

Operation GREENHOUSE

Note: For information related to claims, call the Department of Veterans Affairs (VA) at 800-827-1000 or the Department of Justice (DOJ) at 800-729-7327. For all other information, call the Nuclear Test Personnel Review (NTPR) Program at 800-462-3683.

Operation GREENHOUSE, the third series of nuclear weapons tests in the Marshall Islands in the Pacific Ocean, was conducted by the Atomic Energy Commission (AEC) from April 8 to May 25, 1951. The series consisted of four nuclear weapons tests, all tower shots and all nuclear fission devices except as noted below. All tests were conducted on Enewetak Atoll.

GREENHOUSE was the first test operation in the Pacific since the Soviet Union surprised the world with its first nuclear detonation in 1949, which was much sooner than American scientists had expected. This spurred the United States in an all-out effort to stay ahead of the Soviet Union by developing the much more powerful hydrogen bomb, a thermonuclear device that derived its explosive energy from the fusion of hydrogen atoms. Although no complete fusion devices were tested at GREENHOUSE, the operation helped proof-test the thermonuclear triggering process through achieving a detectable fusion component of nuclear yield, an important step toward the first successful thermonuclear detonation at Operation IVY the next year. Thermonuclear processes also contributed to a design successfully tested at GREENHOUSE to boost the efficiency of fission explosions.

In addition to the weapons development experiments, the Department of Defense (DoD) conducted tests of the physical and biological effects of nuclear weapons—tests that involved a large number of DoD organizations and personnel and considerable on-site construction.

Shot Summary

GREENHOUSE Nuclear Weapons Tests^a

Shot	Local Date	Location	Burst Type/Height	Yield
DOG	April 8	Runit Island	Tower (300 Feet)	81 kilotons
EASY	April 21	Runit Island	Tower (300 Feet)	47 Kilotons
GEORGE	May 9	Eleleron Island	Tower (200 Feet)	225 kilotons
ITEM	May 25	Enewetak	Tower (200 Feet)	45.5 kilotons

^a Source: *United States Nuclear Tests, July 1945 through September 1992*, DOE/NV-209 (Rev. 15), Dec 2000.

^b One kiloton equals the approximate energy release of one thousand tons of TNT.

Operation GREENHOUSE Highlights

Operation GREENHOUSE proceeded as planned except for the fallout that occurred on the residence islands after each shot except GEORGE. The fallout from Shot DOG was heavier than previously had been encountered in a residence situation at a nuclear test site; this was the first time that fallout appreciably increased cumulative doses of support personnel relative to the dose limit. The fallout on residence islands from Shot ITEM was heavier yet.

Fallout from **Shot DOG**, caught in wind shifts in the hours after detonation, doubled back on the atoll and contaminated some of the islands and ships. Of the residence islands, Parry Island received the most with a peak reading (an average from several points around the island during the hours of highest radiation from accumulated fallout) of 0.083 roentgen per hour (R/hr). High radiation levels on the forward islands postponed all but the most essential survey and recovery missions until the next day, when the radiation had decayed to acceptable levels.

Only very light fallout from **Shot EASY**, compared to the fallout from Shot DOG, fell on the residence islands. JTF planners situated Shot EASY on Enjebi, the largest of the forward islands, to accommodate extensive DoD projects. Because of these projects, more DoD personnel were involved in the forward activities at Shot EASY than for any of the other three shots. Most of the activity involved an extensive DoD structural response program in which a large number of full-sized and scaled-down dummy structures were built at varying distances from the shot point. The structures, sample buildings and aircraft parts, were heavily instrumented to record their response to the nuclear burst. Also, DoD conducted the largest biotic test program of the Oceanic tests; this program used a variety of plant specimens, as well as mice, pigs, dogs, and other animals.

Shot GEORGE, at 225 kilotons, nearly tripled the yield of any nuclear device detonated up to that time. Because of the large anticipated yield, the winds had to be consistently from the south before detonating to assure that fallout would blow away from occupied atolls. With the help of a nearby typhoon, the wind conditions were perfect, with strong southerly winds at all altitudes. No fallout was detected at the residence islands.

