

**SEGMENTATION STRATEGIES USED IN CALCULATING HAZARD CATEGORY 3
THRESHOLD VALUES AT THE RADIOACTIVE AND MIXED WASTE
MANAGEMENT FACILITY, SANDIA NATIONAL LABORATORIES, NEW MEXICO**

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ABSTRACT

This paper demonstrates how facility segmentation is used at the Radioactive and Mixed Waste Management Facility (RMWMF) compound successfully, thus providing greater flexibility in operations, storage, and processing of radioactive and mixed waste (R/MW) materials generated at Sandia National Laboratories, New Mexico. The RMWMF compound is divided into 6 segments. For every segment, the R/MW material radionuclide inventories are recorded in a database. To verify that the radionuclide inventories are below their corresponding hazard category 3 threshold values, the R/MW materials are managed to yield a sum of fractions per segment of <1.0. In addition, the Environmental Assessment (EA) base case scenario provides information regarding natural phenomena and operational accidents (i.e., scenarios) that could result in a loss of containment and co-mingling of R/MW materials between segments. The EA base case scenario consisted of a severe earthquake which damages Building 6920 located inside the RMWMF compound, causing propane gas lines to fracture, which then results in a fire. The annual probability of this scenario per segment was 5×10^{-5} , and the effective dose equivalents (EDEs) to the maximum on-site and off-site individuals were 1.3 rem and 3.8×10^{-1} rem, respectively. Although there were scenarios having higher annual probabilities of occurrence per segment (e.g., 10^{-2} , 10^{-1}), their on-site and off-site EDEs were still less than the base case scenario results. Actual events will likely disperse the R/MW materials rather than concentrate them, further limiting interaction between individual segments.

INTRODUCTION

The Radioactive and Mixed Waste Management Facility (RMWMF) compound is located on approximately 12,141 square meters (3 acres) of land in the southeastern portion of Technical Area III at Sandia National Laboratories, New Mexico (SNL/NM). The RMWMF compound is not located on a 100-year flood plain, and the underlying groundwater table is approximately

149.4 meters (490 feet) below grade. Radioactive and mixed waste (R/MW) materials generated at SNL/NM are transported to the RMWMF compound already containerized in 55-gallon drums and 744 boxes. The on-contact effective dose equivalent (EDE) rates of the containers vary according to the R/MW-generating processes. There are between 10 and 20 employees at the RMWMF compound at any one time responsible for R/MW management activities. These activities are described in the Primary Hazard Screening (PHS) and the Hazard Analysis (HA) documents (e.g., routine assay, treatment, packaging, interim storage, and container staging for off-site shipment to approved disposal facilities) (1). There are four structures located inside the compound; Buildings 6920, 6921, 6925, and 6926. These buildings provide workspace and utility support to perform these aforementioned activities.

During processing, waste staging, and packaging activities inside Building 6920, the ventilation system is designed to isolate potential releases to the environment. Tritium (H-3) is the only gaseous radionuclide that has been measured, and contributes approximately 1% to the overall EDE to the maximum exposed individual (2).

RADIOLOGICAL FACILITY CLASSIFICATION

Based on the potential consequences from unmitigated radionuclide releases, DOE Order 5480.23 states that facilities should be classified as a hazard category 3 facility if the potential exists for “significant localized consequences” (3). These types of facilities are required to prepare a Safety Analysis Report (SAR). Essentially, all facilities have the potential for significant localized consequences from typical industrial accidents. The additional hazard is from the R/MW materials.

DOE-STD-1027-92 (Change Notice 1) provides guidance and radionuclide threshold values for determining the hazard category of a particular facility, and states “Facilities that do not meet or exceed Category 3 threshold criteria but still possess some amount of radioactive material may be considered Radiological Facilities” (4). In addition, if the inventory of a facility is maintained less than the hazard category 3 threshold quantities, they are exempt from DOE Order 5480.23. However, this exemption does not excuse evaluating, where applicable, potential significant radiation exposures to workers (4). Therefore, the PHS/HA documents provide qualitative techniques to pinpoint weaknesses that could produce undesirable results (e.g., accidents, environmental releases) (1). In addition, DOE-EM-STD-5502-94 was prepared to provide guidance and ensure safety for radiological facilities. This standard defines a radiological facility as “...those facilities that do not meet or exceed the hazard category 3 threshold quantity values published in DOE-STD-1027-92, but still contain some quantity of radioactive material...” (5). Specifically, the R/MW materials at the RMWMF compound are managed to stay below the hazard category 3 threshold values. Therefore, in accordance with the definitions provided in references 4 and 5, the RMWMF compound is classified as a sub-category 3 (i.e., < hazard category 3) radiological facility.

