HANFORD SITEWIDE

TRANSPORTATION SAFETY DOCUMENT

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CHAPTER 1.0 - PURPOSE, SCOPE, AND APPLICABILITY

This chapter describes why the *Hanford Sitewide Transportation Safety Document* (TSD) is required, the scope of its coverage and applicability to contractors, user organizations, and individuals responsible for hazardous material and waste transportation and packaging (T&P) activities at the Hanford Site.

1.1 INTRODUCTION AND PURPOSE

This TSD defines the onsite T&P program at the Hanford Site, which complies with the U.S. Department of Energy (DOE) transportation safety requirements specified in DOE Order 460.1B, *Packaging and Transportation Safety*. This TSD is the onsite documented safety analysis (DSA) for T&P activities. Package-specific safety documents (PSSD) demonstrate compliance with the DSA for specific packages used onsite, and are considered to be part of the T&P safety basis. The TSD complies with the safe harbor methodology prescribed in Title 10 *Code of Federal Regulations* (CFR) 830, "Nuclear Safety Requirements," documenting compliance with the nuclear safety rule for T&P activities.

DOE Order 460.1B and 10 CFR 830 require each DOE site to establish and maintain an onsite T&P program for the safe movement of hazardous materials, substances, and wastes. The T&P program is to be documented in an onsite TSD that is approved by the DOE, Richland Operations Office (RL). The program must provide a level of onsite safety equivalent to that achieved offsite under U.S. Department of Transportation (DOT) regulations provided in 49 CFR Subchapter C, "Hazardous Materials Regulations," and U.S. Nuclear Regulatory Commission (NRC) standards provided in 10 CFR 71, "Packaging and Transportation of Radioactive Material."

This TSD includes the following:

- Identification of responsibilities, lines of authority, and program approval procedures.
- Definition of minimum safe packaging requirements including necessary design, fabrication, and quality assurance (QA) elements, using appropriate codes and standards.
- Description of the process and analysis used to ensure equivalent safety requirements are established.
- Description of the Hanford Site including maps identifying boundaries, railways, and roadways that clearly delineate offsite and onsite areas, and procedures for clearly establishing access control for any area having occasional public access.

- Provisions for effective emergency response and recovery under credible accident conditions (AC).

- Process for accomplishing nonroutine T&P activities

- Process for identifying and evaluating unreviewed safety questions for transportation (USQ_T).

This TSD also addresses onsite "equivalent safety" by establishing a comprehensive set of onsite T&P performance standards and risk-based standards. The requirements and standards presented are equivalent to DOT and NRC standards (10 CFR 71) currently used for commercial offsite transportation. Hanford Site standards, however, are developed to be reflective of the unique transport environment within Hanford Site boundaries. Hanford Site restricted roadways, fenced facilities, Hanford Patrol inspection points, and barricades, as well as weather and physical location, shape Hanford's unique transportation environment. Additionally, Hanford Site contractors retain control over all onsite shipments, provide enhanced worker training, and possess unique site emergency preparedness and response capability that influence safety across the Hanford Site. "Equivalent safety" for on-site shipments is documented in DOE-approved PSSDs and/or exemptions. Approved exemptions are generally termed One-Time Requests for Shipment (OTRS), and provide bases for maintaining equivalent safety for conditions that do not warrant preparation of a formal PSSD.

1.2 SCOPE AND APPLICABILITY

The TSD encompasses all onsite shipments of government-owned hazardous materials, substances, and wastes within the Hanford Site, which includes radioactive materials and wastes. Only materials identified as hazardous by the DOT, and regulated if shipped in commerce, are covered. The modes of transportation are defined in the DOT regulations (e.g., vehicles, vessel, air).

The TSD does not include movement of these government materials by hand or hand truck. This movement must be included in the contractor's industrial safety and health program (29 CFR 1910/1026, "Occupational Safety and Health Administration") and/or safety or authorization basis.

The movement by rail or vehicle of DOE-owned materials within and between onsite facilities is covered by this TSD. The TSD provides the framework for demonstration of equivalent safety for all movement of hazardous and radioactive materials on the Hanford site over rails and roadways where public access is controlled or restricted and includes intra-area and inter-area movements. An intra-facility transfer is the movement of material between individual buildings within a facility or facility complex or the surrounding compound area that is adequately covered under a single facility documented safety analysis (DSA) or other DOE-approved safety or authorization basis document.

This document and its provisions apply to DOE and all DOE Hanford Site prime contractors and their subcontractors performing government work at the Hanford Site, unless specifically excluded in their respective contracts.

Requests for a deviation to the requirements of this TSD must be submitted to DOE-RL for processing. The TSD exemption process is outlined in Chapter 9.0 for nonroutine shipments.

The DOE-RL Manager is the Hanford Site Approval Authority for the TSD. The DOE-RL Manager approves the content and applicability of this document.

All personnel involved in on-site shipments of hazardous and radioactive material are subject to the requirements of this TSD.

1.3 ROADMAP THROUGH THE TSD

Chapter 1.0 Purpose, Scope, and Applicability of the Hanford Site Transportation Safety Document. This chapter describes why the Hanford Sitewide TSD is required, the scope of its coverage and applicability to contractors, user organizations, and individuals responsible for hazardous material and waste T&P activities at the Hanford Site.

Chapter 2.0 Definitions and Acronyms. This chapter provides key definitions, common acronyms, and references specific regulatory sources for additional definitions that must be understood.

Chapter 3.0 Site Description. This chapter describes the Hanford Site boundaries and roadways used to transport hazardous materials and wastes.

Chapter 4.0 Organizational Responsibilities. This chapter identifies DOE-RL and contractor responsibilities and interfaces within the transportation safety program as defined in this TSD, and specific package development and approval process.

Chapter 5.0 External Regulations. This chapter identifies the external regulations that contain requirements applicable to onsite T&P activities. Several regulations are written specifically to address onsite packaging and transfer operations. Additional regulations apply to various activities that make up the overall process of T&P because they apply to the materials being handled or the activity being performed.

Chapter 6.0 Site-Specific Standards, Procedures, and Instructions. This chapter provides standards, requirements, programs, and processes that are needed to support safe T&P operations such as integrated safety management, QA, configuration management, and equivalent safety. Alternate design and performance requirements for onsite packagings are identified.

Chapter 7.0 Safety Assessment Methodology. This chapter identifies the methodologies used for achieving and demonstrating onsite safety equivalent to that accomplished by complying with the DOT regulations. In addition, it identifies specific evaluation methodology and acceptance criteria to apply when demonstrating compliance with the requirements found in Chapter 6.0 for achieving equivalent onsite T&P activity safety.

Chapter 8.0 Routine Transfers. This chapter describes the processes and procedures used to make routine onsite shipments. All packagings prepared and shipped as routine must be authorized and fully comply with the provisions of the TSD. Basic procedures and processes for handling onsite shipments of hazardous materials and wastes are included in this chapter. Contractors provide more detailed facility/project operation procedures at the facilities where T&P activities occur.

Chapter 9.0 Nonroutine Transfers. This chapter describes the processes and procedures for dealing with nonroutine or emergency transfers. Conditions and circumstances for nonroutine or emergency transfers are defined, as well as applicable procedures and the approval process.

Chapter 10.0 Personnel Qualification and Training. This chapter describes the qualification and training requirements for Hanford Site contractor hazardous material (hazmat) personnel, authorized shippers, drivers, and USQ_T evaluators. Individual facilities and organizations, to which personnel may be assigned, may establish additional qualifications and required training based on specific job task analysis, job classification, or individual training plans.

Chapter 11.0 Documentation and Record Keeping. This chapter identifies documentation and records requirements for different package categories. It also identifies or references processes and procedures for managing this documentation throughout the Hanford Site.

Chapter 12.0 Incident Reporting and Emergency Response. This chapter describes requirements for incident reporting, emergency response, and references Hanford Site-specific policies, manuals, and procedures for emergency management. It also addresses emergency planning, drills and exercises, and Hanford Site response capabilities.

Chapter 13.0 Transport Vehicle Operations. This chapter describes the requirements for transport vehicle inspection and maintenance programs on the Hanford Site.

Appendices A through H provide additional information and guidance to support application of the requirements found in the TSD.

Appendix A. Approved Package-Specific Safety Documents List. This appendix provides listings of onsite package-specific safety documents (PSSD) and their approval status.

Appendix B. Justification and Basis for Equivalency to DOT Regulations for Type B and Fissile Packages Transported on the Hanford Site. This appendix provides the justification and basis for demonstrating the equivalency of the TSD requirements to those identified in 10 CFR 71.

Appendix C. Unreviewed Safety Question for Transportation (USQ_T) Process. This appendix identifies a procedure for performing USQ_T evaluations.

Appendix D. Technical Safety Requirements (TSDs) for Hanford Onsite T&P. This appendix identifies the TSRs established for Hanford onsite T&P.

Appendix E. Package-Specific Safety Document Contents and Format. This appendix provides guidance in formatting and preparing an onsite package-specific safety document (PSSD).

Appendix F. Additional Guidance For Preparation Of Package Specific Safety Documents. This appendix provides additional guidance and reference documents pertinent to preparation of PSSDs.

Appendix G. Justification and Basis for Shipment of Risked-Based Packages. This appendix provides the justification and basis used for demonstrating the equivalency of the TSD Hanford site equivalent requirements to those identified in DOT Hazardous Materials Regulations.

Appendix H. Example Checklists. This appendix contains typical example checklists used to verify or demonstrate compliance with shipping requirements.

Appendix I. Special Packaging Authorizations (SPAs). This appendix provides pre-approved packaging configurations for specified payloads.

1.4 PRECEDENCE OF REQUIREMENTS

In cases where there are two or more similar requirements or limits that impact design, testing, analysis, fabrication, or use of a packaging approved within the TSD, all requirements and limits must be met as applicable. If one requirement is less restrictive than another, the more restrictive requirement must be implemented unless an exception is granted under the provisions of this TSD.

1.5 POLICY FOR PRE-TSD PACKAGINGS AND THEIR APPROVALS

The status of existing onsite T&P systems is identified in Appendix A, Approved Package-Specific Safety Documents List, Table 1. Existing packaging, may continue to be used in accordance with the associated PSSD, as indicated in the appendix. Operation of the packaging systems shall be conducted in compliance with the existing PSSD (onsite safety analysis report for packaging [SARP], onsite safety evaluation for packaging [SEP], or revised PSSD) as identified in the table. Other existing onsite T&P systems shall not be used until approved by a Hanford DOE Approval Authority.

1.6 DOCUMENT UPDATES, MAINTENANCE, AND DISTRIBUTION

The TSD must be reviewed annually and updated, if determined necessary, to ensure the approved safety basis is maintained as regulations and requirements change and as Hanford Site conditions and mission requirements mature.

All TSD changes must be performed in accordance with a TSD maintenance program. The TSD maintenance responsibility is assigned to Fluor Hanford, subject to contractual changes that may be exercised by DOE.

TSD Maintenance includes minor changes and/or rewrites to provide clarifying language to the document. These are limited to inconsequential changes as discussed in Section 6.6.1.2. Major rewrites, redesigns, or analytical work are considered to be "updates," must be approved by DOE prior to use, and are handled separately based on Hanford Site programmatic needs.

Recommendations and changes must be submitted to DOE-RL in writing and demonstrate the required levels of safety are achievable based on packaging performance and/or risk assessment. The cognizant DOE Field Office Manager must approve all changes to the TSD, including consequential changes to PSSDs.

The requirement for annual reviews extends to include the active PSSDs in use onsite. Active PSSDs are to be reviewed annually to determine whether they require updating to remain consistent with the TSD, and revised at least annually, as needed, if there are changes that have been accepted but not implemented through the USQ_T process. As noted above, changes to the PSSDs require DOE approval prior to implementation.

1.7 REFERENCES

10 CFR 71, "Packaging and Transportation of Radioactive Material," *Code of Federal Regulations*, as amended.

10 CFR 830, "Nuclear Safety Requirements," *Code of Federal Regulations*, as amended.

29 CFR 1910/1026, "Occupational Safety and Health Administration," U.S. Department of Labor, *Code of Federal Regulations*, as amended.

49 CFR, Subchapter C, "Hazardous Materials Regulations," *Code of Federal Regulations*, as amended.

DOE Order 460.1B, *Packaging and Transportation Safety*, U.S. Department of Energy, Washington, D.C.

CHAPTER 2.0 – DEFINITIONS AND ACRONYMS

This chapter provides key definitions, common acronyms, and references specific regulatory sources for additional definitions that must be understood.

