# Hazard Classification of the Remote Handled Low-Level Waste Disposal Facility

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## Abstract

The Battelle Energy Alliance (BEA) at the Idaho National Laboratory (INL) is constructing a new facility to replace remote-handled low-level radioactive waste disposal capability for INL and Naval Reactors Facility operations.

Current disposal capability at the Radioactive Waste Management Complex (RWMC) will continue until the facility is full or closed for remediation (estimated at approximately fiscal year 2015). Development of a new onsite disposal facility is the highest ranked alternative and will provide RH-LLW disposal capability and will ensure continuity of operations that generate RH-LLW for the foreseeable future.

As a part of establishing a safety basis for facility operations, the facility will be categorized according to DOE-STD-1027-92. This classification is important in determining the scope of analyses performed in the safety basis and will also dictate operational requirements of the completed facility.

This paper discusses the issues affecting hazard classification in this nuclear facility and impacts of the final hazard categorization.

## Introduction

The Idaho National Laboratory is a multi-mission national laboratory specializing in nuclear research in providing science and engineering solutions in support of U.S. Department of Energy (DOE) programs. Initially, missions of the INL included development of civilian and defense-related nuclear reactor technologies and the management of spent nuclear fuel. The designation as the DOE lead nuclear energy laboratory for reactor technology supports the nation's expanding nuclear energy initiatives.

These energy research solutions are conducted on the INL primarily at the Advanced Test Reactor (ATR) and the Materials and Fuels Complex (MFC). The ATR complex houses facilities used for studying the effects of radiation on reactor materials and fuels. Materials are tested under operating reactor conditions. The ATR reactor is a water cooled test reactor with operating power levels up to 250 MW.

The MFC was formerly known as Argonne National Laboratory-West and was the location for the Experimenter Breeder Reactor (EBR)-II, which was used extensively for several decades in reactor fuel and fuel cycle development programs before its shutdown in 1994. The MFC currently supports missions in fuel examination and reactor fuel and materials development and demonstration programs supporting nuclear energy technologies.

The Naval Reactor Facility (NRF) on the INL supports the U.S. Navy's nuclear powered fleet in a fuel and material research and development capacity. Spent nuclear fuel from Navy vessels is shipped to NRF for examination, processing, and preparation for permanent geologic repository storage. The mission of the NRF is important to national security in providing reactor fuel development as well as an end-of-life disposal support program.

Remote-handled low-level waste (RH LLW) that is generated at these various locations at the Idaho National Laboratory (INL) requires proper disposal. The predominant generators of RH waste are the NRF and the ATR Complex from established and ongoing missions. A lesser amount of waste is expected to be generated from new missions, including processing of EBR-II waste currently in storage at the Radioactive Scrap and Waste Facility (RSWF) located at the MFC.

Since the mid 1970's, RH LLW generated at NRF has been disposed of at the Radioactive Waste Management Complex (RWMC) in disposal vault systems. Originally, the waste was buried in bored soil vaults. After placement of the RH LLW container, the hole would be backfilled, completing the disposal process. However, beginning with a project in 1992, the disposal method for RH LLW changed from a soil vault to a concrete disposal vault system. [1]

On July 1, 2009, the DOE approved a mission need statement for the INL RH-LLW Disposal Project (RHLLWDP) to develop replacement RH LLW disposal capability in support of INL's nuclear energy mission and the Naval Nuclear Propulsion Program[2], and identified the disposal facility associated with this project as the highest ranked alternative for providing continued, uninterrupted RH LLW disposal for the INL.

The proposed facility design will retain many of the characteristics of the current RH-LLW vaults at the RWMC. The current process for disposal in the concrete vaults will be retained. This involves transport of remote-handled LLW from the individual generators to the proposed RH-LLW disposal facility in scrap casks on a truck-trailer transporter. The same cask liner placement methods currently used at RWMC for the disposal for NRF waste liners will be used at the proposed RH LLW disposal facility. Figure 1 depicts the proposed concrete facility vault disposal system based on previous successful disposal systems.

