 1950s and developed into a regular monitoring program having, among other things, environmental, safety, and security and safeguards purposes. Also, aerial radiation monitoring by Air Force aircraft was practiced in conjunction with the many nuclear bomb tests conducted at the Nevada Test Site and in the Pacific Ocean during the late 1940s and throughout the 1950s. For example, according to one source, during Operation Sandstone in the Pacific in April-May 1948, a fallout-tracking test called Operation

[1]Also in 1949, at an undetermined time before July 28, aerial monitoring tests of routine production effluents were conducted at the Harshaw Uranium Refining Plant in Cleveland, Ohio. Overflights detected particles, likely uranyl fluoride, 1,150 yards downwind from the source in concentrations of 0.71 micrograms per cubic meter. Also in 1949, on an undetermined date, aerial effluent monitoring of the Mallinckrodt Uranium Refining Plant in St. Louis, Missouri, detected uranium concentrations of 0.4 micrograms per cubic meter in the atmosphere 3,000 feet downwind from the plant.

Fitzwilliam monitored radioactive fallout gases for several thousand miles at levels many times above background levels.

Safety and Health Implications

Some routine Hanford radiation safety procedures were intentionally relaxed for test purposes. Specifically, in order to calibrate means of detecting Soviet production from Hanford plant operations, the cooling period for Hanford spent fuel was shortened from 90 or more days to only 16 days to simulate presumably less efficient or careful Soviet operations, and separations off-gas scrubbers were not operated. Furthermore, while the release was conducted on a weekend, which may have limited the number of workers on-site, the off-site populace was not forewarned of the event or made aware of it for several decades.

The test was also conducted despite less-than-optimal weather conditions, which limited the test results and may have exposed greater-than-expected numbers of the population to the radioactive cloud. Prevailing wind patterns prior to the test had been inopportune, and wind shifts during the test caused the emission of gases close to the ground, including directional shifts over populated areas in southeast Washington and greater-than-expected deposition at the Hanford site. Because of shifting winds, long-distance tracking of the cloud for several hundred miles was not possible. Two AEC contractor officials responsible for conducting the test differ in their recall of who decided that the weather for the test was acceptable. According to one, AEC contractor officials judged the weather to be acceptable. According to the other, the AEC did not wish to proceed, but the Air Force made the decision to conduct the test.[2] The recorded total release of iodine 131—about 7,800 curies—was about 2 times the predicted quantity. However, the accuracy of the recorded amounts has been questioned, and they have been recalculated.[3]

According to officials conducting the test, the amount of the release was not considered unsafe at the time. While the release was extremely concentrated, since it occurred over a 12-hour period, regulatory limits on the amount of such emissions did not exist at the time. In fact, the release was a small fraction of the total releases that occurred during wartime and immediate postwar Hanford operations, before radioactive iodine removal

[2]The AEC's Hanford contractor, General Electric Company, had a Health Instruments Division with the day-to-day authority to decide when reactor fuel could be processed.

[3]In June 1992, in the journal Health Physics, Maurice Robkin, a participant in the Hanford Dose Reconstruction Project, estimated the amount of iodine released to be about 11,000 curies, well over twice the predicted quantity. He calculated the release of xenon to be about 16,000 curies, for a total of about 27,000 curies.

systems were installed. For example, during 1945, production releases estimated at over 45,000 curies of iodine per month occurred at Hanford. By one estimate, the Green Run test accounted for about 1.1 percent of the total radioactive iodine released during 1944-49.

Test participants said the release was considered to be well within the standards of the time for human exposure to radiation.[4] In some locations, the release reportedly exceeded then-existing local Hanford limits for radioactive deposition in animal tissue and vegetation. According to the test report, the release resulted in iodine deposition in animal thyroids up to 80 times above the limit of 4 microcuries per kilogram of tissue. The then-existing local Hanford tolerance for continuous deposition on vegetation—9 microcuries per kilogram—was temporarily exceeded in the areas of Yakima, The Dalles, Spokane, and Blue Mountains. Based on post-test documentation available to us, radiation doses that the off-site population might have received as a result of the test were not estimated at the time.

