MARSHALL ISLANDS DOSE ASSESSMENT AND RADIOECOLOGY PROGRAM

BIKINI • ENEWETAK • RONGELAP • UTROK

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TECHNICAL FACT SHEET

THE RUNIT ISLAND WASTE CONTAINMENT STRUCTURE (RUNIT DOME)






AT A GLANCE

- The concrete containment structure on Enewetak Atoll was built inside an unlined nuclear test crater on the northern end of Runit Island.

- The structure is clearly vulnerable to leakage and the sustained impacts of storm surge and sea-level rise.

- Under existing conditions, contemporary measurements on the level and isotopic composition of contaminants in lagoon water collected off Runit Island show that any leakage of radioactivity from the containment structure is being effectively masked or disguised by local sources of contamination inside the lagoon and/or from worldwide fallout deposition.

- The local marine radiation environment adjacent to Runit Island is dominated by plutonium mobilization from sedimentary sources to solution, … not from leakage of radioactive from the concrete containment structure.

- To provide added assurances to the people of Enewetak, and in consultation with local and national government officials, the U.S. DOE in cooperation with the U.S. Department of Interior (DOI) has embarked on a program to provide periodic monitoring of the structural integrity of the concrete cap and develop a long-term groundwater monitoring monitor on Runit Island. This work was signed into Public Law (P.L. 112-149) by President Obama during May of 2012.

INTRODUCTION

The nuclear waste containment structure on Enewetak Atoll in the northern Marshall Islands was designed, constructed and completed during the 1970s at a time when specific radioactive waste management definitions, guidelines, and practices were first being developed. Radioactive waste compiled during the radiological cleanup of Enewetak was subsequently entombed inside a 9.5-meter deep, unlined nuclear test crater on a narrow spit of land on the northern end of the Runit Island. The stabilized debris pile placed inside the crater was composed of a soil-cement grout mixture, encapsulated oversize soil and debris, dumped legacy equipment, structural steel, concrete and other forms for debris. The dome-shaped waste pile was then covered with a 45-cm thick layer of concrete to form an erosion-resistant, non-load bearing, barrier or cap (Fig. 1). The pulverized material that fell back into the crater immediately upon detonation of the device and materials that were subsequently washed into the open crater were not removed prior to construction. The concrete cap is composed of 357 individually formed, trapezoid-shaped, concrete panels and a top section. The concrete cap also serves as a façade to shield (block) external radiation that might otherwise result in human exposure from walking around the dome.

Upon completion of formal cleanup operations on Enewetak, it was agreed by all contracting parties, and stated by Iroij Johannes Peters, that Runit Island should remain OFF LIMITS. The need for continued quarantine of Runit Island was rationalized on the basis that the island may still contain elevated levels of plutonium and Americium-241 contamination above prescribed cleanup standards, especially buried in the subsurface environment. Concerns were expressed that buried soil contamination could be exposed by erosion and place visitors to Runit Island at risk from increased radiation exposure.

Plutonium and americium-241 produce alpha particle radiation. Radiation is energy. Alpha particles are a non-penetrating form of radiation. Consequently, exposure to alpha particles outside of the body is generally not considered a major risk factor. However, once inside the body, alpha particles can be very harmful and may cause more localized damage to cells and tissues than other forms of radiation.

The main pathway for human exposure to plutonium and americium-241 on Runit Island is from breathing in plutonium-contaminated dust particles or from intakes of contaminated particles via ingestion or through

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PROJECT: Enewetak Radiological Cleanup

PROJECT RESPONSIBLE AGENCY: U.S. Department of Defense (DOD)

BUILT: U.S. Army Corps of Engineers (USACE)

PERSONNEL: Approximately 1,000 personnel forming part of an on-atoll task force

CONSTRUCTION DATE: 1978-1980

TOTAL COST: ~US$100 Million (full cost of the Enewetak cleanup and rehabilitation program, 1972-1980)

VOLUME: 83,000 cubic meters

CONTENTS: Soil-cement grout, encapsulated oversize soil and debris, dumped legacy equipment, structural steel, concrete and other forms of debris

ESTIMATED RADIONUCLIDE INVENTORY: 545 GBq TRU (plutonium isotopes + americium-241) waste, not accounting for any associated fission and activation products

LOCATION: Cactus crater, Runit Island, Enewetak Atoll (N 11.69713°; E 165.27420°)

