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Using a Risk-Based Methodology for the Transfer of Radioactive Material within the Savannah River Site Boundary (Onsite Transfers)

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ABSTRACT

Shipment of radioactive materials (RAM) is discussed in the Code of Federal Regulations in parts of both 49 CFR and 10 CFR. The regulations provide the requirements and rules necessary for the safe shipment of RAM across public highways, railways, waterways, and through the air. These shipments are sometimes referred to as in-commerce shipments. Shipments of RAM entirely within the boundaries of Department of Energy sites, such as the Savannah River Site (SRS), can be made using methodology allowing provisions to maintain equivalent safety while deviating from the regulations for in-commerce shipments. These onsite shipments are known as transfers at the SRS. These transfers must follow the requirements approved in a site-specific Transportation Safety Document (TSD) [1]. The TSD defines how the site will transfer materials so that they have equivalence to the regulations. These equivalences are documented in an Onsite Safety Assessment (OSA). The OSA can show how a particular packaging used onsite is equivalent to that which would be used for an in-commerce shipment. This is known as a deterministic approach. However, when a deterministic approach is not viable, the TSD allows for a risk-based OSA to be written. These risk-based assessments show that if a packaging does not provide the necessary safety to ensure that materials are not released (during normal or accident conditions) then the worst-case release of materials does not result in a dose consequence worse than that defined for the SRS. This paper will discuss recent challenges and successes using this methodology at the SRS.

BACKGROUND

The SRS has been making shipments and transfers of RAM since the first SRS facilities began production in the early 1950s. Transfers were mainly between production facilities. In the past two decades, however, the SRS has transitioned from the production of RAM to clean-up and disposition of RAM. The need has arisen in this time for an efficient way to safely transfer RAM that is awaiting final disposition and burial (wastes) as well as a small amount of RAM that still has a use (non-wastes). These non-wastes typically are transferred using a deterministic methodology that is very similar to and meets the requirements found in the associated CFR. This paper will not focus on these non-wastes but instead will focus on the wastes that are typically transferred at the SRS.

Types of Waste at the SRS

The SRS primarily has two types of wastes. Those two types are transuranic (TRU) waste and low-level waste (LLW). LLW, such as contaminated ground soils, are typically transferred to a central location at the SRS and are buried. TRU waste produced

at the SRS is typically transferred to a central location to be packaged and shipped to a facility offsite. These wastes are produced in volumes that require frequent transfers to the onsite burial (for LLW) and the packaging (for TRU) locations.

Regulations and Rules for Onsite Transfers

The contractors at SRS operate their transportation program under the authority granted by DOE Order 460.1C [2] and 10 CFR 830 [3]. The resulting document from the rules outlined in the DOE Order and the CFR is a site-specific Transportation Safety Document (TSD). The SRS TSD is approved by the local DOE office (Savannah River, DOE-SR) and allows for the use of a Risk-Based Methodology for the assessment of onsite transfers of RAM. The risk-based onsite transfer is assessed and analyzed in an Onsite Safety Assessment that is also approved by DOE-SR. All transfers authorized under an OSA must show equivalent safety for the public and the co-located SRS worker.

DISCUSSION

History of Risk-Based Methodology at the SRS

The use of a Risk-Based OSA is not a new concept for the SRS. Throughout the past decade risk-based methodologies have been incorporated into the transportation program at the SRS. However, these assessments generally relied on DOT data and inputs to show equivalent safety. With the introduction of the DOE-SR approval of the OSA program, additional approvers began to scrutinize the program.

Challenges

With the introduction of the DOE-SR approval cycle into the OSA program came new challenges. The first was that the local DOE did not have many, if any, analysts and engineers intimately familiar with the Code of Federal Regulations (CFR) related to transportation of RAM, the DOT, DOE, and NRC transportation regulations, and the DOE orders related to the onsite transportation of RAM. DOE-SR instead had reviewers familiar with the regulations and orders related to facility safety. These orders are somewhat similar, but they do have quite a few differences as well. It is these differences that proved to be a challenge to gain approval for risk-based OSAs since the typical DOE facilities have large barriers preventing the release of RAM and use various engineered controls to keep RAM contained and isolated.