2.1 DEFINITIONS

For additional definitions related to this subject, see the following CFRs:

- 10 CFR 71.4, "Definitions"
- 49 CFR 171, "General Information, Regulations, and Definitions"
- 49 CFR 171.8, "Definitions and abbreviations"
- 49 CFR 173, "Shippers—General Requirements for Shipments and Packagings"
- 49 CFR 173.403, "Definitions"
- 49 CFR 178, "Specifications for Packagings"
- 49 CFR 178(a), "Definitions"
- 49 CFR 350.105, "What definitions are used in this part?"
- 49 CFR 355.5, "Definitions"
- 49 CFR 365.201, "Definitions"
- 49 CFR 367.1, "Definitions"
- 49 CFR 368.2, "Definitions"
- 49 CFR 371.2, "Definitions"
- 49 CFR 372.107, "Definitions"
- 49 CFR 375.1, "Applicability and definitions"
- 49 CFR 376.2, "Definitions"
- 49 CFR 381.110, "What definitions are applicable to this part?"
- 49 CFR 382.107, "Definitions"
- 49 CFR 383.105, "Definitions"
- 49 CFR 384.105, "Definitions"
- 49 CFR 385.3, "Definitions"
- 49 CFR 386.2, "Definitions"
- 49 CFR 387.5, "Definitions"
- 49 CFR 389.3, "Definitions"
- 49 CFR 390.5, "Definitions"
- 49 CFR 393.5, "Definitions"
- 49 CFR 395.2, "Definitions"
- 49 CFR 397.65, "Definitions"
- 49 CFR 399.205, "Definitions"

A_1 means the maximum activity of special form Class 7 (radioactive) material permitted in a Type A package. This value is either listed in 49 CFR 173.435, "Table of A_1 and A_2 values for radionuclides," or may be derived in accordance with the procedures prescribed in 49 CFR 173.433, "Requirements

for determining basic radionuclide values, and for the listing of radionuclides on shipping papers and labels."

A_2 means the maximum activity of Class 7 (radioactive) material, other than special form, low specific activity (LSA) or surface contaminated object (SCO), permitted in a Type A package. These values are either listed in 49 CFR 173.435 or derived in accordance with the procedure prescribed in 49 CFR 173.433.

Approval Authority (contractor) means the contractor person responsible for the contractor's overall onsite T&P program activities, including providing contractor approval to forward package specific safety documents (PSSDs) and changes to DOE for approval.
Approval Authority is the RL Manager, which is responsible for approving Hanford onsite transportation Safety documents, including approval of onsite PSSDs and exemptions. Additionally, the RL Manager is the Approval Authority for this TSD and is responsible for coordinating sitewide assessments of the program.

Authorization Basis is safety documentation supporting the decision to allow a process or facility to operate. Included are corporate operational and environmental requirements as found in regulations and specific permits, and, for specific activities, work packages or job safety analyses. (See also nuclear safety authorization basis.)

Box means a packaging with complete rectangular or polygonal faces, made of metal, wood, plywood, reconstituted wood, fiberboard, plastic, or other suitable material. Holes appropriate to the size and use of the packaging, for purposes such as ease of handling or opening, or to meet classification requirements, are permitted as long as they do not compromise the integrity of the packaging during transportation, and are not otherwise prohibited in this subchapter.

C means Celsius or Centigrade.

Cargo tank means a bulk packaging which: (1) Is a tank intended primarily for the carriage of liquids or gases and includes appurtenances, reinforcements, fittings, and closures (for tank, see 49 CFR 178.345-1(c), "Definitions"; 178.337-1, "General requirements"; or 178.338-1, "General requirements" as applicable); (2) Is permanently attached to or forms a part of a motor vehicle, or is not permanently attached to a motor vehicle but which, by reason of its size, construction or attachment to a motor vehicle is loaded or unloaded without being removed from the motor vehicle; and (3) Is not fabricated under a specification for cylinders, portable tanks, tank cars, or multi-unit tank car tanks.

Cargo tank motor vehicle means a motor vehicle with one or more cargo tanks permanently attached to or forming an integral part of the motor vehicle.

Categorical exclusion (CX) means a screening method that defines a category or categories of items or procedures that may be excluded from the unreviewed safety question for transportation (USQ_T) process. The justification for a categorical exclusion must define the conditions required for the exclusion to be valid. Categorical exclusions must be approved by the safety review board and the U.S. Department of Energy, Richland Operations Office (RL), before they become effective. A listing

of categorical exclusions is contained in Attachment C.9 to Appendix C of the *Hanford Sitewide Transportation Safety Document* (TSD).

Certificate of Compliance is the summary transportation safety document which contains technical requirements and operating conditions (payload specifications, package leak testing, surveillance, and other requirements) for a specific package design and specifies what the user (licensee) is authorized to transport in the packaging system. The Certificate of Compliance is the authorization document for a particular package or packaging system, including payload.

Change, as used in the USQ_T process, means a change created by any of the following conditions:

1. A physical modification (permanent or temporary) to a transportation activity as described in the documented safety analysis (DSA), or a revision to a transportation activity procedure (permanent or temporary), or other policies or procedures as described in the DSA;

2. Introduction of new tests or experiments; and/or

3. A technical safety requirement (TSR)-basis revision.

Class means hazard class. See hazard class.
Class 1. See 49 CFR 173.50 (Explosives)
Class 2. See 49 CFR 173.115 (Flammable gas)
Class 3. See 49 CFR 173.120 (Flammable liquid)
Class 4. See 49 CFR 173.124 (Flammable solid)
Class 5. See 49 CFR 173.128 (Oxidizer, organic peroxide)
Class 6. See 49 CFR 173.132 (Poisonous, infectious)
Class 7. See 49 CFR 173.403 (Radioactive)
Class 8. See 49 CFR 173.136 (Corrosive)
Class 9. See 49 CFR 173.140 (Miscellaneous hazardous material)

Closed transport vehicle means a transport vehicle or conveyance equipped with a securely attached exterior enclosure that during normal transportation restricts the access of unauthorized persons to the cargo space containing the Class 7 (radioactive) materials. The enclosure may be either temporary or permanent and, in the case of packaged materials, may be of the "see-through" type, and must limit access from top, sides, and bottom.

Closure means a device that closes an opening in a receptacle.

"Co-located" or "Onsite Worker" is represented by the maximum onsite individual, a hypothetical receptor located at the distance (at least 100 m [328 ft] or at the boundary of the facility or its emergency control area) and in the direction from the point of release at which the maximum dose occurs.

Combination packaging means a combination of packaging, for transport purposes, consisting of one or more inner packagings secured in a non-bulk outer packaging. It does not include a composite packaging.

Commerce means trade, traffic, transportation, or communication among the several States, or between a State and any place outside thereof, or between points in the same State.

Commercial motor vehicle (CMV) means a motor vehicle that has any of the following characteristics: (1) A gross vehicle weight, gross vehicle weight rating, gross combination weight, or gross combination weight rating of 4,537 kg (10,001 lb) or more; (2) Regardless of weight, is designed or used to transport 16 or more passengers, including driver; (3) Regardless of weight, is used in the transportation of hazardous materials and is required to be placarded pursuant to 49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements," Subpart F.

Composite packaging means a packaging consisting of an outer packaging and an inner receptacle, so constructed that the inner receptacle and the outer packaging form an integral packaging. Once assembled, it remains thereafter an integrated single unit; it is filled, stored, shipped, and emptied as such.

Confinement system means the assembly of components of the packaging intended to retain the Class 7 (radioactive) material intact during transport.

Containment system means the assembly of components of the packaging intended to prevent the leakage of all Class 7 (radioactive) material (including gases and liquids) during transport within the leakage rate limits specified in the TSD.

Contamination means the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters or 0.04 Bq/cm^2 for all other alpha emitters.
Contamination exists in two phases.
(1) Fixed radioactive contamination means radioactive contamination that cannot be readily removed from a surface.
(2) Non-fixed radioactive contamination means radioactive contamination that can be readily removed from a surface.

Conveyance means (1) For transport by public highway or rail: any transport vehicle or large freight container; (2) For transport by water: any vessel, or any hold, compartment, or defined deck area of a vessel including any transport vehicle on board the vessel; and (3) For transport by air: any aircraft.

Corrective Maintenance means work tasks that repair or rework failed or malfunctioning equipment, systems, or facilities to restore the intended function or design condition.

Criticality Safety Index (CSI) means a number (rounded up to the next tenth) which is used to provide control over the accumulation of packages, overpacks, or freight containers containing fissile material. The CSI for packages containing fissile material is determined in accordance with the instructions provided in 10 CFR 71.22, "General license: Fissile material"; 71.23, "General license: Plutonium-beryllium special form material"; and 71.59, "Standards for arrays of fissile material packages." The CSI for an overpack, freight container, or consignment containing fissile material packages is the

arithmetic sum of the criticality safety indices of all the fissile material packages contained within the overpack, freight container, or consignment.

Design means the description of a Class 7 (radioactive) material package, packaging, or LSA-III container that enables the structure and characteristics of these items to be fully identified. The description may include specifications, engineering drawings, reports showing compliance with regulatory requirements, and other relevant documentation.

Designated facility means a hazardous waste treatment, storage, or disposal facility that has been designated on the manifest by the generator.

Deuterium means, for the purposes of 49 CFR 173.453, "Fissile materials—exceptions," deuterium and any deuterium compound, including heavy water, in which the ratio of deuterium atoms to hydrogen atoms exceeds 1:5000.

Documented safety analysis (DSA) means a documented analysis of the extent to which a packaging system or transportation activity can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety. For transportation, this is the TSD, associated PSSDs and SERs.

DOT/NRC/DOE/DOD-approved packagings (performance-based packagings): Packagings approved and/or certified by the DOT, NRC, DOE, and the U.S. Department of Defense (DOD) must comply with all applicable federal regulations, specifications, and performance standards.

Drum means a flat-ended or convex-ended cylindrical packaging made of metal, fiberboard, plastic, plywood, or other suitable material. This definition also includes packagings of other shapes made of metal or plastic (e.g., round taper-necked packagings or pail-shaped packagings) but does not include cylinders, jerricans, wooden barrels, or bulk packagings.

Employer means a person engaged in a business affecting commerce that has employees.

Employee means an employee of an employer who is employed in a business of their employer, which affects commerce.

Established federal standard means any operative standard established by any agency of the United States and in effect on April 28, 1971, or contained in any Act of Congress in force on the date of enactment of the Williams-Steiger Occupational Safety and Health Act.

Evaluation of safety means a qualitative discussion on why it is safe to remove the operational restrictions that were put in place as a result of a potential inadequacy in the safety analysis (PISA). It demonstrates that the risk RL has accepted has not increased or provides a safety-basis change for RL approval. It identifies the protection that the operational restrictions provided and the evidence that the potential increased risk is not a valid concern.

A suggested content of the evaluation of safety includes:

- Summary of PISA determination
- Listing of interim operational restrictions and their purposes
- Results of USQ_T determination
- Description of review actions taken
- Conclusion of safety review
- Statement of disposition of operational restrictions.

Excepted packaging: See 49 CFR 173.403, Package, (1) "Excepted package means a packaging together with its excepted Class 7 (radioactive) materials as specified in 49 CFR 173.421 through 173.426 and 173.428."

Exclusive use means sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. The consignor and the carrier must ensure that any loading or unloading is performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor must provide to the initial carrier specific written instructions for maintenance of exclusive use shipment controls, including the vehicle survey requirement of 49 CFR 173.443 , "Contamination control," (c) as applicable, and include these instructions with the shipping paper information provided to the carrier by the consignor.

Exemption means a document issued by a Hanford DOE Approval Authority that authorizes a person to perform a function that is not otherwise authorized under this TSD.

Exemption value means either an exempt material activity concentration or an exempt consignment activity limit listed in the table in 49 CFR 173.436, "Exempt material activity concentrations and exempt consignment activity limits for radionuclides," or determined according to the procedures described in 49 CFR 173.433, and used to determine whether a given physically radioactive material is sufficiently radioactive to be subject to the hazardous material regulations (see definition of radioactive material). An exemption value is different from an exemption as defined in 49 CFR 171.8.

F means degree Fahrenheit.

Facility transfer means the movement of material or packages between processing areas or storage areas within a specific facility or facility compound (e.g., Central Waste Complex [CWC]) covered by a single facility DSA or other DOE-approved safety or authorization basis document(s). These transfers are not considered onsite shipments, and are authorized by this TSD only when the safety basis for these facility movements is adequately addressed in the facility DSA or other DOE-approved safety or authorization basis document(s).