Shot ITEM, the last shot of GREENHOUSE, was moved up three hours to avoid unfavorable winds predicted for later in the morning. Even so, high-altitude winds blew fallout back onto the residence islands and ships at anchorage in the lagoon. The first wave of fallout began in the morning, three to four hours after the detonation, and the second wave peaked in the early evening. The peak reading in occupied areas was 0.118 R/hr on Enewetak Island, which received the most fallout. The men living on the residence islands were exposed to fallout there until they departed from the atoll.

The amount of fallout received by the six JTF 3 ships varied with their locations at shot time and their decontamination procedures. Radiation intensities were lower for shipboard personnel than for island-based personnel because many of the ships' external surfaces could be decontaminated quickly by the water washdown systems.

An important experimental program at GREENHOUSE was the use of unmanned, radio-controlled drone aircraft for cloud sampling. Eight B-17 drones were flown close to the detonation to measure blast and thermal effects and then into the nuclear cloud to collect radioactive samples.

Radiation Protection Standards

Safety standards were established to limit the exposure of participants to the effects of nuclear detonations while, at the same time, allowing them to receive the sometimes unavoidable small doses of radiation as they performed their missions in the radiation areas.

Standards governing permissible radiation dose were established as upper limits for each individual. The standards, which followed those set by the National Committee on Radiation Protection, were 0.1 rem* per day, not to exceed a total of 3.9 rem for 13 weeks. The Commander of JTF 3 could authorize a total dose of up to 3.0 rem on any one day for personnel who had to perform special missions, but only once per individual.

operation, about 2,300 were badged one or more times. Film badges were issued to individuals who had the potential to be exposed to radiation while performing their duties, such as radiation monitors, boat pool crews, aircrews, runway crash crews, personnel responsible for decontaminating aircraft, and especially those visiting any of the forward islands shortly after the shots. Film badges for personnel entering radioactive areas normally were issued and turned in daily. Boat pool and ship badges generally were issued for one week. For each test, more than 75 film badges were distributed to each of the six participating JTF 3 ships to be worn for seven days after the test by representatives of cohort groups (participants physically grouped together and engaged in similar activities). The dose to these individuals would approximate that of the whole group. After being turned in, the badges were developed and the reading recorded on 5x8-inch dose cards maintained for each individual who was badged. Dose cards were not maintained for unbadged personnel.

Radiation Doses at Operation GREENHOUSE

A number of individuals had recorded film badge readings of between 5 and 9 rem. The higher doses among DoD participants were recorded for radiation monitors with the radiological safety unit, individuals supporting scientific projects, and Air Force personnel working in the sampling program and long-range radioactive cloud-tracking programs, especially the Air Force Experimental Aircraft Unit. This unit controlled the B-17s used as drones and decontaminated personnel and aircraft on Enewetak Island.