In regard to today's more stringent radiation standards, which are not directly comparable to those of the 1940s, it has not been determined whether the test exceeded present limits for off-site radiation doses and emissions.[5] The effects of the Green Run release and other postwar Hanford radioactive iodine releases that may have had effects on the off-site population are being addressed in an ongoing dose reconstruction study, directed by the Centers for Disease Control, focusing on Hanford operations and releases from the site's beginning in 1944.[6] In regard to deposition standards that exist today, post-test deposition on vegetation in Richland, Walla Walla, and Pendleton reached levels above the threshold of 50 picocuries per gram listed in recent Environmental Protection Agency guidance for the interdiction of foodstuffs, applicable to accidents

[4]At about the time of the test, the National Committee on Radiation Protection—whose recommendations the AEC followed—recommended (but did not immediately publish) a public external dose limit corresponding to about 1.5 rem (roentgen equivalent man) annually, or 10 percent of its recommended worker limit of about 15 rem annually. We were unable to document a then-existing specific limit for internal radioactive iodine doses. Rem is a measure of the dose of any ionizing radiation to body tissues in terms of its estimated biological effect relative to a dose of 1 roentgen of X-rays.

[5]Per 40 C.F.R. 61.92, applicable to the Department of Energy under departmental order 5400.5, air pathway radiation doses to the off-site populace are limited to 0.01 rem annually.

[6]Preliminary dose estimates from the study indicate that, during 1945-47, when routine Hanford iodine releases were conducted that totaled up to several dozen times more than the Green Run release, doses exceeding present limits may have been received by downwind infants through the air-pasture-cow-milk-thyroid pathway. According to DOE, at the time, scientists had not identified this as a pathway for significant doses of radioactive iodine to individuals.

or other mishaps at both /civilian and Department of Energy (DOE) nuclear plants.[7]

Furthermore, if proposed today, the test (including procedures that intentionally increased the amount of the release) might not be permissible under the principle of limiting radiation effects from nuclear production operations to levels "as low as reasonably achievable" (10 C.F.R. 20.1, and DOE Order 5400.5). This principle was not operative in 1949, at the time of the Green Run test. In addition, if proposed today, such a test would appear to be imprudent from the point of view of operational safety procedures. DOE has categorized the test as one of the 14 most significant safety-related incidents in Hanford's history.

Our work did not document that the test was intended to be a radiation warfare experiment or a field test of radiobiological effects on humans. In particular, we examined still-classified passages in the Green Run test report and found that they did not refer to any such intentions or operations.

[7]EPA Manual For Protective Actions for Nuclear Incidents, No. 520/1-75-001-A, Jan. 1990.

Details of Other Releases

In addition to the Green Run test, we documented 12 other planned radioactive releases that occurred during post World War II nuclear weapons-related tests conducted at three U.S. sites: Oak Ridge, Tennessee, Los Alamos, New Mexico, and Dugway, Utah. Eight of the releases were conducted as part of the U.S. radiation warfare program. Four others were related to atmospheric radiation-tracking research. Like the Green Run test, none of these releases were accidental, and none resulted from routine production operations at nuclear sites.[1]

Releases During the Radiation Warfare Program, 1948-52

We documented eight planned radiation releases conducted during the postwar U.S. radiation warfare program. Two of these releases occurred at the AEC's Oak Ridge site, and six others at the U.S. Army's Dugway, Utah, test site. The releases were conducted as part of a research program conducted by a joint AEC-military panel on radiation warfare. Specific program participants (and roles) included the AEC (study and production of radioactive sources, study of biomedical effects), top military leadership (dissemination methods and protection measures), the Armed Forces Special Weapons Project (coordination and evaluation of the program), the Air Force (aerial delivery of device), and the Army (design, selection, testing of tactical device). Field testing of a radiation warfare device continued through at least 1952, as discussed below. The program appears to have ended in 1954 because it was not considered a high military priority.

Early on, the limitations of the concept of an offensive radiation warfare device were seen. For example, problems were seen related to preparing sufficient quantities of a suitable radioisotope for use in an offensive device. In some respects, chemical and biological weapons were perceived to be potentially as effective as a radioactive device, and logistically more convenient. During the program, the idea of using an air-dropped, cluster-type radiation warfare munition for tactical area exclusion (up to 25 square miles) was pursued, with the Army being the principal proponent.