Facility worker means any individual located within the facility safety or authorization basis boundary or its emergency control area that is knowledgeable of the potential hazards and is trained to the facility emergency procedures. The consequences to the facility worker are typically evaluated qualitatively in the hazard evaluation rather than in the accident analysis.

Federal hazardous material transportation law means 49 USC 5101 et seq.

Fissile material means ^{239}Pu, ^{241}Pu, ^{233}U, ^{235}U, or any combination of these radionuclides. This term does not apply to material containing fissile nuclides, unirradiated natural uranium and unirradiated depleted uranium, or to natural uranium or depleted uranium that has been irradiated in thermal reactors only. Certain additional exceptions are provided in 49 CFR 173.453.

Fissile material package: See 49 CFR 173.403, Package, (5) 'Fissile material package' means a packaging, together with its fissile material contents, which meets the requirements for fissile material packages described in 10 CFR 71, Subpart E. A fissile material package may be a Type AF package, a Type B(U)F package, or a Type B(M)F package.

Gas means a material that has a vapor pressure greater than 300 kPa (43.5 psi) at 50 °C (122 °F) or is completely gaseous at 20 °C (68 °F) at a standard pressure of 101.3 kPa (14.7 psi).

Gross weight or Gross mass means the weight of a packaging plus the weight of its contents.

Hanford DOT-equivalent packagings (performance-based packagings): Hanford DOT-equivalent packagings must comply with Hanford-defined performance standards based on the Hanford Site transportation environment.

Hanford non-DOT-equivalent packagings (risk-based packagings): Hanford non-DOT-equivalent packagings are authorized under a dose consequence/risk assessment methodology defined in this TSD and approved by RL.

Hazard class means the category of hazard assigned to a hazardous material under the definitional criteria of 49 CFR 173 and the provisions of the 49 CFR 172.101 table. A material may meet the defining criteria for more than one hazard class, but is assigned to only one hazard class.

Hazard Control: Within the TSD, the term hazard control is used in a broad context and is used to denote those requirements appropriate for the level of containment and communication specified in the safety basis. For radioactive materials, appropriate controls need to be provided to ensure nuclear criticality safety and minimize personnel exposures in accordance with as low as reasonably achievable (ALARA) principles. The use of this term in the TSD in the broad context described above is consistent with its use in the transportation community and is not necessarily the same context as controls associated with Technical Safety Requirements as defined in 10 CFR 830, "Nuclear Safety Management." Hazard controls are measures to eliminate, limit, or mitigate hazards to workers, the public, or the environment that are derived from the safety analyses, including: physical, design, structural, and engineering features; safety management programs; TSRs; and other controls necessary to provide adequate protection from hazards.

Hazardous material means a substance or material, which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. The term includes hazardous substances, hazardous waste, marine pollutants, and elevated temperature materials as defined in 49 CFR 171.8, materials designated as hazardous under the provisions of 49 CFR 172.101, "Purpose and use of hazardous materials table," and materials that meet the defining criteria for hazard classes and divisions in 49 CFR 173.

Hazardous substance for the purposes of this TSD, means a material, including its mixtures and solutions, that: (1) Is listed in Appendix A, 49 CFR 172.101; (2) Is in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) listed in Appendix A in 49 CFR 172.101; and (3) When in a mixture or solution--

(i) For radionuclides, conforms to paragraph 7 of Appendix A in 49 CFR 172.101.

(ii) For other than radionuclides, is in a concentration by weight which equals or exceeds the concentration corresponding to the RQ of the material, as shown in the following table:

RQ pounds (kilograms)	Concentration by Weight	
	Percent	PPM
5000 (2270)	10	100,000
1000 (454)	2	20,000
100 (45.4)	0.2	2,000
10 (4.54)	0.02	200
1 (0.454)	0.002	20

The term does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance in Appendix A to 49 CFR 172.101, and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas).

Hazardous waste means, for the purposes of this TSD, any material that is subject to the Hazardous Waste Manifest Requirements of the U.S. Environmental Protection Agency (EPA) specified in 40 CFR 262, "Standards Applicable to Generators of Hazardous Waste."

Hazmat employee means a person who in the course of employment directly affects hazardous materials transportation safety. This term includes an owner-operator of a motor vehicle that transports hazardous materials on site This term includes an individual who, during the course of employment: (1) Loads, unloads, or handles hazardous materials; (2) Manufactures, tests, reconditions, repairs, modifies, marks, or otherwise represents containers, drums, or packagings as qualified for use in the transportation of hazardous materials; (3) Prepares hazardous materials for transportation; (4) Is responsible for safety of transporting hazardous materials; or (5) Operates a vehicle used to transport hazardous materials.

Hazmat employer means a person who uses one or more of its employees in connection with: transporting hazardous materials on site; causing hazardous materials to be transported or shipped on site; or representing, marking, certifying, selling, offering, manufacturing, reconditioning, testing, repairing, or modifying containers, drums, or packagings as qualified for use in the transportation of hazardous materials. This term includes an owner-operator of a motor vehicle that transports hazardous materials on site. This term also includes any department, agency, or instrumentality of the

United States, a State, a political subdivision of a State, or an Indian tribe engaged in an activity described in the first sentence of this definition.

Head of Operations or Field Offices are terms used in DOE Order 460.1B to identify who is responsible for implementing the requirements of the order. For the Hanford Site, the Heads of the Richland Operations Office (RL), the Office of River Protection (ORP) and the Pacific Northwest Site Office (PNSO) are the Hanford DOE Managers identified as the individuals responsible for implementing DOE Order 460.1B requirements for their respective contractors.

Highway route controlled quantity means a quantity within a single package which exceeds: (1) 3,000 times the A_1 value of the radionuclides as specified in 49 CFR 173.435 for special form Class 7 (radioactive) material; (2) 3,000 times the A_2 value of the radionuclides as specified in 49 CFR 173.435 for normal form Class 7 (radioactive) material; or (3) 1,000 TBq (27,000 Ci), whichever is least.

IATA means International Air Transport Association.

ICAO means International Civil Aviation Organization.

IMO means International Maritime Organization.

Industrial package: See 49 CFR 173.403, Package, (2) 'Industrial package' means a packaging that, together with its LSA material or SCO contents, meets the requirements of Sections 173.410 and 173.411. Industrial packages (IP) are categorized in 49 CFR 173.411 as either:
(i) Industrial package Type 1 (IP-1)
(ii) Industrial package Type 2 (IP-2)
(iii) Industrial package Type 3 (IP-3)

Inner packaging means a packaging for which an outer packaging is required for transport. It does not include the inner receptacle of a composite packaging.

Inner receptacle means a receptacle that requires an outer packaging to perform its containment function. The inner receptacle may be an inner packaging of a combination packaging or the inner receptacle of a composite packaging.

Inter-area: An onsite shipment between two site-processing areas (i.e., 200 East Area to 200 West Area).

Intermediate packaging means a packaging that encloses an inner packaging or article and is itself enclosed in an outer packaging.

Intra-area: An onsite shipment between two facilities within a single site processing area (i.e., between T Plant and the Plutonium Finishing Plant [PFP] within the 200 West Area).

Intra-facility movement or intra-facility transfer means the movement of material between individual buildings within a facility or facility complex that are adequately covered under a single facility DSA or other DOE-approved safety or authorization basis document.

Large truck means a truck over 4,536 kg (10,000 lb) gross vehicle weight rating including single unit trucks and truck tractors (Fatality Analysis Reporting System definition).

Like-for-like Replacement means exact replacement of a component with a new component satisfying the original design specification in every detail (e.g., replace a ½" x 2" grade 8 bolt with a ½" x 2" grade 8 bolt).

Limited quantity. 'Limited quantity,' when specified as such in a section applicable to a particular material, means the maximum amount of a hazardous material for which there is a specific labeling or packaging exception. See 49 CFR 171.8.

Limited quantity of Class 7 (radioactive) material means a quantity of Class 7 (radioactive) material not exceeding the materials package limits specified in 49 CFR 173.425 and conforming with requirements specified in 49 CFR 173.421. See 49 CFR 173.403.

Liquid means a material, other than an elevated temperature material, with a melting point or initial melting point of 20 °C (68 °F) or lower at a standard pressure of 101.3 kPa (14.7 psi). A viscous material for which a specific melting point cannot be determined must be subjected to the procedures specified in American Society for Testing and Materials (ASTM) D4359 "Standard Test Method for Determining Whether a Material is Liquid or Solid."

Liquid phase means a material that meets the definition of liquid when evaluated at the higher of the temperature at which it is offered for transportation or at which it is transported, not at the 37.8 °C (100 °F) temperature specified in ASTM D4359-84.

Low specific activity (LSA): See 49 CFR 173.403, 'Low Specific Activity' material means Class 7 (radioactive) material with limited specific activity which satisfies the descriptions and limits set forth below. Shielding materials may not be considered in determining the estimated average specific activity of the package contents. LSA material must be in one of the following three groups:

(1) LSA-I. (i) Uranium and thorium ores, concentrates of uranium and thorium ores, and other ores containing naturally occurring radionuclides which are intended to be processed for the use of these radionuclides; or (ii) Solid unirradiated natural uranium or depleted uranium, or natural thorium or their solid or liquid compounds or mixtures; or (iii) Radioactive material, other than fissile material, for which the A_2 value is unlimited; or (iv) Other radioactive material, excluding fissile material in quantities not excepted under 49 CFR 173.453, in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the values for activity concentration specified in 49 CFR 173.436, or 30 times the default values listed in Table 8 of 49 CFR 173.433.

(2) LSA-II. (i) Water with tritium concentration up to 0.8 TBq/L (20.0 Ci/L); or (ii) Other radioactive material in which the activity is distributed throughout and the average specific activity does not exceed $10^{-4}A_2$/g for solids and gases, and $10^{-5}A_2$/g for liquids.

(3) LSA-III. Solids (e.g., consolidated wastes, activated materials), excluding powders, that meet the requirements of 49 CFR 173.468, "Test for LSA-III material," and in which: (i) The radioactive material is distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.); (ii) The radioactive material is a relatively insoluble material, so that, even under loss of packaging, the loss of Class 7 (radioactive) material per package by leaching when placed in water for 7 days would not exceed 0.1 A_2; and (iii) The estimated average specific activity of the solid, excluding any shielding material, does not exceed $2 \times 10^{-3}A_2$/g.

Low toxicity alpha emitters means natural uranium; depleted uranium; natural thorium; ^{235}U, ^{238}U, ^{228}Th, ^{230}Th and ^{232}Th when contained in ores or physical and chemical concentrates or tailings; and alpha emitters with a half-life of less than 10 days.

Maintenance Activity means the proactive and reactive work that is required to maintain and preserve packaging systems in a condition suitable for performing their designated purpose, and includes planned or unplanned periodic, preventive, predictive, seasonal or corrective (repair) maintenance. A maintenance activity is **not** a modification. [Derived from DOE Guide 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1*.]

Marking means a descriptive name, identification number, instructions, cautions, weight, specification, or UN marks, or combinations thereof, required by this subchapter on outer packagings of hazardous materials.

Material of trade means a hazardous material, other than a hazardous waste, that is carried on a motor vehicle: (1) For the purpose of protecting the health and safety of the motor vehicle operator or passengers; (2) For the purpose of supporting the operation or maintenance of a motor vehicle (including its auxiliary equipment); or (3) By a private motor carrier (including vehicles operated by a rail carrier) in direct support of a principal business that is other than transportation by motor vehicle.

Material poisonous by inhalation means: (1) A gas meeting the defining criteria in 49 CFR 173.115(c) and assigned to Hazard Zone A, B, C, or D in accordance with 49 CFR 173.116(a); (2) A liquid (other than as a mist) meeting the defining criteria in 49 CFR 173.132(a)(1)(iii) and assigned to Hazard Zone A or B in accordance with 49 CFR 173.133(a); or (3) Any material identified as an inhalation hazard by a special provision in column 7 of the 49 CFR 172.101 table.

Maximum allowable working pressure or MAWP. For DOT specification cargo tanks used to transport liquid hazardous materials, see 49 CFR 178.320(a).

Maximum capacity means the maximum inner volume of receptacles or packagings.

Maximum Exposed Offsite Individual (MOI) means a hypothetical receptor located at or beyond the Hanford Site boundary (or public access area) at the distance and in the direction from the point of release at which the maximum dose occurs.

Maximum net mass means the allowable maximum net mass of contents in a single packaging, or as used in 49 CFR 178, Subpart M, the maximum combined mass of inner packaging and the contents thereof.