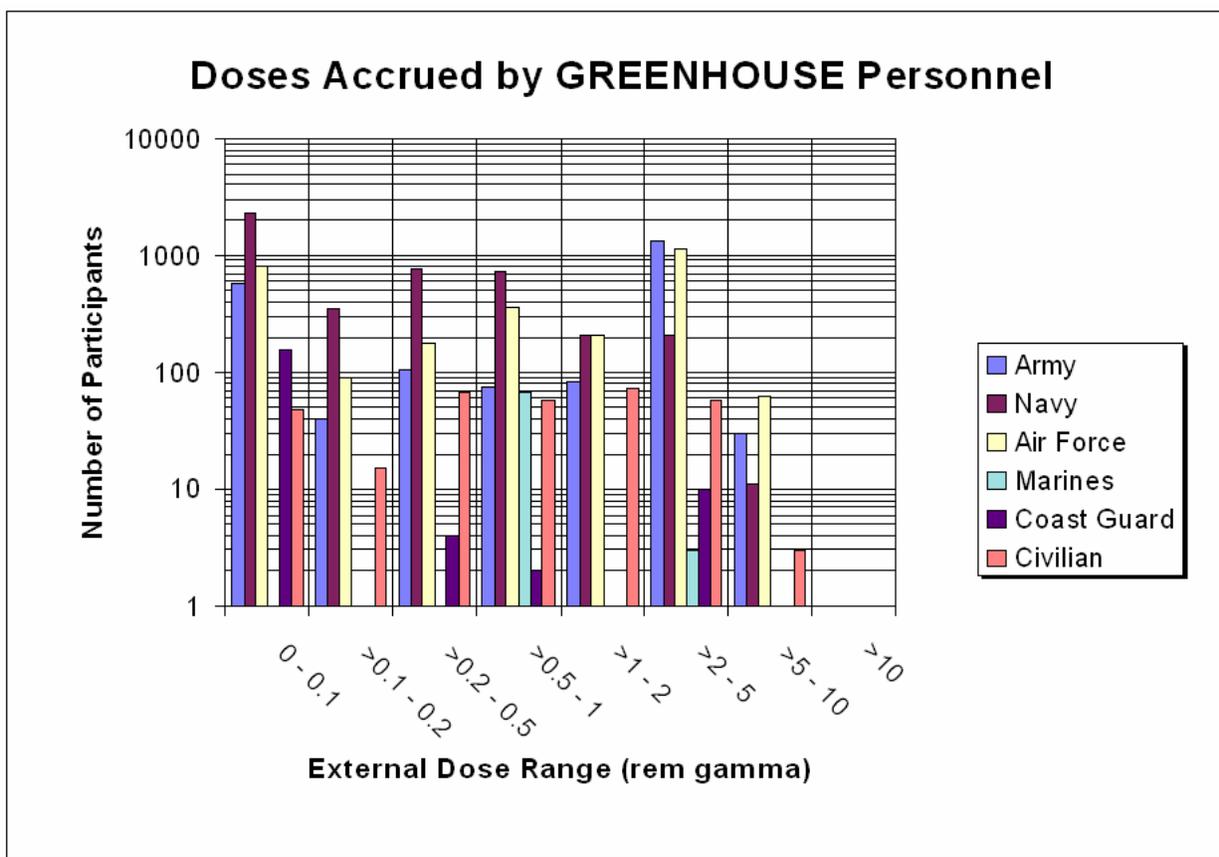
Fallout from Shots DOG, EASY, and ITEM on the residence islands and on the ships contributed to the accumulated dose of everyone who lived there. For typical support personnel remaining on the islands throughout the operation, reconstructed doses from DOG fallout range from 0.6 to 1.3 rem; doses for personnel on ships tend to be lower because of the washdown systems and because sailors spent a large amount of time below deck. The fallout from ITEM was most intense. The corresponding reconstructed doses from ITEM through four days after the shot, when many participants departed, range from 1.1 to 2.1 rem. Most people had left Enewetak Atoll within a week after Shot ITEM, but some garrison forces remained for months thereafter and received greater doses.

Many of these personnel were not issued film badges. Others were issued film badges for a short time only – to help out briefly on a mission, for example – but went unbadged for the balance of the time. At the conclusion of GREENHOUSE, doses for some of these men were estimated using erroneous assumptions and entered onto their individual dose cards. For example, readings on Parry Island were used regardless of the residence islands on which a person was based and without consideration of actual lengths of stay on the islands. Most of these estimates were either understated

or overstated when compared to the actual radiation exposures. Some personnel who were almost certainly exposed to fallout had no dose entered in their personal files.

To correct these inadequacies, doses in the files for individuals who did not continuously wear a film badge have been replaced by dose reconstructions derived by the Nuclear Test Personnel Review (NTPR) Program from the known radiation conditions of each island and ship.

Reconstructed doses for typical shipboard and land-based personnel are derived and published in “Analysis of Radiation Exposure for Naval Personnel at Operation GREENHOUSE” (DNA-TR-82-15). The dose totals for GREENHOUSE participants are depicted below.



**A rem is a radiation protection unit of measure that quantifies the risk of biological effects resulting from exposure to ionizing radiation. Ionizing radiation is any radiation (gamma, x-ray, beta, neutron or alpha) capable of displacing electrons from atoms or molecules, thereby producing ions. According to the National Council on Radiation Protection and Measurements (NCRP, Report No. 93, Table 8.1), the general U.S. population receives about 0.36 rem per year from natural background radiation sources (radon, cosmic rays and rocks) and man-made radiation sources (medical diagnostic x-rays and consumer products).*

For more information on reconstructed doses, see the report “Analysis of Radiation Exposure for Naval Personnel at Operation GREENHOUSE” (DNA-TR-82-15), available online at http://www.dtra.mil/rd/programs/nuclear_personnel/pubs.cfm. Also see the report “Operation GREENHOUSE 1951” (DNA 6034F), available online at http://www.dtra.mil/rd/programs/nuclear_personnel/atr.cfm.

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