CRATERING EVENT: Operation Hardtack I, 18 kt surface nuclear test conducted on 5/5/1958

Abbreviations and acronyms

DOD	U.S. Department of Defense
USACE	U.S. Army Corps of Engineers
USDOE	U.S. Department of Energy (DOE)
USDOI	U.S. Department of Interior (DOI)
TTPI	Trust Territory of the Pacific Islands
DNA	Defense Nuclear Agency
JTG	Joint Task Group

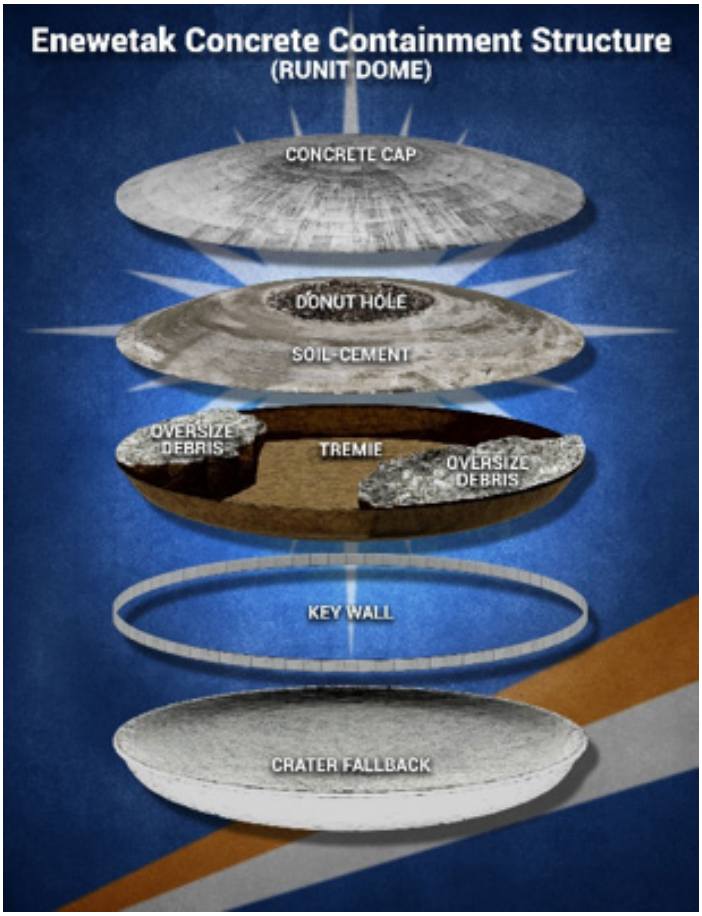

Fig 1. Schematic of the Design of the Runit Island Waste Containment Structure (Runit Dome).

open wounds. Plutonium is a long-lived and persistent radionuclide with a half-life of 24,000 years. TRU contamination composed of plutonium isotopes and americium-241 was the primary focus of the Enewetak cleanup program.

We urge the people of Enewetak to avoid use of the island or, if they are compelled to visit Runit Island, to use precautions by wearing a particle filter mask while digging in the soil or otherwise resuspending dust in the air that they breathe.

By comparison, the Runit Island waste containment structure itself poses little or no risk of direct human exposure to residual fallout contamination. The cracks appearing in the concrete cap are not a site for leakage of radioactive contamination nor of external or internal human radiation exposure. Moreover, independent assessments conducted by licensed engineers show that surface cracks in the dome are largely superficial in nature and do not appear to be impacting on the overall strength properties of the concrete.

Leakage of radioactive waste away from the site will be driven by the solubilization potential of radioactive contaminants contained inside the waste pile and local groundwater hydrology. Recent studies show that levels of fallout contamination in surface groundwater collected from inside the containment structure may exceed background concentrations observed in the open ocean by factors of 1000 or more. The groundwater is relatively fresh and has a high pH (approx. 12.4). The high pH is suggestive that the cement-soil grout mixture residing in the saturated zone of the waste pile is reacting with the surrounding groundwater, possibly reducing the binding capacity of the concrete. Water depth sensor data also illustrates that groundwater beneath the containment structure is in physical communication with the ocean and lagoon (Fig. 2). The lag time between the rise and residing ocean tide can be measured in terms of minutes. This physical coupling of water masses combined with the forcing caused by the action of ocean tides may displace contaminated groundwater and increase the potential for migration of radionuclides away from the site boundary. Moreover, increases in the frequency and severity of storm events and sea-level rise are likely to enhance forcing and rates of radionuclides' dispersion into the marine environment.

