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ONSITE TRANSPORTATION OF RADIOACTIVE MATERIALS AT THE SAVANNAH RIVER SITE

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ABSTRACT

The Savannah River Site (SRS) Transportation Safety Document (TSD) defines the onsite packaging and transportation safety program at SRS and demonstrates its compliance with Department of Energy (DOE) transportation safety requirements, to include DOE Order 460.1C, DOE Order 461.2, *Onsite Packaging and Transfer of Materials of National Security Interest*, and 10 CFR 830, *Nuclear Safety Management* (Subpart B).

INTRODUCTION

SRS is a 310 square mile federal facility located near Aiken, SC. SRS consists of 14 major areas including two former Reactor areas (P and R), three material storage areas (C, K, and L), two Processing and Tank Farm areas (F and H), three waste management areas (E, S, and Z), a former heavy water reprocessing area (D), a Central Shops area (CS), the Savannah River National Laboratory (SRNL) 3/700 (A), and an administration and support area (B). The roads and railways onsite were developed to provide safe and efficient transportation of personnel, supplies, products, and wastes in support of facility operations. U.S. Highway 278 (US 278) and SRS Road 1 parallel the site along the site boundary. Two major public highways that traverse SRS are South Carolina Highway 125 (SC 125) and US 278. Both highways are patrolled and maintained by the state of South Carolina. Access to other areas on SRS is strictly controlled.

DOE Order 460.1C establishes packaging and transportation requirements to ensure the safety of offsite shipments and onsite transfers of hazardous material. The safety basis requirements for all onsite packagings are derived from DOE Order 460.1C. In accordance with DOE Order 460.1C, the TSD describes three different ways that radioactive material can be transferred onsite. Packages can be DOT compliant, packages/transfers with greater than or equal to HC-3 quantities of radioactive materials can be transferred under a DOE-SR approved Transportation Safety Basis (TSB) document, or packages/transfers containing less than HC-3 quantities of radioactive materials can be transferred under a SRNS approved (TSB) document. Packages that are DOT compliant meet the DOT Hazardous Material Regulations. Packages/transfers with greater than or equal to HC-3 quantities of radioactive materials are subject to the requirements of 10 CFR 830. Packages/transfers containing less than HC-3 quantities of radioactive materials are subject to the principles of integrated safety management.

OVERVIEW OF TRANSPORTATION SAFETY

Onsite transfers mean transfers via transport vehicle (including rail) within the SRS boundary but external to the boundary of a facility Documented Safety Analysis (DSA). Onsite transfers stay within the contiguous fenced, access controlled, outer perimeter of SRS and do not cross or travel along a public access road, and travel outside the boundary of a facility DSA. The term "facility" describes distinct DOE and/or contractor buildings, plants, multi-complex storage units, laboratories, and/or test ranges normally within a fenced or otherwise access-controlled operating area within the boundaries of a site or as designated within the applicable facility Safety Basis document. Onsite transfers do not include intra-facility movements covered by a facility DSA.

The TSD onsite transfer definition is derived from the U.S. Department of Transportation (DOT), which defines "transportation" as the movement of material and the loading, unloading, and storage incidental to that movement. Loading means placement of the package (in the presence of carrier personnel) onto a transport vehicle, and unloading means removing a package from a transport vehicle. For the purpose of onsite transportation at SRS (or onsite transfer), an onsite transfer occurs between the originating and receiving facility

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DSA boundaries, and may begin as early as securement of the package onto the conveyance, and may end when the conveyance arrives at the destination and is accepted by the receiving facility. Onsite transfer of radioactive material can be performed in three ways:

(1) Packages (i.e., contents and packaging) can be DOT compliant.
(2) Packages/transfers containing greater than or equal to Hazard Category (HC)-3, as defined in DOE STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports,* quantities of radioactive materials can be transferred under a DOE-Savannah River (DOE-SR) approved Transportation Safety Basis (TSB) document (i.e., Onsite Safety Assessment [OSA] or Non-routine Transfer [NRT]).
(3) Packages/transfers containing less than HC-3 quantities of radioactive materials can be transferred under a Savannah River Nuclear Solutions (SRNS) approved TSB document (i.e., Onsite Transportation Report [OTR]).

All onsite transfers of radioactive hazardous material are radiologically controlled by the SRS Radiological Control Manual 5Q, which provides equivalent safety to the 49 CFR required "communications" (e.g., marking, labeling, and placarding). Manual 5Q procedures implement radiological monitoring for personnel exposure, package radiological conditions labeling, and package tracking when radiological conditions warrant.

10 CFR 830

Onsite transfer activities containing HC-3 quantities or greater of radioactive materials are subject to 10 CFR 830 Subpart B, Safety Basis Requirements. The three main requirements defined in 10 CFR 830 are:

- A DSA that addresses the hazards and the controls necessary to provide adequate protection to the public, workers, and the environment from these hazards.