Maximum Normal Operating Pressure (MNOP), is defined for sealed packages as the maximum gauge pressure that would develop in a containment system under bounding normal conditions of package heating and internal gas generation during a period twice the expected shipping time or one year, whichever is shorter. For vented packages, the MNOP is defined as the pressure that could develop under bounding normal conditions during the expected shipping time if all venting devices were plugged.

Mixture means a material comprised of more than one chemical compound or element.

Mode means any of the following transportation methods; rail, highway, air, or water.

Modification means any permanent change, addition, or alteration to a packaging system.

NOTE: *A modification is any permanent change, addition, or alteration to a packaging system included in a configuration baseline (for example, delta pressures, control parameters, load-carrying capacity, response time, shielding, corrosion resistance). Uses of like-for-like or equivalent item, or temporary changes for performing routine repairs, are NOT modifications.*

Motor carrier means a for-hire motor carrier or private motor carrier. The term includes a motor carrier's agents, officers, or representatives responsible for hiring, supervising, training, assigning, or dispatching a driver, or concerned with the installation, inspection, and maintenance of motor vehicle equipment or accessories or both.

Motor vehicle includes a vehicle, machine, tractor, trailer, or semi-trailer, or any combination thereof, propelled or drawn by mechanical power and used on the highways in the transportation of passengers or property. It does not include a vehicle, locomotive, or car operated exclusively on a rail or rails, or a trolley bus operated by electric power derived from a fixed overhead wire, furnishing local passenger transportation similar to street-railway service.

Multilateral approval means approval of a package design or shipment by the relevant Competent Authority of the country of origin and of each country through or into which the package or shipment is to be transported. This definition does not include approval from a country over which Class 7 (radioactive) materials are carried in aircraft, if there is no scheduled stop in that country.

Name of contents means the proper shipping name as specified in 49 CFR 172.101.

National consensus standard means any standard or modification thereof which (1) has been adopted and promulgated by a nationally recognized standards-producing organization under procedures

whereby it can be determined by the Secretary of Labor or by the Assistant Secretary of Labor that persons interested and affected by the scope or provisions of the standard have reached substantial agreement on its adoption; (2) was formulated in a manner which afforded an opportunity for diverse views to be considered; and (3) has been designated as such a standard by the Secretary or the Assistant Secretary, after consultation with other appropriate federal agencies.

Natural thorium means thorium with the naturally occurring distribution of thorium isotopes (essentially 100 wt% ^{232}Th).

"New package" or "new package design" A "new package" or "new package design" means a completely new package design (including hardware and payload) or the circumstance where a feature of a previously approved package is changed such that its structural performance, under normal or accident conditions, compromises the margin of safety for criticality, shielding, or containment. Examples include the following: (1) A new cask or package design with unique payloads, not previously tested, analyzed, and/or approved is clearly considered a new packaging and would require a new PSSD approved by the RL Manager. (2) A previously approved package where removal of a structural feature, such an overpack or impact limiter, would compromise package performance under the accident conditions (e.g., drop, fire, etc.), would be considered a new package, and would require a new PSSD approved by the RL Manager.

Non-bulk packaging means a packaging which has: (1) A maximum capacity of 450 L (119 gal) or less as a receptacle for a liquid; (2) A maximum net mass of 400 kg (882 lb) or less and a maximum capacity of 450 L (119 gal) or less as a receptacle for a solid; or (3) A water capacity of 454 kg (1,000 lb) or less as a receptacle for a gas as defined in 49 CFR 173.115.

Non-reusable container means a packaging (container) whose reuse is restricted in accordance with the provisions of 49 CFR 173.28.

Normal form Class 7 (radioactive) material means Class 7 (radioactive) material which has not been demonstrated to qualify as "special form Class 7 (radioactive) material."

North American Standard Inspection means the methodology used by State CMV safety inspectors to conduct safety inspections of CMVs. This consists of various levels of inspection of the vehicle or driver or both. The inspection criteria are developed by the Federal Motor Carrier Safety Administration in conjunction with the Commercial Vehicle Safety Alliance, an association of States, Canadian Provinces, and Mexico whose members agree to adopt these standards for inspecting CMVs in their jurisdiction.

N.O.S. means not otherwise specified.

N.O.S. description means a shipping description from the 49 CFR 172.101 table that includes the abbreviation n.o.s.

NPT means an American Standard taper pipe thread conforming to requirements of Federal Standard H28, part II, section VII. See 49 CFR 171.7.

Nuclear safety authorization basis is the basis for the safe operation of a DOE nuclear facility. Nuclear safety authorization basis includes hazard classification documents, DSAs, technical safety requirements (TSR), DOE-issued safety evaluation reports, and facility-specific commitments made to comply with DOE nuclear safety requirements.

Occupationally exposed hazmat employee means a hazmat employee whose duties involve exposure to ionizing radiation.

Occurrence means an event (e.g., package rupture, valve failure, loss of containment, environmental spills) or a condition (e.g., an as-found state, whether or not resulting from an event), that may have adverse safety, health, quality assurance, security, operational, or environmental implications.

Occurrence Report means a documented evaluation of an event or condition that is prepared in sufficient detail to enable the reader to assess its significance, consequences, or implications and to evaluate the actions being proposed or employed to correct the condition or to avoid recurrence. All Occurrence Reports are screened for an USQ_T implications.

Offsite means outside the boundaries of the Hanford Site and on Hanford Site roadways, waterways, and land areas to which the public is given unrestricted access.

Offsite public is represented by the MOI, a hypothetical receptor located at or beyond the Hanford Site boundary (or public access area) at the distance and in the direction from the point of release at which the maximum dose occurs.

Offsite shipment: A government, DOE contractor, or commercial shipment of radioactive or other hazardous material or waste leaving the Hanford Site, or shipment onsite to a non-DOE entity, or an onsite movement of these materials and wastes transported over roadways where the general public has unrestricted access These shipments are regulated under 49 CFR 170-178 and 10 CFR 71.

One-time request for shipment (OTRS) is an exception to the TSD and/or PSSD approved by DOE that provides special authorization to ship radioactive materials in packagings on a limited basis.

Onsite: Inside the boundaries of the Hanford Site where public access is restricted.

Onsite Public is characterized by a hypothetical receptor within the Hanford Site boundary at locations bounded by: (1) The near bank of the Columbia River and (2) Highway 240 traversing the Hanford Site, in the direction and at the distance of highest dose or exposure. This receptor is used for reference purposes and is considered only when accident consequences at either of these locations exceed that for the maximum offsite individual.

Onsite SEP: The onsite SEP was a Pre-TSD technical and safety document that demonstrates radioactive material packaging compliance to Hanford Site T&P standards. It describes the T&P system, the authorized payload, and applicable operational controls. It also describes the testing and analyses performed to demonstrate compliance to the Hanford Site-equivalent T&P standards. Replaced by Package Specific Safety Document.

Onsite shipment: A shipment of radioactive or other hazardous material or waste transported by motorized vehicle within the boundaries of the Hanford Site within or between DOE facilities, and over roadways where public access is controlled or otherwise restricted.

Operations and Maintenance (O&M) Manual: A document issued for onsite packaging systems that identifies the packaging system and its components; the authorized payload including loading, closure and unloading instructions; inspection, testing and maintenance requirements and procedures; cask handling and tiedown for transport; and any other administrative or operational controls necessary to achieve required levels of safety.

Operator means a person who controls the use of an aircraft, vessel, or vehicle.

Outage or ullage means the amount by which a packaging falls short of being liquid full, usually expressed in percent by volume.

Outer packaging means the outermost enclosure of a composite or combination packaging together with any absorbent materials, cushioning and any other components necessary to contain and protect inner receptacles or inner packagings.

Overpack, except as provided in 49 CFR 178, Subpart K, means an enclosure that is used by a single consignor to provide protection or convenience in handling of a package or to consolidate two or more packages. Overpack does not include a transport vehicle, freight container, or aircraft unit load device. Examples of overpacks are one or more packages: (1) Placed or stacked onto a load board such as a pallet and secured by strapping, shrink wrapping, stretch wrapping, or other suitable means; or (2) Placed in a protective outer packaging such as a drum, box or crate.

Package: See 49 CFR 171.8, 'Package or Outside Package' means a packaging plus its contents. For radioactive material, see 49 CFR 173.403, 'Package' means, for Class 7 (radioactive) materials, the packaging together with its radioactive contents as presented for transport.

Package-Specific Safety Document (PSSD) is a package-specific safety assessment for onsite shipments demonstrating compliance with the equivalent or risk-based requirements of the TSD and concludes that, based on the evidence provided, the transport system provides a level of protection commensurate with the hazard of the material transported. PSSDs are package safety analyses, as described in DOE Guide 460.1-1, *The Packaging and Transportation Safety Implementation Guide*, and include existing RL-approved onsite package safety assessments listed in Appendix A, such as SARPs, SEPs, and similar documents, that assess the safety of onsite shipments of radioactive materials. PSSDs are part of the package safety basis and are approved by their respective Hanford DOE Approval Authority.

Packaging: See 49 CFR 171.8, 'Packaging' means a receptacle and any other components or materials necessary for the receptacle to perform its containment function in conformance with the minimum packing requirements of this TSD. For radioactive material, see 49 CFR 173.403, 'Packaging' means, for Class 7 (radioactive) materials, the assembly of components necessary to ensure compliance with the packaging requirements of this subpart. It may consist of one or more

receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and service equipment for filling, emptying, venting and pressure relief, and devices for cooling or absorbing mechanical shocks. The conveyance, tiedown system, and auxiliary equipment may sometimes be designated as part of the packaging.

Packaging system is packaging and ancillary equipment necessary to conduct shipments. It may include the transportation vehicle.

Packing group means a grouping according to the degree of danger presented by hazardous materials. Packing Group I indicates great danger; Packing Group II, medium danger; Packing Group III, minor danger. See 49 CFR 172.101(f).

Periodic Maintenance means work tasks that perform periodic maintenance activities intended to maintain a system or component in the as-designed condition to reduce the need for unplanned *Corrective Maintenance*.

Person means an individual, firm, co-partnership, corporation, company, association, joint-stock association, including any trustee, receiver, assignee, or similar representative thereof; or government, Indian tribe, or agency or instrumentality of any government or Indian tribe when it offers hazardous material for transportation in commerce or transports hazardous material to further a commercial enterprise, but such term does not include: (1) The United States Postal Service; (2) For the purposes of 49 USC 5123 and 5124, any agency or instrumentality of the Federal Government.

Portable tank means a bulk packaging (except a cylinder having a water capacity of 454 kg [1,000 lb] or less) designed primarily to be loaded onto, or on, or temporarily attached to a transport vehicle or ship and equipped with skids, mountings, or accessories to facilitate handling of the tank by mechanical means. It does not include a cargo tank, tank car, multi-unit tank car tank, or trailer carrying 3AX, 3AAX, or 3T cylinders.

Potential inadequacy in the safety analysis (PISA) means situations of concern wherein that give reason to believe that there is the potential that the current safety basis may not be bounding or may be otherwise inadequate.

Preferred route or preferred highway is a highway for shipment of highway route controlled quantities of radioactive materials so designated by a state routing agency, and any Interstate System highway for which an alternative highway has not been designated by such State agency as provided by 49 CFR 397.103, "Requirements for State routing designations."

Primary hazard means the hazard class of a material as assigned in the 49 CFR 172.101 table.

Proper shipping name means the name of the hazardous material shown in Roman print (not italics) in 49 CFR 172.101.

Proposed activity means any proposed change to procedures (including cancellations) or equipment and any proposed new procedures, equipment, tests (including post-modification testing), operations, or experiments.

p.s.i. or psi means pounds per square inch.

p.s.i.a. or psia means pounds per square inch absolute.

p.s.i.g. or psig means pounds per square inch gauge.

Public access roadway: A roadway where the general public has unrestricted access. This can include a state highway, county or city road, or Hanford Site roadway; e.g., Route 10 between the 1100 Area and the Wye Barricade.

Q component is a packaging part (component) identified during the design effort as important to safety. For guidance in identifying parts, see Appendix A of Regulatory Guide 7.10, *Establishing Quality Assurance Programs for Packaging Used in the Transport of Radioactive Material*.

Quality assurance means a systematic program of controls and inspections applied by each person involved in the transport of radioactive material that provides confidence that a standard of safety is achieved in practice.

Radiation level means the radiation dose-equivalent rate expressed in millisieverts per hour or mSv/h (millirem per hour or mrem/h). Neutron flux densities may be converted into radiation levels according to Table 1.