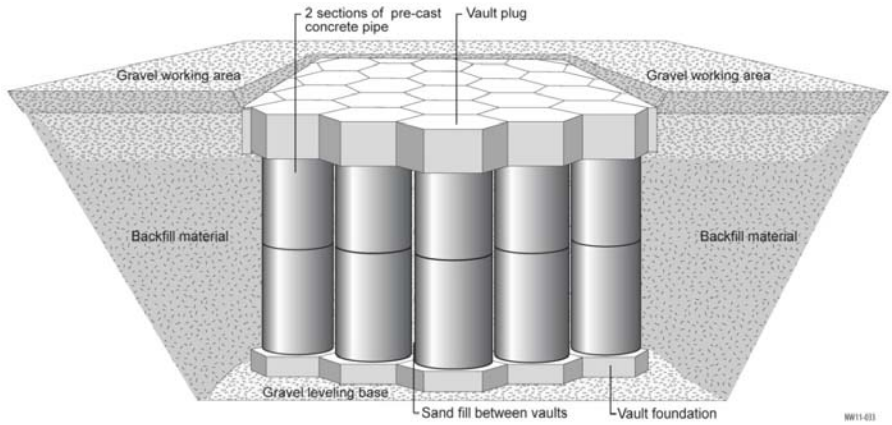


Figure 1. Concrete vault layout.

The facility will be a stand-alone facility providing its own administrative support and maintenance infrastructure. The facility will be laid out in a manner which will allow trucks to enter the disposal facility and proceed directly to the unloading area where a dedicated crane will unload the shielded transportation package and deposit the waste directly into the concrete vault system while minimizing direct radiation exposure to facility workers. A cask-to-vault adapter system will be used to provide a shielded interface between the transportation cask and the concrete vault, also reducing exposure to radiation during waste placement operations. Figure 2 illustrates the facility layout and also shows the cask unloading activities expected to be utilized in the project.

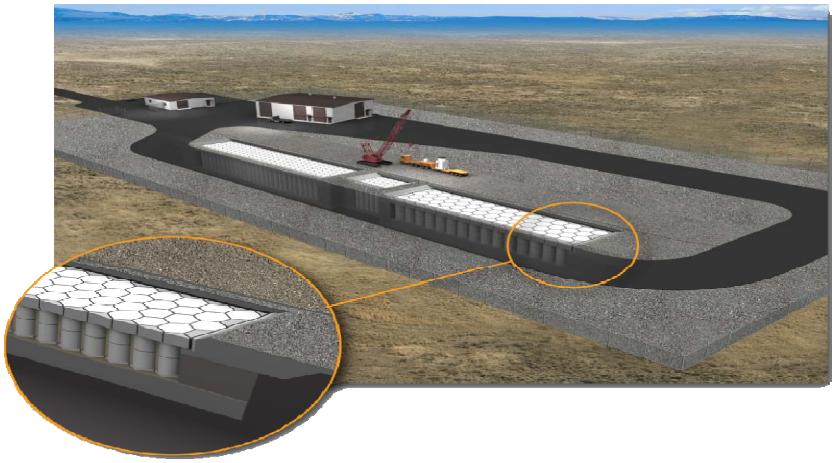

Figure 2. Conceptual layout for the waste disposal facility.

## *Methodology - Hazardous Material Inventory*

RH LLW is considered to be any waste container with contact radiation dose rate (including neutron and beta radiation) >200 mrem/hr. Waste streams generated at ATR may include waste containers with radiation exposure rates up to 30,000 R/hr at near contact, and NRF waste streams may be encountered with exposure rates up to 60,000 R/hr at near contact.

The waste streams that will be accepted for storage at the RH-LLW disposal facility must meet the requirements for LLW as specified in DOE Manual 435.1, "Radioactive Waste Management Manual."[3] These requirements specify that the material must contain <100 nCi/g transuranic (TRU) radionuclides. At this level, there would be <0.34 Ci in the largest (assume 3,400 kg) waste container. For an assumed maximum of two waste containers per vault, this is equivalent to a maximum TRU inventory of 0.68 Ci.

Waste streams containing liquids or Resource Conservation Recovery Act (RCRA) hazardous waste components are expressly excluded from disposal at the proposed facility.

Preliminary evaluations of the waste streams proposed for disposal in this facility indicate that the waste streams involved do not contain significant quantities of fissionable material. A 15 gram limit in waste shipments would be compliant with transportation limits of 40 CFR 173.424(h) and would also be low enough that criticality would not be a credible event even when considering multiple waste containers per vault and also considering potential interaction between adjacent vaults.

These assumptions of low TRU concentration, lack of RCRA hazardous components, and low fissionable material content will be protected through a waste certification program and compliance with an appropriate facility waste acceptance criteria (WAC) document.