However, under existing conditions, it is not clear that contaminated groundwater beneath the dome is having any measurable or discernible impact on the concentration of fallout contaminants in surface waters around Runit Island. Except for plutonium, the level of fallout contamination measured in offshore lagoon waters is very similar to that observed in the open ocean. We conclude that potential leakage of contaminated groundwater into the lagoon is being effectively masked (disguised) by local sources of fallout contamination in the lagoon or from worldwide fallout deposition.

The source of heavy-element fallout contamination in the environment can often be characterized based on isotopic measurements. Such measurements can be likened to taking a nuclear fingerprint. At Enewetak, the characteristic plutonium-239 (239Pu) to plutonium-240 (240Pu) atom isotope ratio in surface groundwater samples collected from inside the containment structure is around ~0.11. The same ratio measured in the marine environment is distinctly different (~0.06). Moreover, the plutonium isotopic composition measured in lagoon water samples collected off Runit Island is identical, on average, to that measured in surrounding sediments. In this instance, the plutonium entering the water column appears to be derived from mobilization of sedimentary sources to solution and not from the flow of containment-derived contaminated groundwater into the lagoon. These measurements again suggest that any leakage of contaminated groundwater from the containment structure is being effectively masked by local sources of fallout contamination in the lagoon.

We have attempted to describe fallout contamination in the groundwater beneath the containment structure by comparative analysis with background concentrations

in the open ocean. We report that the groundwater collected beneath the containment structure contains much higher levels of fallout contamination compared with that contained in the open ocean. As an added perspective, levels of fallout contamination measured in groundwater can be compared with drinking water quality or wastewater release standards. Except for strontium-90, measurements of individual fallout radionuclides in groundwater sample collected from inside the waste containment structure meet U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCL) and other applicable international standards for radionuclides in drinking water. Hence, in relative terms, the groundwater beneath Runit Dome does not necessarily contain excessively high (dangerous) levels of contamination. Moreover, the concentration of fallout radionuclides reaching the marine environment through any outflow points in the lagoon or ocean will be very rapidly diluted.

In general, scientific studies conducted at Runit, including those presented in this document, do not support common conjecture that leakage of radioactive waste from the Runit Island nuclear waste containment structure presents a discernible health and ecological risk. Such statements are very misleading. There is about 100 times more TRU waste (or about 68,000 GBq) available for solubilization in marine sediments of the lagoon compared with the amount of TRU waste dumped inside Cactus crater (about 545 GBq). Under this scenario alone, we can theorize that the exposure contribution from leakage of radioactive waste from the containment structure will be low compared with that associated with existing levels of contamination in the lagoon. Contemporary measurements of the concentration and isotopic composition of fallout

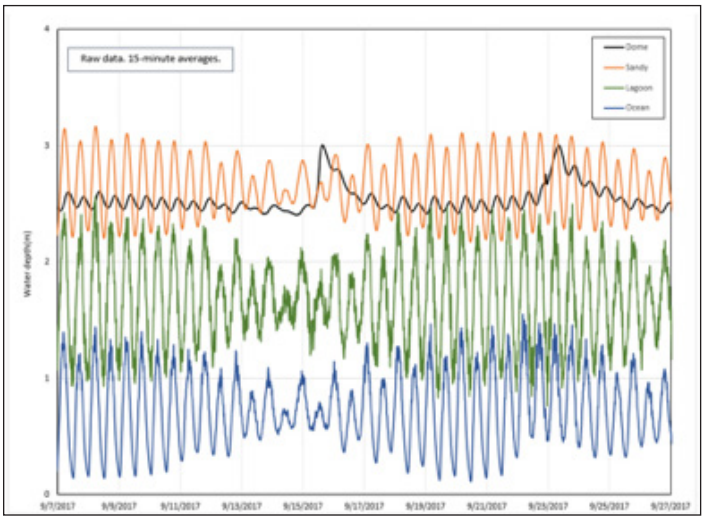

Fig 2. Relative elevation of water inside Runit Dome (dome) in comparison with measurements made in a borehole placed adjacent to the dome (Sandy), and in the lagoon and ocean (September 2017).

radionuclides in groundwater collected from inside the containment structure versus that contained in the offshore marine environment appear to support this view.