Table 1--Neutron Fluence Rates to be Regarded as Equivalent to a Radiation Level of 0.01 mSv/h (1 mrem/h)[1].

Energy of Neutron	**Flux density equivalent to 0.01 mSv/H (1 mrem/h) neutrons per square centimeter per second (n/cm^2/s)**
Thermal (2.510E-8) MeV	272.0
1 keV	272.0
10 keV	281.0
100 keV	47.0
500 keV	11.0
1 MeV	7.5
5 MeV	6.4
10 MeV	6.7

[1] Flux densities equivalent for energies between those listed in this table may be obtained by linear interpolation.

Radioactive contents means a Class 7 (radioactive) material, including any contaminated or activated solids, liquids, and gases within the packaging.

Radioactive instrument or article means any manufactured instrument or article such as an instrument, clock, electronic tube or apparatus, or similar instrument or article having Class 7 (radioactive) material in gaseous or nondispersible solid form as a component part.

Radioactive material means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in the table in 49 CFR 173.436 or values derived according to the instructions in 49 CFR 173.433.

Receptacle means a containment vessel for receiving and holding materials, including any means of closing.

Reportable quantity (RQ) for the purposes of this TSD means the quantity specified in column 2 of the appendix to 49 CFR 172.101 for any material identified in column 1 of the appendix.

Residue means the hazardous material remaining in a packaging, including a tank car, after its contents have been unloaded to the maximum extent practicable and before the packaging is either refilled or cleaned of hazardous material and purged to remove any hazardous vapors.

RSPA means the Research and Special Programs Administration, DOT, Washington, D.C. 20590.

Safety basis means the Documented Safety Analysis (DSA) and hazard controls that provide reasonable assurance that a DOE nuclear facility or activity can be operated safely in a manner that adequately protects workers, the public, and the environment. The safety basis for T&P activities includes the TSD, approved PSSDs listed in Appendix A, and associated SERs documenting the bases and conditions for DOE approval.

scf (standard cubic foot) means 1 ft^3 of gas measured at 60 °F and 14.7 psia.

Shipment means the shipping or transporting of goods between facilities.

Shipping paper means a shipping order, bill of lading, manifest, or other shipping document serving a similar purpose and containing the information required by 49 CFR 172.202, 172.203 and 172.204.

Single packaging means a nonbulk packaging other than a combination packaging.

Site Controlled Access Roadway: Hanford Site roads where public access is controlled or otherwise restricted. Controls include barricades, fences, signs, and Hanford Patrol checkpoints. Road closures can be executed on certain roads to convert a public access roadway to a controlled access roadway.

Solid means a material that is not a gas or a liquid.

Solution means any homogeneous liquid mixture of two or more chemical compounds or elements that will not undergo any segregation under conditions normal to transportation.

Special form Class 7 (radioactive) material means either an indispersible solid radioactive material or a sealed capsule containing radioactive material which satisfies the following conditions: (1) It is either a single solid piece or a sealed capsule containing radioactive material that can be opened only by destroying the capsule; (2) The piece or capsule has at least one dimension not less than 5 mm (0.2 in.); and (3) It satisfies the test requirements of 49 CFR 173.469. Special form encapsulations designed in accordance with the requirements of 49 CFR 173.389(g) in effect on June 30, 1983 (see 49 CFR 173, revised as of October 1, 1982), and constructed prior to July 1, 1985, and special form encapsulations designed in accordance with the requirements of 49 CFR 173.403 in effect on March 31, 1996 (see 49 CFR 173, revised as of October 1, 1995), and constructed prior to April 1, 1997 (10

CFR says 1998), may continue to be used. Any other special form encapsulation must meet the requirements of this paragraph (3).

Special Packaging Authorizations (SPAs) provide DOE preapproved packaging solutions for routine on-site payloads, such as building debris, soil, rock, and limited building debris, retrieval packages (drum and nondrum). The SPA provides the transportation safety basis and, and pre-approved packaging configurations and controls matched to applicable payloads.

Special Packaging Zone (SPZ) is a TSD-designated onsite area composed of multiple facilities connected by a road or roads that are access restricted to onsite users. The facilities may be co-located or in close proximity to each other. The SPZ will include both the designated facilities and roads.

Specific activity of a radionuclide means the activity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the activity per unit mass of the material.

Specification packaging means a packaging conforming to one of the specifications or standards for packagings in 49 CFR 178 or 179.

Spent nuclear fuel or spent fuel means fuel that has been withdrawn from a nuclear reactor following irradiation and has not been chemically separated into its constituent elements by reprocessing. Spent fuel includes the special nuclear material, byproduct material, source material, and other radioactive materials associated with fuel assemblies.

Standard means a standard that requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment.

State means a State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Virgin Islands, American Samoa, Guam, or any other territory or possession of the United States designated by the Secretary.

Strong outside container means the outermost enclosure that provides protection against the unintentional release of its contents under conditions normally incident to transportation.

Subsidiary hazard means a hazard of a material other than the primary hazard. (See primary hazard). Table in 49 CFR 172.101 or 172.101 table means the Hazardous Materials Table (HMT) in 49 CFR 172.101.

Surface contaminated object (SCO) means a solid object which is not itself radioactive, but which has radioactive material distributed on its surface. SCOs exist in two phases:

(1) <u>SCO-I</u>: A solid object on which: (i) The nonfixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2 does not exceed 4 Bq/cm^2 (10^{-4} $\mu Ci/cm^2$) for beta and gamma and low toxicity alpha emitters, or 0.4 Bq/cm^2 (10^{-5} $\mu Ci/cm^2$) for all other alpha emitters; (ii) The fixed contamination on the accessible surface

averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 4 x 10^4 Bq/cm^2 (1.0 μCi/cm^2) for beta and gamma and low toxicity alpha emitters, or 4 x 10^3 Bq/cm^2 (0.1 μCi/cm^2) for all other alpha emitters; and (iii) The nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 4 x 10^4 Bq/cm^2 (1.0 μCi/cm^2) for beta and gamma and low toxicity alpha emitters, or 4 x 10^3 Bq/cm^2 (0.1 μCi/cm^2) for all other alpha emitters.

(2) SCO-II: A solid object on which the limits for SCO-I are exceeded and on which: (i) The nonfixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 400 Bq/cm^2 (10^{-2} μCi/cm^2) for beta and gamma and low toxicity alpha emitters or 40 Bq/cm^2 (10^{-3} μCi/cm^2) for all other alpha emitters; (ii) The fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 8 x 10^5 Bq/cm^2 (20 μCi/cm^2) for beta and gamma and low toxicity alpha emitters, or 8 x 10^4 Bq/cm^2 (2 μCi/cm^2) for all other alpha emitters; and (iii) The nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 8 x 10^5 Bq/cm^2 (20 μCi/cm^2) for beta and gamma and low toxicity alpha emitters, or 8 x 10^4 Bq/cm^2 (2 μCi/cm^2) for all other alpha emitters.

Technical change means a change that:

- Creates or changes functional or performance requirements,
- Changes applicable hazard controls,
- Changes analytical parameters used in the safety basis,
- Introduces a new hazard,
- Changes the material at risk (MAR),
- Changes maintenance or surveillance frequencies,
- Changes procedural steps which direct manipulation of equipment such as manipulation of valves, performance tests, torque values or sequences, tiedown equipment or placement, or
- Alters documentation of package conditions or configurations.

Technical name means a recognized chemical name or microbiological name currently used in scientific and technical handbooks, journals, and texts. Generic descriptions are authorized for use as technical names, provided they readily identify the general chemical group or microbiological group. Examples of acceptable generic chemical descriptions are organic phosphate compounds, petroleum aliphatic hydrocarbons, and tertiary amines. For proficiency testing only, generic microbiological descriptions such as bacteria, mycobacterium, fungus, and viral samples may be used. Except for names that appear in Subpart B of 49 CFR 172, trade names may not be used as technical names.

Transfer: Any onsite shipment or onsite transport of hazardous materials, substances, and wastes, including those that are radioactive, between facilities where the facility boundaries are described and covered under a facility SAR or other DOE-approved safety or authorization basis document(s). For example, an onsite shipment between one of the 200 West Area "tank farms" to the CWC would be considered an onsite shipment or transfer. A movement of material or waste in or around the confines of the CWC would not be considered an onsite shipment or transfer from a transportation safety perspective as long as such movements were properly addressed in the CWC Facility SAR.

Transport index (TI) means the dimensionless number (rounded up to the next tenth) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The TI is determined by multiplying the maximum radiation level in millisieverts (mSv) per hour at 1 m (3.3 ft) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at 1 m [3.3 ft]).

Transport vehicle means a cargo-carrying vehicle such as an automobile, van, tractor, truck, semitrailer, tank car, or rail car used for the transportation of cargo by any mode. Each cargo-carrying body (trailer, rail car, etc.) is a separate transport vehicle.

TSD Exemption: A documented exception or deviation to any TSD requirement approved by the RL Manager. The TSD exemption process is defined in Chapter 9 for nonroutine shipments.

Type A Packaging: See 49 CFR 173.403, Package, (3) 'Type A package' means a packaging that, together with its radioactive contents limited to A_1 or A_2 as appropriate, meets the requirements of 49 CFR 173.410 and 173.412 and is designed to retain the integrity of containment and shielding required by this part under normal conditions of transport as demonstrated by the tests set forth in 49 CFR 173.465, "Type A packaging tests," or 173.466, "Additional tests for Type A packagings designed for liquids and gases," as appropriate. If the prime contractor is qualified to certify Type A packages, a separate Competent Approval Authority approval is not required. When Type A packages are being used to transport Type B quantities of radioactive materials, approval must be received from the respective Hanford DOE Approval Authority.

Type B Packaging: See 49 CFR 173.403, Package, (4) 'Type B package' means a packaging designed to transport greater than an A_1 or A_2 quantity of radioactive material that, together with its radioactive contents, is designed to retain the integrity of containment, criticality, and shielding when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in this TSD.

Type A quantity means a quantity of Class 7 (radioactive) material, the aggregate radioactivity which does not exceed 1 A_1 for special form Class 7 (radioactive) material or 1 A_2 for normal form Class 7 (radioactive) material, where A_1 and A_2 values are given in 49 CFR 173.435 or are determined in accordance with 49 CFR 173.433.

Type B quantity means a quantity of material greater than a Type A quantity.

Ullage means the amount by which a packaging falls short of being liquid full, usually expressed in percent by volume.

UN standard packaging means a packaging conforming to standards in the UN recommendations on the Transport of Dangerous Goods.

Unilateral approval means approval of a package design solely by the Competent Authority of the country of origin of the design.

United States means a State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Virgin Islands, American Samoa, Guam, or any other territory or possession of the United States designated by the Secretary.

Unirradiated thorium means thorium containing not more than 10^{-7} grams ^{233}U per gram of ^{232}Th.

Unirradiated uranium means uranium containing not more than 2×10^3 Bq of plutonium per gram of uranium-235, not more than 9×10^6 Bq of fission products per gram of ^{235}U, and not more than 5×10^{-3} g of ^{236}U per gram of ^{235}U.

Uranium--natural, depleted or enriched means the following: (1)(i) 'Natural uranium' means chemically separated uranium containing the naturally occurring distribution of uranium isotopes (approximately 99.28% ^{238}U and 0.72% ^{235}U by mass). (ii) 'Depleted uranium' means uranium containing a lesser mass percentage of ^{235}U than in natural uranium. (iii) 'Enriched uranium' means uranium containing a greater mass percentage of ^{235}U than 0.72%. (2) In all cases listed in this definition, a very small mass percentage of ^{234}U is present.

USQ_T is an unreviewed safety question (USQ) process for transportation activities used to evaluate onsite packaging and transportation issues.

Vessel includes every description of watercraft, used or capable of being used, as a means of transportation on the water.

Work Instruction means the documentation that specifies the actual work that will be conducted in the field including prerequisites, performance instructions, and system testing/restoration steps. The work instruction is the "activity" part of a work order that the USQ_T process applies to. Other materials, such as additional forms, permits and administrative fields on work management generated forms are not part of the work instructions, and as such, the USQ_T process does not apply to this material.

Work Package means a general term for the folder, forms, permits, and work instructions that are packaged together in order to provide direction on how to accomplish maintenance or other work activity. Examples include a No Planning Required (NPR) Work Order, Work It Now (WIN) Ticket, Planned Work Order, or Service Ticket.