RMWMF COMPOUND SEGMENTATION ANALYSIS

DOE-STD-1027-92 (Change Notice 1) states in part that “It is necessary to avoid placing excessive requirements on simple, or even trivial co-located (i.e., contiguous) operations. Therefore, the concept of independent facility segments should be applied where facility features

preclude bringing material together or causing harmful interaction from common severe phenomenon. It should be noted that DOE 5480.23 states that an analysis and categorization is to be performed on 'processes, operations, or activities' and not necessarily whole facilities" (4).

Although contiguous operations are performed within the RMWMF compound, facility features such as independent buildings, and storing R/MW materials in transportainers (e.g., 2.4 m x 2.7 m x 12.2 m transport containers) "...preclude bringing material together or causing harmful interaction from common severe phenomenon" (4). Therefore, in accordance with reference 4, the RMWMF compound has been divided into the following 6 segments, thus providing greater flexibility in operations, storage, and processing of R/MW materials:

- Segment 1 - Building 6920 - processing facility and waste staging.
- Segment 2 - Building 6925 - waste storage facility.
- Segment 3 - Building 6926 - waste storage facility and transportainers located in the northwest portion of the compound.
- Segment 4 - Building 6921 - waste assay facility and transportainers located in the northeast and southeast portions of the compound.
- Segment 5 - Transportainers and waste containers located in the southwest portion of the compound.
- Segment 6 - Transportainers and waste containers located outside the fence, in the southern portion of the compound.

Figure 1 depicts the RMWMF compound and location of each segment.

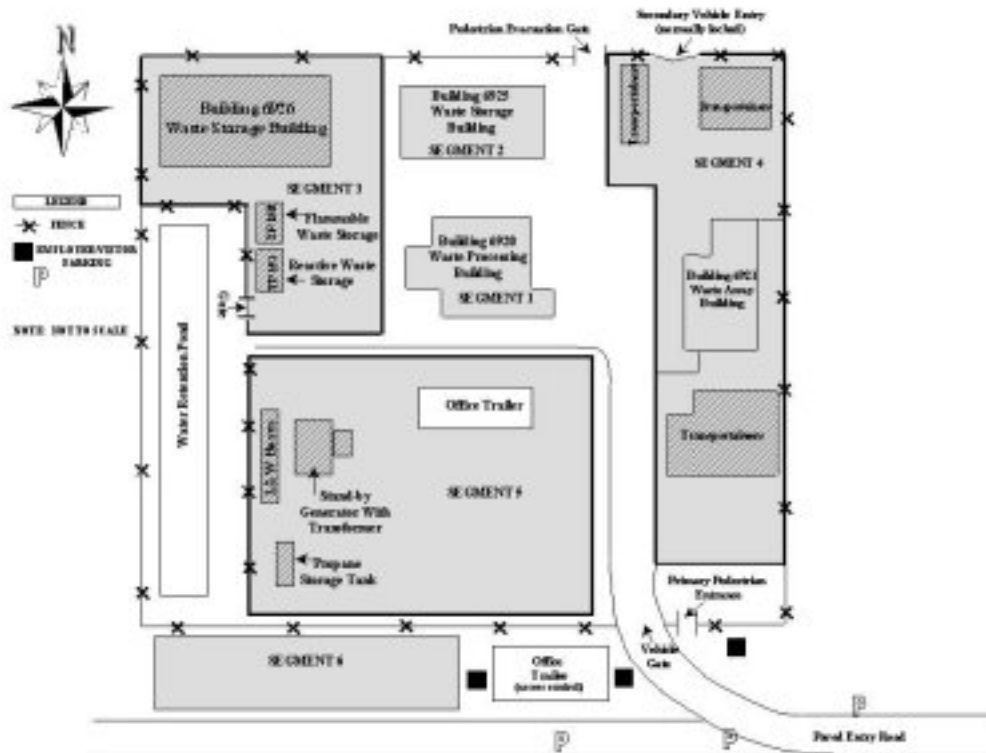


Figure 1. KRYANF Ground Segmentation

INVENTORY TRACKING AND DATABASE MANAGEMENT

The R/MW material radionuclide inventories are derived from disposal requests and travelers, and recorded in a database. To verify the radionuclide inventories are below their corresponding hazard category 3 threshold values, equation 1 is used to calculate the sum of fractions per segment (S_n):