The waste streams destined for disposal at the proposed facility consist largely of activated reactor hardware, highly radioactive process materials, and resins from coolant purification systems. The reactor hardware waste streams are characterized as consisting of mostly activated metals with Co-60 being a principle component. The resin waste is comprised of contaminants removed from primary cooling systems and contains quantities of fission generated isotopes in addition to activation products. In no case will reactor fuel be considered for disposal at this facility. Table 1 shows maximum expected content of select inventory components.[4]

| Waste Stream | Maximum TRU content (nCi/g) | Maximum Co-60 content (Ci) | Maximum Fissile Material Content (g) |
|---|---|---|---|
| NRF activated metals | 5.4 | 2500 | 0.06 |
| | 5.4 | 7000 | 0.15 |
| NRF resins | 7.4 | 159 | 0.17 |
| | 7.4 | 443 | 0.48 |
| ATR activated metals | 0 | 2000 | 0 |
| ATR resins | 5.0 | 44 | 1.2 |
| MFC legacy waste (RSWF) | 0.4 | 337 | 6.5 |
| MFC future (HFEF) | 26 | <0.001 | 0.11 |

Table 1. Maximum concentrations of selected inventories

## *Results - Compare to HC levels*

DOE-STD-1027-92, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports,"[5] and the Supplemental Guidance to that

document provide a uniform methodology in developing nuclear facility hazard categorization. The first step in this process is to apply a simple screening of radiological hazards present in a facility to determine likely hazard categorization. The initial screening does not consider material form, location, dispersibility, and interaction with available energy sources. The only modifications applied in the initial categorization are the exemptions of sealed sources and radionuclides in commercially available products.

A final hazard categorization is made later in the process giving consideration to 1) change in release fractions from those used in DOE-STD-1027 or 2) a change in the amount of the total facility inventory subject to an accident due to facility features that preclude bringing material together or interactions from a common severe phenomenon (facility segmentation).

In the case of the RH-LLW disposal facility, initial hazard categorization was performed during the conceptual design phase and documented in the project Safety Design Strategy (SDS)[6] and Conceptual Safety Design Report (CSDR)[7] following guidance of DOE-STD-1189, "Integration of Safety into the Design Process."[8] It was determined at that time that the facility would exceed the DOE-STD-1027 threshold quantities (TQ) for several radionuclides. Therefore the initial hazard categorization for the facility was HC-2 nuclear facility based on the entire facility inventory.

During preliminary design the hazard categorization was revisited with consideration given for facility segmentation precluding the entire facility inventory being involved in any credible accident. Table 2 shows the maximum TQ of a single container or for a single waste storage vault where more than one container may be disposed in a single vault.[4]

| Waste Stream | Container Designation | Sum of Ratios to HC-2 TQs (single container) | Number of Containers per vault | Sum of Ratios to HC-2 TQs (single vault) |
|---|---|---|---|---|
| NRF activated metals | 55-ton cask liner | 0.021 | 2 | 0.041 |
| NRF activated metals | New concept container | 0.058 | 1 | 0.058 |

Table 2. Maximum HC-2 sum of ratios.

As shown in Table 2, the highest anticipated inventory for a loaded waste disposal vault is a HC-2 sum of ratios of 0.058. This indicates that based on DOE guidance, the individual vaults can be categorized as HC-3 if considered as separate facility segments.

## *Conclusion*

Facility segmentation is an accepted method for downgrading a HC-2 nuclear facility to HC-3 by using the multiple structure facility method described in DOE-STD-1027. In this case the RH-LLW disposal facility would qualify as a facility consisting of multiple, physically separated structures, each containing radiological inventories. The facility therefore qualifies as HC-3 in the final hazard categorization. The question then becomes is this best for the facility.

As a HC-3 facility, the safety basis could be established on qualitative analysis since by definition the potential exists only for significant localized consequences. In this case, the facility design criteria are determined by the seismic design criteria (SDC) of DOE-STD-

1189. The Performance Category (PC) is unaffected since the facility is a below-ground facility. Natural phenomena hazards (NPH) such as wind force, snow load, and lightning are not significant hazards driving design requirements. The SDC will not change whether the facility is HC-3 or HC-2, so no design changes result from either hazard category designation.

By being classified as HC-2, the facility could be more flexible with regard to disposing of other waste streams not currently identified. From an operations standpoint, as a HC-2 facility, there is a reduced risk in that there are no upper limits on vault inventory, so no danger of exceeding a hazard category TQ. As HC-2, new concept vault designs could be use, again providing more facility flexibility.

In the end, if there are no benefits or advantages of downgrading the facility to HC-3, then the HC-2 designation derived from the initial hazard categorization should be maintained.

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