2.2 ACRONYMS AND ABBREVIATIONS

AC	accident condition
ANSI	American National Standards Institute
ARF	airborne release fraction
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BPVC	boiler and pressure vessel code
Bq	becquerel
CDL	commercial driver's license
CEDE	committed effective dose equivalent
CFR	*Code of Federal Regulations*
Ci	curie
CMV	commercial motor vehicle
CoC	certificate of compliance
CSB	Canister Storage Building
CSI	Criticality Safety Index
CWC	Central Waste Complex
CX	categorical exclusion
DCF	dose conversion factor
DDT	deflagration to detonation transition
DE-Ci	dose-equivalent curie
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy-Headquarters
DOT	U.S. Department of Transportation
DR	damage ratio
DSA	Documented Safety Analysis
EPA	U.S. Environmental Protection Agency
ES&H	environment, safety, and health
EU	extremely unlikely
FMCSR	Federal Motor Carrier Safety Regulations
GCX	general categorical exclusion
GIS	Geographic Information System
GSA	Government Services Administration
HAC	hypothetical accident condition
hazmat	hazardous material (commonly includes hazardous materials, substances, and wastes)
HEMP	*Hanford Emergency Management Plan*
HLW	high-level waste
HMPS	Hanford Minimum Packaging Standards
HMSR	*Hazardous Material Shipment Record*
HMT	Hazardous Materials Table
HNF	Hanford Nuclear Facility (document identifier)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection

ICV	inner containment vessel
IP	industrial package
ISMS	Integrated Environment, Safety and Health Management System
ISO	International Standards Organization
JCO	justification for continued operations
LFL	lower flammability limit
LLW	low-level waste
LPF	leak path factor
LSA	low specific activity
MAR	material at risk
MNOP	maximum normal operating pressure
MOI	Maximum Exposed Offsite Individual
MW	Mixed waste (radioactive and other hazardous constituents mixed)
NC	normal condition
NCT	normal conditions of transport
NQA-1	Nuclear Quality Assurance
NRC	U.S. Nuclear Regulatory Commission
O&M	Operations and Maintenance
OR	Occurrence Report
ORP	U.S. Department of Energy, Office of River Protection
ORRSR	*Onsite Routine Radioactive Shipment Record*
OTRS	one-time request for shipment
PISA	potential inadequacy in the safety analysis
POC	Patrol Operations Center
psi	pounds per square inch
psia	pounds per square inch, absolute
PSSD	package-specific safety document
QA	quality assurance
QAP	quality assurance program
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	radiological control technician
RF	respirable fraction
RL	U.S. Department of Energy, Richland Operations Office
RQ	reportable quantity
RSR	*Radioactive Shipment Record*
s/m^3	seconds per cubic meter
SAR	safety analysis report (generally prepared for facilities or specific projects)
SARAH	*Hanford Safety Analysis and Risk Assessment Handbook (SARAH)*
SARP	safety analysis report for packaging
SC	Significance Category
SCO	surface contaminated object
SED	strain energy density
SED	DOE/RL's Safety and Engineering Division
SEP	safety evaluation for packaging
SER	safety evaluation report
SNM	special nuclear material

SPA	special packaging authorization
SPZ	Special Packaging Zone
SSC	structures, systems, or components
SWITS	Solid Waste Information Tracking System
T&P	transportation and packaging
TI	transport index
TRAMPAC	*TRUPACT-II Authorized Methods for Payload Control (TRAMPAC)*
TRU	transuranic
TSD	*Hanford Sitewide Transportation Safety Document* (DOE/RL-2001-36)
TSL	Triaxial Strain Limit
TSR	technical safety requirement
UHWM	*Uniform Hazardous Waste Manifest*
USC	*United States Code*
USQ	unreviewed safety question
USQ_T	unreviewed safety question for transportation
USQ_TD	unreviewed safety question for transportation determination
USQ_TS	unreviewed safety question for transportation screening
V/R	velocity/radius
WAC	*Washington Administrative Code*

2.3 REFERENCES

10 CFR 71, "Packaging and Transportation of Radioactive Material," *Code of Federal Regulations*, as amended.

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*, as amended.

40 CFR 262, "Standards Applicable to Generators of Hazardous Waste," *Code of Federal Regulations*, as amended.

49 CFR 171, "General Information, Regulations, and Definitions," *Code of Federal Regulations*, as amended.

49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements," *Code of Federal Regulations*, as amended.

49 CFR 173, "Shippers—General Requirements for Shipments and Packagings," *Code of Federal Regulations*, as amended.

49 CFR 178, "Specifications for Packagings," *Code of Federal Regulations*, as amended.

49 CFR 179, "Specifications for Tank Cars," *Code of Federal Regulations*, as amended.

49 CFR 397, "Transportation of Hazardous Materials; Driving and Parking Rules," *Code of Federal Regulations*, as amended.

49 USC, "Transportation," *United States Code*, Washington, D.C.

ASTM D4359, "Standard Test for Determining Whether a Material is a Liquid or a Solid," *American Society for Testing and Materials*, West Conshohocken, PA.

DOE Guide 460.1-1, *The Packaging and Transportation Safety Implementation Guide*, U.S. Department of Energy, Washington, D.C.

DOE Order 460.1B, *Packaging and Transportation Safety*, U.S. Department of Energy, Washington, D.C.

Regulatory Guide 7.10, *Establishing Quality Assurance Programs for Packaging Used in the Transport of Radioactive Material*, U.S. Nuclear Regulatory Commission, Washington, D.C.

CHAPTER 3.0 SITE DESCRIPTION

This chapter describes the Hanford Site boundaries and roadways used to transport hazardous materials and wastes. It describes exclusion areas and facilities, and their principle missions. A Hanford Site map and Internet links are provided for more detailed site and area maps.

3.1 PHYSICAL DESCRIPTION

The Hanford Site covers approximately 1,450 km^2 (560 mi^2) of semiarid land along the Columbia River in southeastern Washington State. It is owned by the U.S. Government and managed by the RL and ORP. The city of Richland adjoins the southeastern most portion of the Hanford Site boundary and is the nearest population center.

In early 1943, the U.S. Army Corps of Engineers selected the Hanford Site as the location for plutonium production for national defense. For over 20 years, activities were primarily dedicated to the continuation of plutonium production and managing the waste generated. In later years, activities became increasingly diverse, involving research and development for advanced reactors and renewable energy technologies. The end of the Cold War brought the shutdown of most of the Hanford Site's plutonium production and management facilities. Current missions are to safely cleanup and manage the legacy waste on the Hanford Site and to develop and deploy science and technology (DOE/RL-96-92, *Hanford Strategic Plan*).

The Hanford Site is divided into numerically designated areas. These areas served as the location for reactor, chemical separation, and related activities for the production and purification of special nuclear materials (SNM) and other nuclear activities. The reactors are located along the Columbia River in the 100 Areas. The reactor fuel reprocessing units are in the 200 Areas, which are on a plateau approximately 11 km (7 mi) from the Columbia River. The 300 Area, located adjacent to and north of Richland, contains the reactor fuel manufacturing plants and research and development laboratories. The 400 Area, 8 km (5 mi) northwest of the 300 Area, contains the Fast Flux Test Facility designed for testing liquid metal reactor systems. The 600 Area covers all locations within the Hanford Site boundary not specifically given an area designation. Adjacent to and north of Richland, the 1100 Area contains offices associated with administration, maintenance, transportation, and materials procurement and distribution. Offices also are located in the 700 Area, which is in downtown Richland.

The regional public highway network traversing the Hanford Site (Washington State Highways 24 and 240), nonrestricted access roadways (Route 10 and portions of Route 4S located south of the Wye Barricade), and restricted access roadways are shown in Figure 3-1. Roadways east of the Yakima Barricade, north of the Wye Barricade, and within the 300 and 400 areas are restricted to authorized personnel only. Other roadways are subject to such restrictions or closure as the DOE might require.

Figure 3-1. Hanford Site Major Roads.

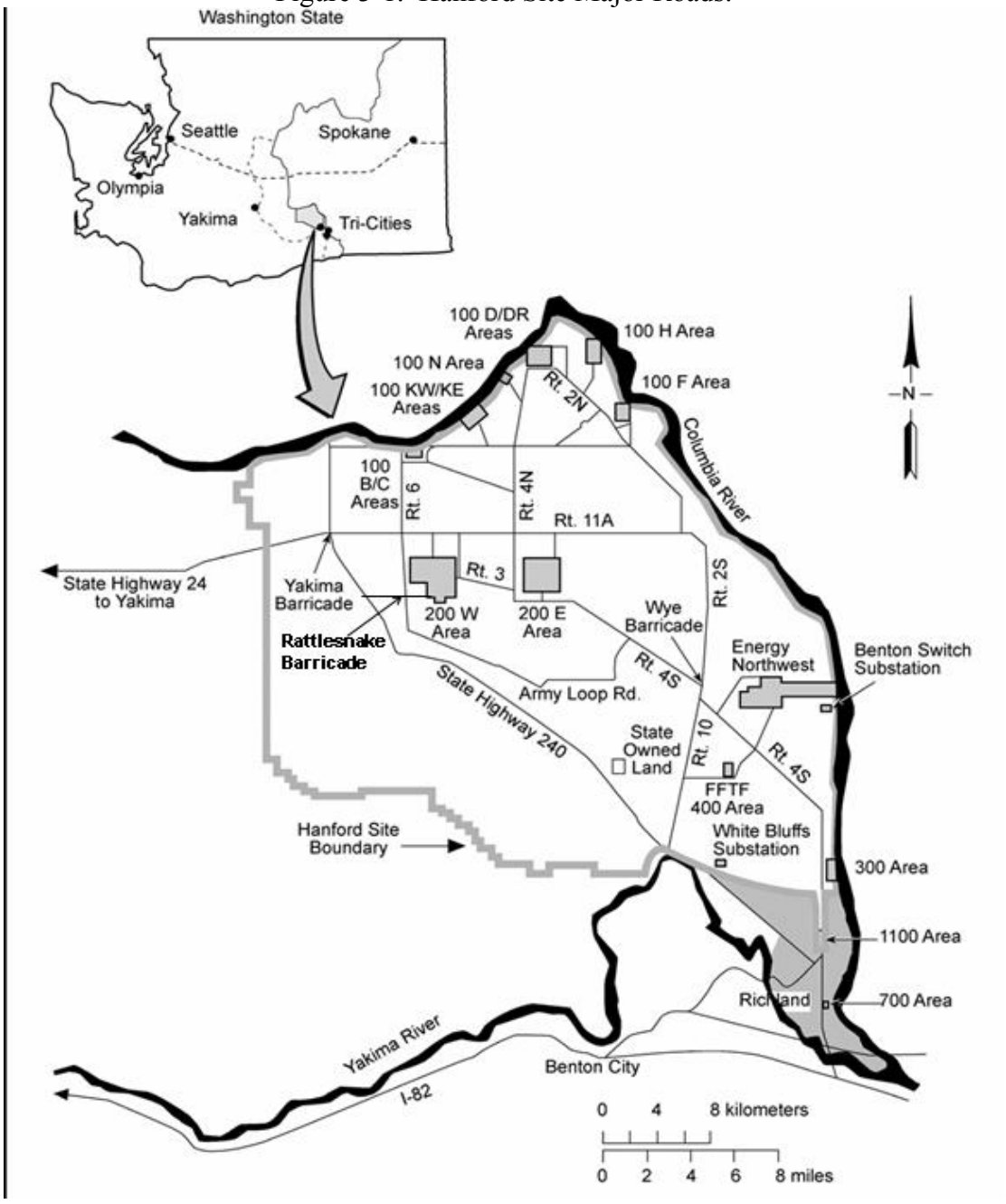


Figure 3-1 shows the major roads throughout the Hanford Site. These roads are classified as either primary or secondary routes. The primary routes include Routes 4N, 4S, 10, 2S, 3, 6, and 11A as well as various avenues within each area. The primary routes are constructed of bituminous asphalt (usually 5 cm [2 in.] thick, but the thickness of the asphalt layer will vary with each road) with an underlying aggregate base in accordance with DOT requirements. The

secondary routes are constructed of layers of an oil-and-rock mixture with an underlying aggregate base. The aggregate base consists of various types and sizes of rock found onsite. The present load-bearing capacities of these roads are unknown; however, loads as large as 9.8 kg/cm^2 (140 psi) have been transported without observable damage to road surfaces. All roads meet the requirements for the American Association of State Highway and Transportation Officials HS-20-44 load rating (AASHTO 1983). An HS-20-44 loading represents a two-axle tractor (front-axle loading of 3,630 kg [8,000 lb] and rear-axle loading of 14,500 kg [32,000 lb] plus a single-axle trailer with a 14,500 kg [32,000 lb] axle loading).