Concurrently in the early 1950s, another logistically simpler kind of radiation warfare was foreseen. There was growing knowledge of fallout effects from so-called "dirty" atomic bombs, which advanced their potential for area exclusion and further limited the perceived need for a

[1]These events were classified at the time of their occurrence over four decades ago. We were unable to document some event details, including in some cases the radionuclide involved and the extent of atmospheric diffusion during the release.

non-bomb radiation warfare device.[2] Such "dirty" fallout effects were first witnessed at an underwater detonation during Operation Crossroads in 1946, and they were further studied through surface and cratering tests at the Nevada Test Site. For example, November 1951 ground-level detonations in the Buster-Jangle test series were conducted in Nevada to determine the military effects of atomic blasts. The enormous potential of "dirty" fallout came to be recognized after the Bravo detonation in the Operation Castle test series in the Pacific in 1954.

Oak Ridge Releases

In 1948, as directed by a newly formed AEC-military joint panel on radiation warfare, two radiation warfare field experiments were conducted by the AEC's Oak Ridge office. Both tests involved gamma radiation released from non-bomb point sources at or near ground level. The first test, on or before July 23, 1948, concerned the effectiveness of scattered radiation from a single gamma-emitting source—metallic lanthanum. Oak Ridge was assigned to prepare the single source (1,000 curies in strength) and place it near the ground in a 700-yard-long field. Radiation readings were to be taken at several distances up to 1,000 feet from the source, and at 3-, 6-, and 12-foot altitudes. (We were unable to document specific test results.)

The second test was conducted on an undetermined date in July 1948 following the first test. The second test concerned the effectiveness of gamma-emitting sources distributed uniformly over an area. One thousand separate small sources were to be prepared, consisting of metallic tantalum rods or wires in suitable containers, each of a uniform strength of 300 curies (a total of 300 kilocuries for the test). The overall grid pattern area was to be 300 yards on a side or greater and was to be varied for different measurements. (We were unable to document specific test results.)

Dugway Releases

During 1949-52, the military conducted six tests of radiation warfare ballistic dispersal devices containing radioactive agents at the U.S. Army's Dugway, Utah, site. The principal agencies involved in the tests were the Army Chemical Corps, the AEC, and the Air Force. The tests were conducted concurrently with four series of non-radioactive drop tests over Great Salt Lake to test the dispersion of various types of spheres to be used in a cluster munition. The spheres for the drop tests carried

[2]According to a former Hanford official, "dirty" atomic bombs were exploded at or near the surface to propel large amounts of dust particles into the atmosphere.

fluorescein dyes whose patterns in the water were photographed and analyzed.

The first and second live tests were conducted on October 22 and November 30, 1949, and their specific purpose was to obtain information about the uniformity of ballistic dispersal from an air-dropped device over an approximately 1-square-mile area. For both tests, 300 curies of tantalum 182 particles were prepared by the AEC's Oak Ridge office. For the first test, the particles were charged to a strength of 260 curies, and for the second test, to 1,506 curies. The particles were loaded into a 2,000-pound cluster device for each test. The devices were dropped by the Air Force from an altitude of about 15,000 feet, bursting at about 1,300 feet, resulting in dispersal areas about 50 percent greater than anticipated. For the first test, a 0.6-square-mile area was covered, with annular (circular) effects noted. The mean radius of contamination was 500 yards, with the main area of contamination being within a circle 200 yards in diameter. For the second test, contamination covered a 0.8-square-mile area, with a less pronounced annular effect because some of the tantalum particles were smaller than those used in the first test.

Four additional test events were conducted during 1950-52, for which detailed documentation is unavailable:[3]

- During September 1950, two tests of a 2,000-pound ballistic dispersal device were conducted.
- In November 1951, an undetermined number of drop tests from various altitudes were conducted using spheres filled with a radioactive agent with various physical characteristics.
- In May 1952, a further series of drop tests was conducted.

[3]We were unable to document other details of these tests, including the specific radioactive agent used. However, by 1952, the radiation warfare program had turned from tantalum and protactinium to zirconium-niobium as the radioactive agent under primary consideration. In addition, the program in 1952 projected a single-aircraft delivery capability of up to 15 megacuries, dispersed over 3 to 4 square miles, or 10 square miles using four aircraft.

