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SUMMARY OF HEALTH AND ENVIRONMENTAL IMPACTS OF NUCLEAR TESTING AT THE NEVADA TEST SITE

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The Nevada Test Site (NTS)[1] had the largest number of nuclear explosions of any nuclear test site in the world; 100 of them were atmospheric tests, starting on 27 January 1951. Six of the 828 underground tests had significant venting of radioactive materials, notably in the early underground testing period; the last of these was the Baneberry test, on 18 December 1970 (IPPNW and IEER 1991, Chapter 4).

Choice of the Nevada Test Site

The location of the test site in terms of protection of the public from fallout was contrary to the recommendation of the Chief of Radiological Safety at the very first nuclear weapons test conducted in the New Mexico desert on 16 July 1945. Noting that there was fallout as much as 200 miles (320 kilometers) away from the test location on the fourth day after the test, Colonel Stafford L. Warren recommended that future similar tests be done at a site "preferably with a radius of at least 150 miles without population…." (Warren 1945). The choice of the Nevada Test Site disregarded this recommendation. In general the atmospheric tests were conducted when the winds were blowing away from the Los Angeles and Las Vegas metropolitan areas. As a result, prevailing westerly winds meant that almost the entire country that lay east of NTS suffered fallout, much of it in hot spots, including some that were as far as New York State, about 4,000 kilometers away. The Nevada Test Site is on Western Shoshone land (Nuclear Princeton 2022).

Health Impacts

A detailed study of health impacts of atmospheric testing was published by the National Cancer Institute in 1997 (NCI 1997). The health impact assessment was partial by design since the study focused on doses from short-lived iodine-131 alone and on thyroid cancer. Yet, the study illustrated how widespread the fallout had been and the great difference that hot spots, often created by rainout of radioactivity, made to radiation doses and cancer risk. NCI 1997 estimated that about 5.5 million

[1] The site has been renamed the Nevada National Security Site. It is referred to here by the name that it had during the period of nuclear testing.

terabecquerels (TBq) of I-131 was released (NCI 1997, p. ES.1) – roughly 10 million times more than the I-131 release officially estimated for the 1979 Three Mile Island nuclear power plant accident (TMI Commission 1979, p. 31).

The estimated collective radiation dose to the thyroids of the 160 million people in the United States exposed to the fallout was about 3 million person-Gray, with an average individual dose of about 0.02 gray; doses to large numbers of young people under 20 years old averaged five times higher. The number of thyroid cancers that resulted was estimated to be between 11,300 and 212,000, with a central estimate of 49,000 thyroid cancers (NCI 1997, p. ES.2 and IOM 1999).

Four of the five most affected counties were in Idaho, while the fifth was in Montana; all were largely rural and 1,000 or more kilometers away from the test site. The average estimated thyroid dose in these counties (all ages) was between 0.12 gray and 0.16 gray as can be seen on the accompanying map. These doses are county averages; in general, it is likely that there would be considerable variation within counties, especially as some of them are very large. For example, Meagher County, Montana has an area of more than 6,000 square kilometers. Most of the fallout was due to tests conducted in 1952, 1953, 1955, and 1957 (NCI 1997).

It was known during the 1950s that I-131, when deposited on vegetation and consumed by grazing animals (cows, goats, and sheep), became concentrated in their milk. Since I-131 has a half-life of only about eight days, the fresher the milk, the higher the dose to those who drank it, all other things being equal. As a result farm families, especially children, and among children, girls, were disproportionately impacted. Despite the knowledge, milk producers were given no information to help protect the country's milk supply. In contrast, the photographic film industry, which at the time packaged film in crop residues, was given advance notice of expected fallout patterns so that it could protect its film supply from radiation-caused fogging (Ortmeyer and Makhijani 1997).

The National Cancer Institute did not make estimates of radiation dose or cancer incidence for the people of Canada and Mexico, though some of their people also experienced fallout from atmospheric testing at NTS, as is clear from fallout at their respective borders in maps in NCI's report (NCI 1997, Figures 3.21 and 3.22 for the border with Canada and Figures 3.28 and 3.30 for the border with Mexico).

A follow-up National Cancer Institute study examined the feasibility of estimating doses from all radionuclides and all atmospheric to the U.S. public. The study estimated that 22,000 cancers, resulting in 11,000 deaths in the United States would be caused by fallout; about 10 percent of these deaths were estimated to be from leukemia. In view of the risk of leukemia, this study also estimated dose to the bone marrow of children born on 1 January 1951 (the month that testing started at NTS), as an illustration of children who would be most affected due to their date of birth. Essentially all children born then would have received bone marrow doses of 1 milligray or more. Children in large parts of the county, notably in areas to the northwest of NTS and also in the Midwest were estimated to have bone marrow doses of more than 3 milligray (NCI 2005, Summary and Chapter 3). The full study was never completed.