Standard traffic control signs are used throughout the Hanford Site (e.g., octagonal stop signs and triangular yield signs). Speed limits are posted throughout the Hanford Site, and the maximum posted speed is 88 km/h (55 mi/h) on major thoroughfares. Inside the various areas, posted speeds are reduced to a maximum of 56 km/h (35 mi/h) and held to speeds as low as 24 km/h (15 mi/h).

The Hanford Site railroad is infrequently used. The trackage and roadbed are only maintained and inspected on an as-needed basis.

3.2 PUBLIC ACCESS

The Hanford Site boundary (Figure 3-1) is marked by fences and signs. With the exception of one area, public access to other than roadways is restricted. Fences, signs, and security patrols are used to enforce the access restrictions.

On the south end of the Hanford Site, the public has access to a foot and bike path located near the Columbia River. The path extends between the south boundary of the Hanford Site and the 300 Area. The public has free access to the Columbia River where the river flows along the Hanford Site boundary. Access includes several islands located in that stretch of the river.

As noted in Section 3.1, Physical Description, several public highways pass through the Hanford Site. The public is permitted free access through Washington State Highways 24 and 240. In addition, the public also is permitted free access to the following Hanford Site roadways:

- Route 4S from the intersection with Horn Road to the Wye Barricade
- The two roads from 4S that go into the Energy Northwest area
- Kentucky Boulevard from 4S to the 400 Area
- Alabama Boulevard from Kentucky Boulevard to Route 10
- Route 10 from Washington State Highway 240 to Route 4S
- George Washington Way between Horn Road and Route 4S

3.3 OTHER SITE MAPS

A site map locating and describing the Hanford Site is located on the Hanford Intranet site for onsite use.

3.4 PRIMARY ONSITE TRANSPORT ROUTES

Transportation routes are generally specified for each onsite packaging system in the onsite PSSD. When routes are not specified, it is expected that shipments will be executed using the most direct route on principal site roadways. Back roads, unimproved roads, and shortcuts are not to be used unless specifically authorized in the onsite PSSD, transportation plan, project plan, health and safety plan, or are required by the activity, or other improved routes are not available.

The most common routes for transporting hazardous materials, substances, and wastes are as follows:

- 1100 Area to 300 Area: Take Route 4S north to 300 Area
- 1100 Area to 400 Area: Take Route 4S north to 400 Area
- 1100 Area to 200E: Take Route 4S north to 200E Area
- 1100 Area to 200W: Take Route 4S north to Route 3, then west to 200W Area

- 300 Area to 1100 Area: Take Route 4S south to 1100 Area
- 300 Area to 200W Area: Take Route 4S north to Route 3, then west to 200W Area

- 200E Area to 200W Area: Take Route 3 west to 200W Area
- 200E Area to 300 Area: Take Route 4S to 300 Area
- 200E Area to 1100 Area: Take Route 4S south to 1100 Area

- 200W Area to 200E Area: Take Route 3 east to 200E Area
- 200W Area to 300 Area: Take Route 3 east to Route 4S, then south to 300 Area
- 200W Area to 1100 Area: Take Route 3 east to Route 4S, then south to 1100 Area

- 100 Areas to 200E Area: As appropriate, take Route 1 or Route 2N to Route 4N, then turn south on Route 4N to Route 3, then turn east into 200E Area

- 100 Areas to 200W: As appropriate, take Route 1 or Route 2N to Route 4N, then turn south on Route 4N to Route 3, then turn west to 200W Area

- 100 Areas to 1100 Area: As appropriate, take Route 1 or Route 2N to Route 4N, then turn south onto Route 4N. Route 4N turns into Route 4S. Follow Route 4S to 1100 Area.

3.5 REFERENCES

AASHTO, 1983, American Association of State Highway and Transportation Officials HS-20-44, Washington, D.C.

DOE/RL-96-92, *Hanford Strategic Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

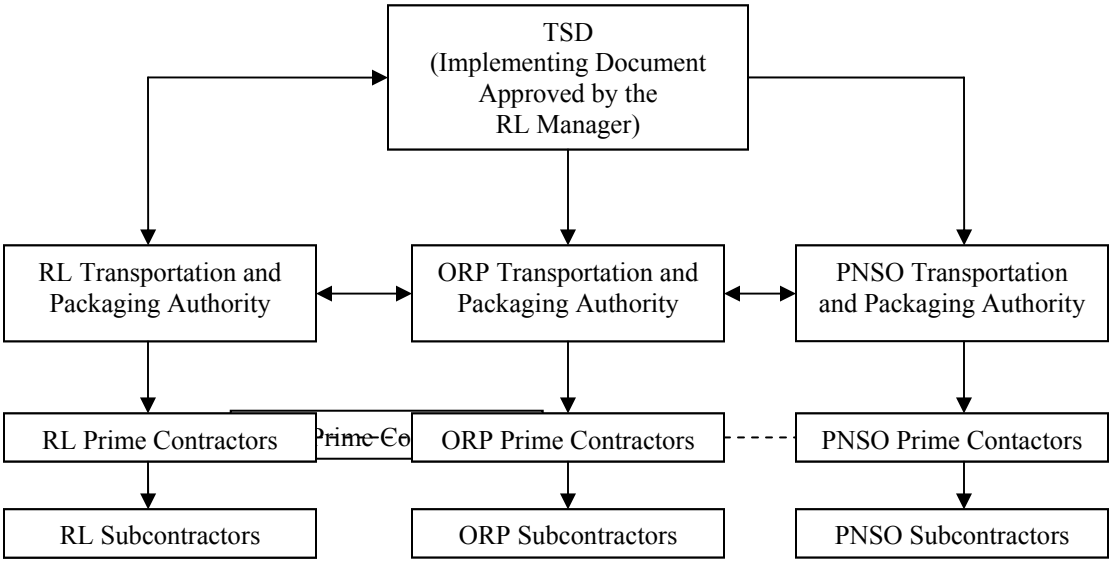
CHAPTER 4.0 ORGANIZATIONAL RESPONSIBILITIES

This chapter identifies DOE and contractor responsibilities and interfaces within the transportation safety program as defined in this TSD and specific package development and approval. It identifies Internet links to more detailed contractor charters that describe organizational responsibilities for program implementation.

4.1 SITE ORGANIZATIONAL STRUCTURE

DOE has sitewide responsibility for onsite T&P activities. DOE implements the Hanford Sitewide T&P safety program through the RL Manager-approved sitewide TSD (see Figure 4-1). The sitewide TSD applies to DOE and all Hanford Site prime contractors and their major subcontractors who perform hazardous material T&P activities in association with their project or mission.

Figure 4-1. Hanford Site TSD Program.



The Hanford Site Internet sites at http://www.hanford.gov identify the RL, ORP, and prime contractor structure at the Hanford Site and identify appropriate senior management contacts. Senior managers or their delegates provide detailed organizational charts, identify key positions, roles and responsibilities, and lines of authority.

Within this organizational structure, RL is responsible for and recommends approval of the technical content and methodology used to provide adequate levels of control and safety for the onsite shipment of hazardous materials, substances, and wastes. Each prime contractor is responsible for complying with the provisions of this TSD.

4.2 DOE-RL, ORP AND PNSO ROLES AND INTERFACES

DOE-RL, ORP and PNSO Field Office Managers are jointly responsible for implementing the Hanford Site hazardous materials T&P program identified in this TSD. The RL, ORP and PNSO interact with each other and their contractors to accomplish implementation. DOE-RL acts as the DOE contact for all requests for TSD changes or exemptions. DOE-RL will coordinate all TSD changes with the other Hanford Site DOE Field Office Managers. The DOE-RL Manager will approve all changes to the TSD.

DOE-RL will act as the Configuration Manager for the TSD and changes or exemptions to the TSD. As many packages may be used by some or all of the Site Prime Contractors, it is vital that a central Configuration Manager be designated. A vital function of the TSD is to designate a single set of standards that govern all onsite shipments of hazardous materials. This single set of standards will reduce costs and enhance safety and operations throughout the Hanford site.

DOE-RL Safety and Engineering Division (SED) maintains DOE-HQ certified packaging analysts who are qualified to review transportation safety documents and exemption requests. All new and revised transportation safety documents and requests for exceptions for all three Hanford site DOE Field Offices will be submitted to SED for technical review prior to approval. The results of these reviews and recommendations for transportation safety document or exemption request will be forwarded to the effected DOE Field Office Manager's nuclear safety organization(s) for review and then on to effected DOE Field Office Manager(s) for approval.

ORP provides RL with review and comments on the TSD and any ORP PSSD identified in the TSD as requiring RL Manager approval processing.

The cognizant Hanford DOE Field Office Manager will review and approve all new PSSDs.

RL, ORP and PNSO will perform assessments of the respective contractor's program and T&P operations to ensure compliance with this TSD and applicable DOE orders (i.e., DOE Order 460.1B, DOE Order 460.2, *Departmental Materials Transportation & Packaging Management*, and DOE regulations in 10 CFR 830, "Nuclear Safety Management").

The cognizant Hanford DOE Field Office Manager will approve all exemptions from technical standards or administrative requirements that have the potential to impact worker safety, public safety, or environmental compliance. Requests for exemptions must be submitted in writing to the cognizant Hanford DOE Field Office Manager by the requesting contractor. The TSD exemption process is further defined in Chapter 9.0, Nonroutine Shipments.

4.3 CONTRACTOR ROLES AND INTERFACES

Each contractor performing T&P activities must have a formal program in place to ensure compliance with the TSD standards that are applicable to the onsite shipment or transfer of hazardous materials, substances, and wastes as defined by applicable regulations.

Each contractor must identify an organization to manage the program and an approval authority to approve packaging systems authorized under the TSD.

Each contractor must complete a compliance or implementation matrix that identifies organizational responsibilities and key personnel.

Each contractor must list manuals, policies, procedures, processes, and systems to implement the TSD requirements and standards, and demonstrate compliance.

Each contractor must develop, test or evaluate, and document all new or modified packaging systems in compliance with the provisions of this TSD and applicable DOE orders.

Each contractor must implement and maintain a formal system for documenting the packaging and payload evaluation process to ensure that all packagings are approved for the payload, that packaging operating and maintenance requirements are met for each shipment, and that package configuration control is maintained within the packaging authorization.

Each contractor is to implement the process for an unreviewed safety question for transportation (USQ_T) as defined in Section 6.6.1 and Appendix C of this TSD. All positive USQ_T determinations (USQ_TD) must be submitted to RL for approval prior to implementation.

Each contractor must have a system for performing required updates and maintenance activities on specific PSSDs (e.g., onsite SARPs and SEPs). The T&P system safety basis for each design must be assessed fully during document updating and maintenance.

Each contractor may use another contractor's PSSD after documented review and approval of the PSSD by their T&P approval authority.

Each contractor generating a new transportation safety basis document or request for exemption must obtain DOE approval prior to implementation. Requests for changes to an existing transportation safety document, depending on the scope of the change, may require DOE approval.

Each contractor may use another contractor's transportation system after documented review and approval by their transportation approval authority.

Each contractor must conduct an annual management assessment of their T&P safety program/operation to ensure compliance with the TSD, applicable regulations, DOE orders, and to identify opportunities to improve program performance.

DOE-RL SED is the TSD Configuration Manager. Due to staffing and resource constraints, some of the administrative functions of the configuration management process may be delegated to contractors. These functions may include:

1. Ensure that notifications of potential inadequacies in the safety analyses are appropriately distributed to the contractor T&P points of contact.

2. Ensure that USQ_TDs are appropriately distributed to the contractor T&P points of contact.

3. Maintain configuration control of the TSD.

4. Prepare the annual TSD update and the annual USQ_T summary report.

5. Maintain the safety basis current as required by DOE Order 460.1B and 10 CFR 830.

4.4 REFERENCES

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*, as amended.

DOE Order 460.1B, *Packaging and Transportation Safety*, U.S. Department of Energy, Washington D.C.

DOE Order 460.2, *Departmental Materials Transportation & Packaging Management*, Change 1, U.S. Department of Energy, Washington, D.C.

CHAPTER 5.0 EXTERNAL REGULATIONS

This chapter identifies the external regulations that contain requirements applicable to onsite T&P activities. Several regulations are written specifically to address onsite packaging and transfer operations. Additional regulations apply to various activities that make up the overall process of T&P because they apply to the materials being handled or the activity being performed. Specific local and supplemental regulations may also apply. These local and supplemental regulations may vary from Hanford Site Prime Contractor to Prime Contractor. Specific requirements may be found in each respective contract.