SUMMARY REMARKS

The waste containment structure on Enewetak Atoll was built inside an unlined nuclear test crater on a narrow spit of land on the northern end of Runit Island. The structure is clearly vulnerable to leakage and the sustained impacts of storm surge and sea level rise. Moreover, there is clear evidence showing that groundwater within the containment structure is in direct communication with the ocean and lagoon. Consequently, there is a high probability of some leakage of radioactive waste from the containment structure into the marine environment. Radioactive contaminates derived from leakage of waste from the containment structure may become available for assimilation into marine organisms and the wider marine ecosystem. However, contemporary measurements on the level and isotopic composition of lagoon water collected off Runit Island show that any leakage of radioactive contaminants from the containment structure is being effectively masked or disguised by local sources of contamination inside the lagoon and/or from worldwide fallout deposition. The local marine radiation environment is dominated by plutonium mobilization from sedimentary sources to solution not from leakage of radioactive contaminants from the Runit Island waste containment structure.

To provide added assurances to the people of Enewetak, and in consultation with local and national government officials, the U.S. DOE in cooperation with the U.S. Department of Interior (DOI) has embarked on an ambitious program to provide periodic monitoring of the structural integrity of the concrete cap and develop a long-term groundwater monitoring monitor on Runit Island. This work was signed into Public Law (P.L. 112-146) by President Obama during May of 2012. In cooperation with the local leadership, the U.S. DOE is also helping support efforts to perform routine maintenance of the concrete cap. Such efforts are expected to help manage negative perception about the formation of cracks and other visibly defective elements in the concrete and build public trust and confidence in site management.

SUGGESTED READING

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QUESTIONS AND ANSWERS

Q: *It is dangerous to walk around the waste containment structure on Runit Island?*
A: There is little or no added risk of external or internal radiation exposure from walking around the dome. External exposure rates atop of Runit Dome are less or very similar to those experienced when walking on other concrete formations. Exposure is dominated by natural occurring uranium isotopes in the concrete.

Q: *Can I eat fish collected near Runit Island?*
A: The concentration of fallout radioactivity in fish collected near Runit Island is not measurably different to other locations in the lagoon. In general, all fishes collected from inside Enewetak lagoon are safe to eat.

Q: *How can you tell if the containment structure on Runit Island is leaking?*
A: It is difficult to quantify the extent of leakage of radioactive from the containment structure because the outfall appears to be masked by higher-level fallout contamination in the lagoon and/or from worldwide fallout deposition. Characteristic plutonium isotope data comparing the groundwater collected from inside the containment structure versus that contained in the marine environment should provide an effective monitoring tool to assess future change in these conditions.

Q: *What will be the impact of increases in storm surge and sea level rise on the containment structure?*
A: The containment structure is partially protected from storm surge by an artificial riprap mole wall formed from large size quarry blast rock and rejected concrete sections, choked with smaller rocks and aggregate. A key wall in the form of a concrete curtain was also poured around the circumference of the containment structure to prevent scouring and undercutting of the structure by wave action. Sea-level rise and storm events will undoubtedly lead to wave-driven flooding on and around the lower segments of the structure. These events may eventually impact on the durability of the containment structure and increase forcing for flow of contaminated groundwater away from the site.

Q: *What actions are being taken to monitor the containment structure and assess future change in the risk posed by leakage of radioactive waste to the resident population?*
A: Public Law (P.L. 112-149) provides U.S. legislative authority to address radiological concerns about the structural integrity and leakage of radioactive waste from the Runit Island Cactus crater containment structure. This work is being conducted by the U.S. Department of Energy (DOE) with support from the U.S. Department of Interior (DOI). The intent of the P.L. is to conduct periodic visual surveys of the containment structure and implement a long-term groundwater monitoring program. Site monitoring will include analyses of groundwater, lagoon water, marine sediments and marine biota. Findings are expected to provide a basis for quantifying site-specific risks posed by leakage of radioactive waste from the containment structure on the health and safety of the people of Enewetak. As an interim measure, individual radiological protection monitoring programs on Enewetak will be continued to include assessments of internally deposited cesium-137 based on whole body counting, and plutonium urinalysis bioassay. These data can be viewed at https://marshallislands.llnl.gov

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DISCLAIMER

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