- Technical Safety Requirements (TSRs) that establish limits, controls, and related actions necessary for safe operations. The exact form and contents of the TSRs will depend on the circumstances as defined in the DSA.

- An Unreviewed Safety Question (USQ) process.

Table 2 in 10 CFR 830 sets forth an acceptable methodology for preparing a DSA for transportation activities. The “Safe Harbor” methodology defined in 10 CFR 830 is a TSD prepared in accordance with DOE Guide 460.1-1. To comply with 10 CFR 830, SRS has established the TSD in accordance with DOE Order 460.1C and DOE Guide 460.1-1. A key provision of the TSD is the definition of the interface between the TSB and the Safety Basis of the originating and/or receiving facility. By definition of this TSD, that interface occurs when the package leaves the boundary of the originating facility’s DSA (as that boundary is defined in the DSA) and when the package enters the boundary of the receiving facility’s DSA. The TSD is the governing safety document when the package is outside of either DSA boundary.

The TSB, in the form of an Onsite Safety Assessment (OSA), Non-Routine Transfer (NRT) or Onsite Transportation Report (OTR), addresses the hazards associated with the transportation activities and defines the administrative controls and design features necessary to provide adequate protection to the public, workers, and the environment. Because of the nature of the transportation activities, only administrative controls and design features (the vehicle and the package) are applicable. No other safety systems, structures or components (SSCs) are involved in the transfer.

As described above, TSRs establish limits, controls, and related actions necessary for safe operations. TSRs are developed primarily to ensure proper operability of SSCs and to provide actions in the event that such SSCs become inoperable. This primary function is not relevant to onsite transportation activities given the lack of safety SSCs credited in the OSAs and NRTs (other than vehicles and packages). The administrative controls (OSA/NRT controls and programmatic attributes) typically address inventory limits, speed limits, and traffic route restrictions. The package itself is a passive design feature, which once in transport, has no related operator actions associated with it. The degree of specificity within the OSA for these administrative controls and design features is consistent with the degree of specificity within a TSR. Additionally, the implementation of these DOE-SR approved TSB controls is consistent with the operational and engineering rigor associated with the implementation and use of DOE-SR approved facility SB documents. Based upon these considerations, no benefit to the Transportation Program is realized by creating a separate TSR document to simply specify and implement the same controls already delineated in the OSAs/NRTs. This position is consistent with the provision contained in 10 CFR 830, Subpart B, Appendix A, Subsection G.4 that states: “The exact form and contents of technical safety requirements will depend on the circumstances of a particular nuclear facility as defined in the documented safety analysis for the nuclear facility.”

Implementation of the robust safe harbor methodology at SRS, including the 10 CFR 830 requirement for TSRs, was first approved in communications between the DOE-SR Manager and EM-1 and EH-1 [DOE Memorandum, Jessie Hill Roberson (EM-1) to Beverly Cook (EH-1), *Guidance for Onsite Transportation Activities*, December 19, 2002]. In these communications, the DOE-SR Manager explicitly stated that no transportation TSRs were anticipated or required. The formal approval of the robust safe harbor approach to 10 CFR 830 compliance occurred when DOE-SR approved the initial TSD in 2002.

The requirements of 10 CFR 830.203 for Unreviewed Safety Question (USQ) for non-DOT-compliant onsite transfers are met by Transportation Manual 19Q. The Transportation Safety Question (TSQ) process is used to review a situation that could affect the TSB or the associated implementing transportation procedures, and to determine if DOE-SR approval is necessary prior to the implementation of the proposed activity.

The 10 CFR 830.203 requirements for a process to identify and disposition a potential inadequacy of the DSA (e.g., TSB document) are met by utilization of the existing Potential Inadequacy in the Safety Analysis (PISA) process as described in the Facility Safety Document Manual 11Q. The Manual 11Q process formally identifies and tracks the disposition of the PISA as it relates to the TSB documents. This includes the potential declaration of a PISA and a Discovery USQ, as well as the associated Evaluation of the Safety of the Situation. The Manual 11Q PISA process is to be followed with the exception that the TSQ process is used to measure the significance of a PISA (i.e., determine if a Discovery USQ exists) rather than the USQ process.

DOE ORDER 460.1C

DOE Order 460.1C establishes packaging and transportation requirements to ensure the safety of offsite shipments and onsite transfers of hazardous material. The Order requires that offsite shipments for DOE sites be in accordance with the DOT HMR [49 CFR Part 100-185].

The DOE transportation guidance, DOE Guide 460.1-1, allows use of risk-based methodologies to demonstrate that onsite safety is equivalent to that required by DOT for offsite shipping. One benchmark against which safety equivalence can be measured is the degree of risk implicit in the DOT regulations for offsite shipment of radioactive materials. If the risk of an onsite transportation activity is equal to or less than that accepted by DOT for offsite transport, then safety equivalence has been demonstrated.