Worldwide radioactive fallout

Atmospheric testing fallout was deposited all over the world; the contamination from long-lived radionuclides remains. US atmospheric testing (both at NTS and the Pacific Ocean region), deposited on the order of 260 kilograms of unfissioned plutonium-239 in fallout, essentially all of which remains in the environment. This represents almost half of the total plutonium in fallout from tests by all nuclear weapon states (based on data in Chapters 2 and 3 of IPPNW and IEER 1991). As a reference, the Natural Resources Defense Council has estimated that the Nagasaki bomb contained slightly more than 6 kilograms of plutonium. (NRDC 1995). US tests (both at NTS and the Pacific Ocean region) also resulted in the deposition of over a quarter of a million terabecquerels (TBq) of strontium-90 and over 400,000 TBq of cesium-137. More than three-fourths of these two radionuclides have decayed away in the decades since the last U.S. atmospheric test.

Testing also resulted in uneven deposition of radionuclides on the NTS area itself. Besides bomb tests, plutonium dispersal tests were also conducted. Some of areas in the NTS have been used as radioactive and hazardous waste disposal sites (DOE 2021, Chapter 10).

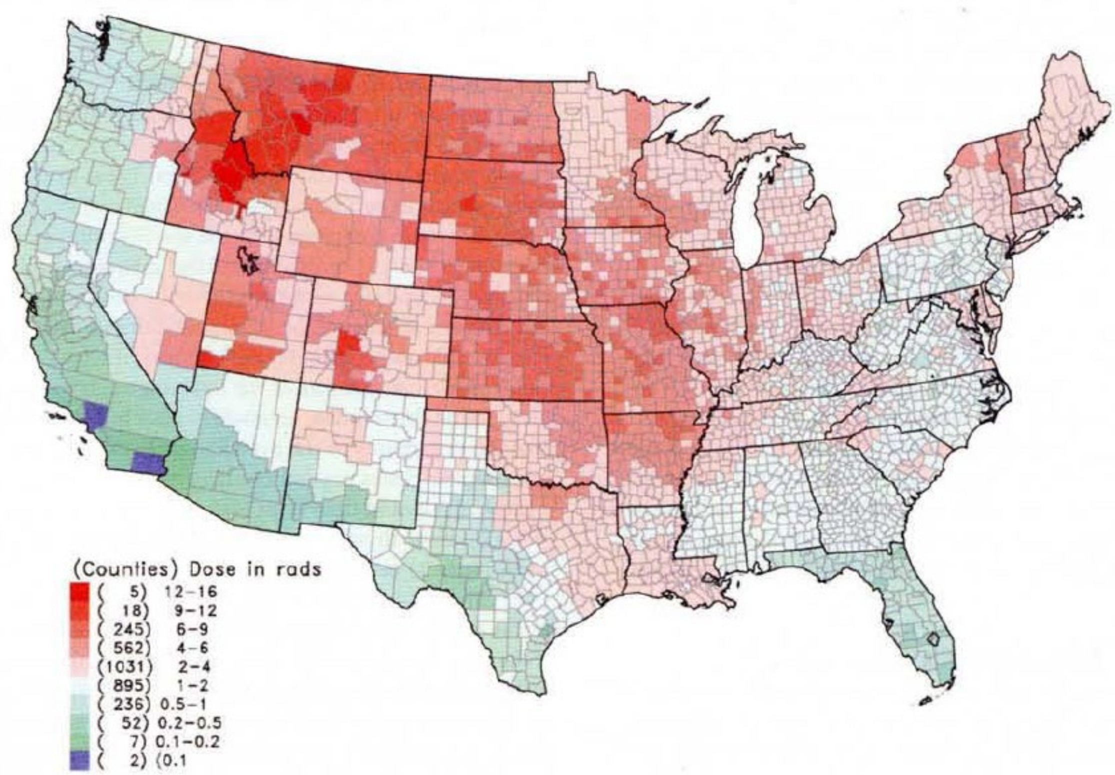
Underground testing impacts

Underground testing at NTS has left a larger inventory of long-lived radionuclides below the test site. An estimated 50,000 TBq of Sr-90, 80,000 TBq of Cs-137 and 1,700 kilograms of plutonium-239 remain on the site as of approximately 2020 (decay-corrected estimates, based on IPPNW and IEER 1991). There are also very long-lived fission products, including technetium-99, cesium-135, and iodine-129 in the underground inventory that will last essentially forever (half-lives: about 210,000 years, 2.3 million years and 15.7 million years respectively). It is as yet unclear what long-term ecological damage to the underground environmental will be over such time frames. The U.S. Department of Energy estimates that some of the groundwater on the site has been contaminated by the tests (DOE 2021).

“Corrective action sites”

There are about 2,200 “corrective action sites” at NTS at or near the surface; some remediation actions have been taken on almost all of them. Over 90 percent of 878 deep underground “corrective action sites” are the subject of long-term monitoring. A transition to long-term monitoring indicates no current plans for corrective actions. Long-term modeling of groundwater flows covering a period of 1,000 years is among the methods being used to assess possible future risk. (DOE 2021, p. 11-1, 11-4 and 11-5).

Figure ES.1. Per capita thyroid doses resulting from all exposure routes from all tests



Map of 48 states of the United States showing thyroid doses from atmospheric testing of nuclear weapons at the Nevada Test Site
Source: [NCI 1997]

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Warren 1945	Stafford L. Warren, Memorandum to Major General Groves, Subject: Report on Test II at Trinity 16 July 1945; dated 21 July 1945, at http://ieer.org/wp/wp-content/uploads/2003/07/14_staffordmemo_trinity_1945.pdf