For instance, a typical production facility uses either a sand filter or a large bank of HEPA filters to mitigate the release of RAM and thus reduce the radiological dose released into the atmosphere. This allows for the facility to have a large amount of RAM within its structure. However, a transportation package does not have a sand filter system nor is it practical to have a bank of HEPA filters attached to a package. Additionally, the package itself will be subjected to accidents that the typical facility is not analyzed to withstand (it is also noted that the typical facility must withstand events that are not

typically analyzed in transportation events due to the mobile nature of transportation packages).

Type B transportation packages are designed to withstand the accidents found in the CFR and would be analyzed for use onsite via a deterministic OSA. Type B packages are typically very expensive and would not be economical to purchase for the transport of the large volume of wastes at the SRS. So, the packages used for these transfers may not withstand the accidents within the CFR and thus may release their contents.

Controls for Packages Under Risk-Based Methods

Since the packages may release their contents, the only control that can be used for limiting the release is the initial loading of the content. In order to determine what the maximum loading for the individual package would be, it must be determined what the impact is to the offsite and co-located workers during an accident. This requires a back-calculation for the initial content based on the allowed dose to the offsite and onsite individuals. The DOT regulations allow a member of the general public to receive, in an accident involving RAM, a dose of 5 rem. The SRS transportation program, in the TSD, sets the offsite dose limit to 5 rem. The onsite collocated worker is allowed to receive a dose of 100 rem at a distance of 100 meters (from the source). In almost every case analyzed, the dose to the onsite worker bounds the dose to the offsite member of the public. In other words, for an accident at SRS involving RAM, the member of the public will not receive a dose greater than 5 rem. It is also important to note that the calculations and analyses used to compile and determine these numbers are very conservative and often incorporate over-conservatisms to further protect the onsite and offsite individuals.

Methodology-Dose Calculations

The calculations for the dose utilize the source term equation found in DOE-HDBK-3010-94 [4]. This source term is the only dose included in the individual dose accumulation due to the location of the site and the general radiological control program at the SRS. DOE-HDBK-3010-94 states that "[t]he airborne source term is typically estimated by the following five-component linear equation:

Source Term = MAR x DR x ARF x RF x LPF

where:
MAR = Material-at-Risk (curies or grams),
DR = Damage Ratio,
ARF = Airborne Release Fraction (or Airborne Release Rate for continuous release),
RF = Respirable Fraction, and
LPF = Leakpath Factor.

Utilizing this method for source term gives the maximum content loading for the entire transfer or conveyance. Adjusting the values for DR and MAR allows for the reduction in the robustness of the packaging and increase in the maximum content loading.

Questions and Answers

The first submittals to DOE-SR using the risk-based methodology resulted in quite a few questions from the review team. The reviewers were very knowledgeable in the use of the DOE Orders, DOE Standards, and the applicable CFRs for facility safety; however, many of the reviewers had little experience in the transportation safety arena. Thus, many of their questions on the OSAs focused on the use of DOT standards which were different than the standards used for generation of facility safety documentation at the SRS. In order to meet production schedules, it was decided by the OSA writing team to adopt the facility standards for generation of the content limits within the OSA. Although beneficial because of the few differences in the calculations, adopting those facility standards reduced the maximum content loading per package and conveyance.

CONCLUSIONS

The use of risk-based methodology in the development of onsite safety assessments allows for maximum flexibility in the packaging of radioactive materials and wastes for transfer between areas at the SRS. This flexibility ensures that the SRS is operated safely, efficiently, and economically while ensuring safety for both the offsite individual as well as the onsite worker. The risk-based methodology allows for the facilities to maximize the content loading per conveyance to decrease the number of transfers at the SRS and eliminating the need for expensive packages that are over-engineered for the applications at the SRS. The maximum allowable loading per package and conveyance is typically still much lower than the actual content loading per package seen in the facilities. Consequently, the facilities are able to make all necessary transfers utilizing the risk-based OSA methodology.

CONTRACT NUMBER AND DISCLAIMER

Contract Number

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy.

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