The risk-based methodology was developed in 2001 and presented in an international packaging and transportation symposium, where it received considerable peer review [K. Stephens, *Use of Risk Assessment in Onsite Radioactive Material Transfers*, PATRAM 2001, International Symposium on the Packaging and Transportation of Radioactive Materials, Chicago, IL USA, September 3-7, 2001]. The DOE-SR acceptance of the methodology was contained in a letter from J. Allison to J. Oakland, *Recommendations for Safety Equivalence Demonstration in Onsite Safety Assessments (OSAs) (Your letter, 5/31/01)*, VC-01-0048, August 15, 2001.

DOE Order 460.1C specifies that onsite transfers either be in accordance with the HMR, or be justified through demonstration of safety equivalence to the HMR. The Order and the associated Guide, DOE Guide 460.1-1, stipulate that the equivalence can be established through a combination of packaging and other factors, such as communications and control measures. The Guide further allows for a graded approach, in which materials representing a greater hazard are subject to greater containment, communications, and control requirements. The Guide allows for two types of methodologies to demonstrate compliance with the Order: Deterministic or Risk-based.

The following examples pertain to radioactive material onsite transfers.

Deterministic

For Type B material quantities, the transport system is expected to prevent loss of containment for both normal handling and for site-specific Credible Abnormal Conditions (CAC). For Type A or lesser material quantities, the HMR assume that the packaging fails under abnormal conditions, and the quantities of material transported are limited such that no offsite receptor at the site boundary would receive more than 5 rem exposure from an accident.

Risk-Based

DOE Guide 460.1-1 allows use of risk-based methodologies to demonstrate safety equivalency and requires that those methodologies be described in the TSD. However, the Guide does not specify nor restrict the methodologies to be used or the conditions for acceptability.

Manual 19Q defines the specifics of the SRS program. Non-radioactive hazardous material packaging is required to be DOT compliant for onsite transfers. Manual 4Q, *Industrial Hygiene Manual*, and Manual D4, *Transportation Administrative Procedures*, contain the details of how the 49 CFR requirements are met.

The remainder of this chapter describes the methodology used at SRS, along with information on related matters such as controls and implementation.

IMPLEMENTATION

The DOE guidance for radioactive material transport allows for use of a graded approach, based on a hierarchy of hazardous materials (i.e., based on risk). In essence, the materials of more concern merit more care, and vice versa. The SRS onsite transport program mirrors the hierarchy inherent in the DOT/ International Atomic Energy Agency (IAEA) regulations for offsite transport. In particular, the hierarchy consists of Type B, Type A Fissile, Type A, and the range of lesser categories specified in the regulations. In many cases, the same high level of analysis and control is applied to all the categories, including those associated with the items of lesser concern, such as low level waste. In any case, the analyses and controls shall be oriented toward preserving the basic requirements, that is, the 5 rem criterion for deterministic methodology, or the criteria for risk-based analyses.

An OSA demonstrates safety equivalence, in accordance with Manual 19Q. This procedure identifies the responsibilities and requirements for controlling the generation of OSAs. Equivalence is frequently demonstrated through an evaluation of packaging performance that shows requirements are met deterministically. In some cases, the demonstration of equivalence uses a risk-based approach, the methodology of which is described in a subsequent section of this TSD.

Deterministic

For onsite risk-based transfers, each of the following dose criteria shall be met:

- Less than or equal to 5 rem at the site boundary
- Less than or equal to 100 rem at 100 meters

Risk Based

In the PATRAM paper cited previously, the risk DOT accepts was calculated to be between 2.6E-3 rem/yr (interstate highways) and 37.5E-3 rem/yr (urban areas). Given that range, the previous risk standard used at SRS for the past several years was conservatively set at 5E-3 rem/yr. The inputs to that risk calculation came predominantly from a comprehensive study of transportation risks, conducted by Argonne National Laboratory [D.F. Brown, et al., *A National Risk Assessment for Selected Hazardous Materials Transportation*, ANL/DIS-01-1, December 2000]. A recent review of hazardous material transportation accident statistics shows that hazardous material transportation is safer today and that the risk criterion used at SRS of 5E-2 rem/yr remains valid. The calculation shows that the risk accepted by DOT of 15E-2 rem/yr remains valid. The current risk criterion for use at SRS has been set at 5E-2 rem/yr.

CONCLUSIONS

The Savannah River Site Transportation Safety Document defines the onsite packaging and transportation safety program at SRS and demonstrates its compliance with Department of Energy (DOE) transportation safety requirements, to include DOE Order 460.1C, DOE Order 461.2, *Onsite Packaging and Transfer of Materials of National Security Interest*, and 10 CFR 830, *Nuclear Safety Management* (Subpart B). The methodology includes both deterministic and risk based approaches. The consequence criteria for deterministic approach is less than or equal to 5 rem at the site boundary and less than or equal to 100 rem at 100 meters. The risk based criteria is 5E-2 rem/yr.