$$S_n = [A_{In} / A_{Tn}] + [B_{In} / B_{Tn}] + \dots + [N_{In} / N_{Tn}] \quad (1)$$

where:

- S_n = Sum of fractions, segment n, where n = 1, 2,...6.
- A_{In} = Inventory of isotope A, segment n.
- A_{Tn} = Hazard category 3 threshold value of isotope A, segment n.
- B_{In} = Inventory of isotope B, segment n.
- B_{Tn} = Hazard category 3 threshold value of isotope B, segment n.
- N_{In} = Inventory of isotope N, segment n.
- N_{Tn} = Hazard category 3 threshold value of isotope N, segment n.

In addition, the following guidelines affirm that the R/MW materials are stored and processed in a safe manner, and preclude co-mingling between segments:

- The S_n for individual R/MW containers or packages shall be <1.0 .
- The S_n for segments 1 through 6 shall be <1.0 .
- An area of 7.6 meters (25 feet) should be maintained free of R/MW containers or packages around segments 1 through 6.

NATURAL PHENOMENA AND OPERATIONAL ACCIDENTS

The Environmental Assessment (EA) for Building 6920 already provides information regarding natural phenomena and operational accidents (i.e., scenarios). These scenarios were estimated to reasonably occur with an annual probability $>10^{-6}$, and serious in nature to warrant evaluation of their consequences (6). The scenarios that could result in a loss of containment and co-mingling of R/MW materials between segments were evaluated as follows:

- Base case scenario - a severe earthquake damages Building 6920 inside the RMWMF compound, causing propane gas lines to fracture, which then results in a fire.
- Large aircraft/helicopter crash.
- Fire (e.g., involving multi-containers, starting in the R/MW processing and storage areas, and inside a laboratory).
- Propane gas pipe or tank explosion.
- Site blackout.
- Ventilation system failure.
- Tornado.

Segment 1 - Building 6920 is designed to withstand a design basis earthquake (DBE), and partially withstand straight line winds exceeding the design basis wind speed of 36.2 meters per second (81 miles per hour). The design basis is defined as the set of requirements that bound the design of systems, structures, and components within the facility. These design requirements include consideration of safety, plant availability, efficiency, reliability, and maintainability (3). A base case scenario was used to evaluate the consequences from natural phenomena and operational accidents, and consisted of multiple events; a severe earthquake damages Building 6920 inside the RMWMF compound, causing propane gas lines to fracture, which then results in a fire. The annual probability of this scenario per segment was 5×10^{-5} . Other scenarios having annual probabilities ranging from 10^{-6} to 10^{-8} are realistically bounded by the base case scenario. During this evaluation, it was reasonable to conclude that not all containers would breach, and not all R/MW materials in the breached containers would be associated with combustible materials.

The computer code AIRDOS-EPA was used to calculate the EDEs resulting from the air transport of the radionuclides. The EDEs for the maximum on-site and off-site individuals were calculated to be 1.3 rem (305 meters North-Northeast of the RMWMF compound) and 3.8×10^{-1} rem (2.8 kilometers South of the RMWMF compound), respectively. Both results were less than the EDE radiological siting guideline of 25 rem (7). In addition, the estimated radionuclide inventory for Building 6920 reported in the EA exceeded its S_n by a factor of 60 (8). Therefore, the actual EDEs resulting from natural phenomena and operational accidents are expected to be less than the maximum on-site and off-site EDEs reported in the EA.