The 1951 and 1952 tests resulted in primary radioactive patterns 250 yards in diameter, with contamination well beyond this distance. The series were conducted during periods of calm winds.[4]

In conjunction with radiation warfare tests at Dugway, monitoring instruments easily detected a ground tantalum source of a few thousand curies at an altitude of 6,000 feet. We found no documentation of whether the Dugway releases were detected off-site.

Releases During Atmospheric Radiation- Tracking Tests at Los Alamos, 1950

We documented a total of four atmospheric tracking tests conducted in 1950 at Los Alamos. In March and April of that year, the Air Force Laboratory, Cambridge, Massachusetts, and Los Alamos Laboratory exploded three simulated nuclear devices at the Los Alamos site, resulting in atmospheric fallout. The purposes of the detonations were to (1) study implosion dynamics and track a radioactively gaseous cloud as long as possible, (2) study the rate at which the ionization produced by the radioactive matter decreased and diffused, and (3) analyze the fallout of radioactive material from the cloud. The tests were conducted on March 24 and 29, and April 6, involving small simulated bombs containing unstated types and amounts of nuclear materials, presumably radioactive lanthanum 140 in kilocurie amounts. Resulting radioactive clouds were tracked downwind by a B-17 aircraft carrying an experimental ionization-measuring apparatus. On July 19, another radiation detection test was conducted near Los Alamos using an unidentified 400-curie radioactive source. The source was detected overhead and a few miles distant.

Fallout from the March 24 and April 6 tests went off-site over sparsely populated areas. The cloud from the March 24 test was tracked as far as the small town of Watrous, New Mexico, about 70 miles east of Los Alamos. The cloud from the March 29 test was tracked westward for an unstated distance. Information was not available concerning whether it went off-site. The cloud from the April 6 test was tracked northward for

[4]We also documented plans for two further tests (though we could not document that the events occurred) as follows: Mass drops of spheres containing a radioactive agent were planned for October-November 1952. Two clusters of 263 spheres each (each sphere containing 0.8 pounds of tantalum oxide pellets at a strength of 15 curies per pound, for a total of about 6,300 curies in the clusters) were to be prepared at Oak Ridge for air drops together from 30,000 feet. Another mass drop was planned for 1953, upon completion of an integrated munition system with ground-handling equipment at Dugway. For the test, six clusters of 263 spheres each were to be dropped, with planned centers of impact of the sphere groups to be 500 to 750 yards apart. Each sphere was to contain 0.8 pounds of tantalum oxide, at a strength of 75 curies per pound (about 95,000 total curies).

about 10 miles. Information was not available concerning whether the radiation from the July 19 test was detected off-site. We found no documentation of potential health effects from the four tests.

Objectives, Scope, and Methodology

As requested by the Chairman, Senate Committee on Governmental Affairs, we developed information on (1) the Green Run test, including test details and potential health effects, and on (2) several other tests at U.S. nuclear sites in the late 1940s and early 1950s that involved radioactive releases. We focused on releases related to special tests conducted at nuclear sites rather than on accidental releases or routine, continuous releases related to sites' ongoing nuclear production operations. In addition, our scope did not include nuclear bomb detonations—hundreds of which were conducted in Nevada and in the Pacific Ocean during the 1950s and 1960s.

Our scope and methodology included interviewing knowledgeable sources and examining pertinent unclassified and classified documents. We interviewed active and former Department of Energy (DOE), Atomic Energy Commission (AEC), and Department of Defense personnel as well as nongovernment sources with knowledge of matters related to the request, including several Green Run test participants. We examined documents in DOE, Air Force, and Defense Nuclear Agency archives, as well as the National Archives and archives of the Massachusetts Institute of Technology. Our results are based on diverse sources of information and are limited by their dependence on necessarily selective records examinations, owing to a lack of complete, definitive AEC or U.S. military documentation of the radiation events that occurred at U.S. nuclear sites in the postwar years. As a result, other planned radioactive releases not documented in this fact sheet may have occurred at AEC and other U.S. nuclear sites during those years.

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