The annual probability of a large aircraft crash per segment was 1.3×10^{-6} . Although the probability of this scenario was lower than the base case scenario, the EDEs increased, yielding 2.6 rem to the maximum on-site individual, and 7.6×10^{-1} rem to the maximum off-site individual. Also, the RMWMF compound is used as a landmark for helicopter training flights. The annual probability of a helicopter crash per segment was 2.5×10^{-6} . Although this probability was higher compared to the crash of a large aircraft, the extent of damage to Building 6920 would be less, yielding EDEs equivalent to the base case scenario analysis.

There were various fire scenarios involving multi-containers, starting in the R/MW processing and storage areas, and inside a laboratory. Although the annual probabilities per segment ranged from 1×10^{-2} to 1×10^{-1} and exceeded the base case scenario analysis, the EDEs were much less ranging from 1.2×10^{-7} rem to 6.5×10^{-1} rem for the maximum on-site individual, and 3.4×10^{-8} rem to 1.9×10^{-1} rem for the maximum off-site individual.

The annual probabilities of a propane gas pipe explosion or a propane gas tank explosion per segment were 1.0×10^{-5} and 1.0×10^{-4} , respectively. Their EDEs were also less than the base case scenario, averaging 1.4×10^{-1} rem for the maximum on-site individual, and averaging 4.0×10^{-2} rem for the maximum off-site individual.

The annual probabilities of a site blackout and ventilation system failure per segment were 1.0×10^{-1} and 1.0×10^{-2} , respectively. Although these probabilities were higher, their corresponding EDEs were much less than the base case scenario. For both scenarios, the maximum on-site individual would receive an EDE of 1.2×10^{-2} rem, and the maximum off-site individual would receive an EDE of 3.5×10^{-3} rem.

The annual probability of a tornado destroying Building 6920 was not considered a credible accident. Although the annual probability per segment was 5×10^{-6} , the consequences would be much less compared to the large aircraft crash scenario.

In summary, R/MW materials from Segment 1 interacting with other segments is unlikely based on its location in a remote, sparsely populated area, the various scenarios analyzed, their annual probabilities of occurrence per segment, and the presence of a retention pond to collect any liquid releases. Also, RMWMF compound emergency response procedures would be used to advise personnel and secure the site during these and similar accident scenarios.

Segments 2 and 3 - Buildings 6925 and 6926, and R/MW materials awaiting processing are stored in transportainers and containers that are not designed to withstand any design basis accidents. Nevertheless, the various scenarios analyzed and their annual probabilities of occurrence that could result in a loss of containment and co-mingling of R/MW materials from Segments 2 and 3 with other segments, including emergency response capability and securing the site, are the same as Segment 1.

Segment 4 - Building 6921 is designed to withstand the same environmental loads as Building 6920, however, the transportainers and containers are not designed to withstand any design basis accidents. Nevertheless, the various scenarios analyzed and their annual probabilities of

occurrence that could result in a loss of containment and co-mingling of R/MW materials from Segment 4 with other segments, including emergency response capability and securing the site, are the same as Segment 1.

Segments 5 and 6 - R/MW materials awaiting processing are stored in transportainers and containers that are not designed to withstand any design basis accidents. Nevertheless, the various scenarios analyzed and their annual probabilities of occurrence that could result in a loss of containment and co-mingling of R/MW materials from Segments 5 and 6, including emergency response capability and securing the site, are the same as Segment 1.

CONCLUSION

This paper demonstrates how facility segmentation is used at the RMWMF compound successfully. The RMWMF compound is divided into 6 segments, thus providing greater flexibility in operations, storage, and processing of R/MW materials generated at SNL/NM. The buildings located on the RMWMF compound are designed to reduce the impact from environmental releases, and prevent co-mingling of segments by complying with applicable Department of Energy, Uniform Building Code, and other local design criteria (e.g., seismic conditions, wind and snow loadings, fire protection, and groundwater protection requirements). Also, the proper implementation of site-specific engineering controls, administrative controls, and using personnel protective equipment, as identified in the PHS, HA, and related reference documents are used to manage R/MW materials safely. Although there were scenarios having higher annual probabilities of occurrence per segment (e.g., 10^{-2} , 10^{-1}), their on-site and off-site EDEs were still less than the base case scenario results, including the radiological siting guideline of 25 rem. Actual events will likely disperse the R/MW materials rather than concentrate them, further limiting interaction between individual segments.

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