5.1 PACKAGING AND TRANSPORTATION, SPECIFIC REQUIREMENTS

The following external requirements specifically identify conditions for the onsite T&P of hazardous materials. Section 5.1.1 describes all hazardous materials transport requirements identified by the DOE. Section 5.1.2 describes nuclear safety requirements.

5.1.1 DOE Order 460.1B, Packaging and Transportation Safety

DOE Order 460.1B is the primary requirement for establishing and maintaining an onsite T&P program for the safe movement of hazardous materials, hazardous substances and wastes, including radioactive materials and wastes. This order requires that onsite hazardous material shipments comply with the DOT Hazardous Materials Regulations, or the site-specific RL-approved TSD. The site-specific document must describe the methodology and compliance process used to provide equivalent safety for any deviation from the DOT Hazardous Materials Regulations. This document fulfills that requirement.

5.1.2 10 CFR 830, Nuclear Safety Management

For nuclear safety associated with radioactive materials, 10 CFR 830 governs the conduct of DOE contractors, DOE personnel, and other persons conducting activities (including providing items and services) that affect, or may affect, the safety of DOE nuclear facilities. This includes transportation activities not regulated by the DOT. The rule permits treating transportation activities separate from the nuclear facilities the activities are conducted to support. In this case, a separate documented safety analyses, as well as plans and programs, must be prepared. The rule also permits integrating the nuclear safety and transportation requirements by integrating activities into site or facility analyses and plans. The rule specifically identifies two “safe harbor” methods in Table 2 of Appendix A to Subpart B for transportation activities covered by this rule. The safe harbor methods endorse the methods and processes described in DOE Order 460.1B and its associated guide, and DOE Order 461.1, *Packaging and Transportation of Materials of National Security Interest*, and it’s associated manual. Both methods are identified as acceptable ways to satisfy the requirements for transportation activities covered by the provisions of this rule. This document takes advantage of the safe harbor method provided by DOE Order 460.1B and its associated guide.

5.2 INDIRECT T&P REQUIREMENTS

The following are external safety requirements that may apply to onsite hazardous material T&P activities. Their applicability depends on the following conditions:

- Where the activity is performed
- What type of material is packaged
- How much material is handled
- Is the material considered waste or non-waste
- Physical form/chemical form
- Package used
- Method of transport.

5.2.1 National Regulations

This section identifies requirements that are known to influence onsite T&P. The organization performing the T&P activity must ensure that applicable requirements are identified and implemented.

10 CFR 71, "Packaging and Transportation of Radioactive Material," *Code of Federal Regulations,* as amended.

10 CFR 72, "Licensing Requirements for the Independent Storage of Spend Nuclear Fuel and High-Level Radioactive Waste," *Code of Federal Regulations*, as amended.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*, as amended.

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*, as amended.

42 USC 9601 et seq., *Comprehensive Environmental Response, Compensation and Liability Act of 1980*.

49 CFR 40, "Procedures for Transportation Workplace Drug Testing Programs," U.S. Department of Transportation, Washington, D.C.

49 CFR 100 through 199, "Research and Special Programs Administration, Department of Transportation," U.S. Department of Transportation, Washington, D.C.

49 CFR 325 through 399, "Federal Highway Administration, Department of Transportation," U.S. Department of Transportation, Federal Highway Administration, Washington, D.C.

DOE Order 151.1A, *Comprehensive Emergency Management System*, U.S. Department of Energy, Washington, D.C.

DOE Order 232.1A, *Occurrence Reporting and Processing of Operations Information*, U.S. Department of Energy, Washington, D.C.

DOE Order 414.1A, *Quality Assurance,* U.S. Department of Energy, Washington, D.C.

DOE Order 460.1B, *Packaging and Transportation Safety*, U.S. Department of Energy, Washington, D.C.

DOE Order 460.2, *Departmental Materials Transportation & Packaging Management*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE Order 461.1, *Packaging and Transfer or Transportation of Materials of National Security Interest*, U.S. Department of Energy, Washington, D.C.

DOE Order 474.1A, *Control and Accountability of Nuclear Materials*, U.S. Department of Energy, Washington, D.C.

DOT, *North American Emergency Response Guidebook*, U.S. Department of Transportation, Research and Special Programs Administration, Office of Hazardous Materials Initiatives and Training.

5.2.2 State Regulations

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

WAC 173-303-180, "Manifest," *Washington Administrative Code*, as amended.

WAC 173-303-220(2), "Generator Reporting," *Washington Administrative Code*, as amended.

WAC 173-303-370, "Manifest System," *Washington Administrative Code*, as amended.

WAC 446-50-080(1), "Transportation of Hazardous Materials," *Washington Administrative Code*, as amended.

5.2.3 Local Regulations

DOE-0223, *Emergency Implementation Procedures*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-91-28, *Hanford Facility Dangerous Waste Permit Application*, General Information Portion, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-94-02, *Hanford Emergency Management Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

RL 95-SWT-186 (Guidance letter, March 29, 1995), Director of Procurement Services Division, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

5.3 POTENTIAL INDIRECT T&P REQUIREMENTS

This section identifies regulatory or activity driven requirements that are not explicitly directed at transportation activities, but which result in imposition of requirements on transportation related activities. Their applicability depends on the following conditions:

- Where the activity is performed
- What type of material is packaged
- How much material is handled
- Is material considered waste or non-waste
- Physical form/chemical form
- Package used
- Method of transport.

The organization conducting the T&P activity should ensure that applicable requirements are identified and implemented. These requirements are contained in current DOE Orders and Contractor Requirement Documents as applicable by contract and other agreements.

5.4 STANDARDS

5.4.1 Government

DOE Guide 421.1-1, 1999, *Criticality Safety Good Practices Program Guide for DOE Nonreactor Nuclear Facilities*, U. S. Department of Energy, Washington, D.C.

DOE-HDBK-3010-94, 2000, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities,* Change Notice 1, U. S. Department of Energy, Washington, D.C.

DOE/RL-92-36, *RL Hoisting and Rigging Manual*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, Change Notice No. 1, U. S. Department of Energy, Washington, D. C.

DOH, *Radiological Health Handbook*, U.S. Department of Health, Education, and Welfare, Rockville, Maryland.

EPA, 1992, *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*, U.S. Environmental Protection Agency, Washington, D.C.

IAEA, 1990, *Explanatory Material for the IAEA Regulations for the Safe Transport of Radioactive Material,* Safety Series No. 7, Second Edition (As Amended 1990), International Atomic Energy Agency, Vienna.

ICRP, 1975, *Report of the Task Group on Reference Man,* International Commission on Radiological Protection, Report No. 23, Elmsford, New York.

MIL-HDBK-5G, *Military Handbook-Metallic Materials and Elements for Aerospace Vehicle Structures*, U.S. Department of Defense, Washington, D.C.

NUREG-1608, *Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects*, Spent Fuel Project Office, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG-1609, *Standard Review Plan for Transportation Packages for Radioactive Material* (including Supplement 1), Spent Fuel Project Office, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-1815, *Recommendations for Protecting Against Failure by Brittle Fracture in Ferritic Steel Shipping Containers up to Four Inches Thick*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-3019, *Recommended Welding Criteria for Use in the Fabrication of Shipping Containers for Radioactive Materials*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-3332 and ORNL-5968, 1983, *Radiological Assessment: A Textbook on Environmental Dose Analysis*, prepared by Radiological Assessments Corporation, Neeses, South Carolina, and Oak Ridge National Laboratory, Oak Ridge, Tennessee, for the U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-3854, *Fabrication Criteria for Shipping Containers*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-4775, *Guide for Preparing Operating Procedures for Shipping Packages*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-4829, *Shipping Container Response to Severe Highway and Railway Accident Conditions*, Lawrence Livermore National Laboratory, Livermore, California.

NUREG/CR-5502, *Engineering Drawings for 10 CFR Part 71 Package Approvals*, Nuclear Regulations, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-5661, *Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packaging for Radioactive Material,* U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-6007, *Stress Analysis of Closure Bolts for Shipping Casks*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-6407, *Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-6672, *Reexamination of Spent Fuel Shipment Risk Estimates*, Sandia National Laboratories, Albuquerque, New Mexico.

Regulatory Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Regulatory Guide 7.6, *Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Regulatory Guide 7.10, *Establishing Quality Assurance Programs for Packaging Used in the Transport of Radioactive Material*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Regulatory Guide 7.11, *Fracture Toughness Criteria of Base Material for Ferritic Steel Shipping Cask Containment Vessels with a Maximum Wall Thickness of 4 Inches (0.1 m)*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Regulatory Guide 7.12, *Fracture Toughness Criteria of Base Material for Ferritic Steel Shipping Cask Containment Vessels with a Wall Thickness Greater than 4 Inches (0.1 m) But Not Exceeding 12 Inches (0.3 m)*, U.S. Nuclear Regulatory Commission, Washington, D.C.

5.4.2 Industry

ANSI/ANS-8.1-1998, *American National Standard for Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors*, American Nuclear Society, La Grange Park, Illinois.

ANSI N14.5, "Radioactive Materials - Leakage Test on Packages for Shipment," *American National Standards Institute*, La Grange Park, Illinois.

ASME, 1995, "Boiler and Pressure Vessel Code," Section VIII, Division 1, *American Society of Mechanical Engineers*, New York, New York.

ASME, 1995, "Boiler and Pressure Vessel Code," Section III, Subsection NE, *American Society of Mechanical Engineers*, New York, New York.

ASME, 1995, "Boiler and Pressure Vessel Code," Section II, Part D, *American Society of Mechanical Engineers*, New York, New York.

ISO 14001, *Integrated Organization for Standardization, Environmental Management System*, International Standards Organization, Geneva, Switzerland.

MIL-HDBK-695, *Rubber Products: Recommended Shelf Life*, Military Handbook, Aerospace Industries Association, Washington, D.C.

CHAPTER.6.0 - SITE-SPECIFIC STANDARDS, PROCEDURES,AND INSTRUCTIONS

This chapter provides standards, requirements, programs, and processes that are needed to support safe T&P operations such as integrated safety management, QA, configuration management, and equivalent safety. Alternate design and performance requirements for onsite packagings are identified.

6.1 OPERATING REQUIREMENTS

Specific standards and procedures are to be followed when conducting onsite shipments at the Hanford Site. The initial discussion is an overview of how the TSD achieves equivalent safety. In addition, the initial discussion provides an overview of requirements to be implemented. This is followed by identifying specific standards, procedures, and operating instructions that are to be implemented by operating procedures when conducting onsite T&P activities.

6.1.1 BASES FOR EQUIVALENT SAFETY

The TSD identifies three categories of packages, all of which achieve "equivalent safety," as required by DOE Order 460.1B for onsite shipments, and are discussed in the following sections. This includes two categories that specifically meet the intent of 49 CFR 173 and 10 CFR 71 as discussed in Sections 6.1.1.1 and 6.1.1.2. The third category of packages (Section 6.1.1.3) used for onsite shipments relies on a risk based approach to demonstrate an equivalent level of safety for the public and an acceptable level of safety for onsite workers.

6.1.1.1 DOT Compliance

In general, T&P safety is achieved onsite by implementing the DOT regulations. All portions of the regulations, other than those identifying the workings and administration of the DOT (e.g., enforcement), will be implemented. Equivalent administrative activities, including approval of exemptions, will be conducted by DOE. This is the preferred technique for achieving onsite safety when conducting onsite T&P activities.

In addition, compliant packagings, such as NRC, DOE, DOD, or IAEA Certificate of Competent Authority, can be utilized for onsite shipments of radioactive materials provided they are used in accordance with the individual package certificate of compliance requirements.

6.1.1.2 DOT-Equivalent Packaging

For radioactive materials, where full compliance with DOT regulations cannot be achieved, an equivalent method for achieving the accepted national level of safety is authorized by DOE Order 460.1B. DOT Equivalent Packaging provides equivalent safety to DOT regulations as modified for Hanford specific site conditions. These requirements are codified as the Hanford Packaging Standards (HPS) and are discussed in Appendix B. For these radioactive hazardous materials, equivalent safety is achieved by

implementing all portions of the regulations as modified by HPS, except for regulations identifying the following:

- Workings and administration of the DOT
- How to obtain exemptions
- Communication requirements associated with shipping radioactive materials.

Equivalent administrative activities, including approval of exemptions or special authorizations, will be conducted by the cognizant DOE Hanford Field Office Manager. Performance requirements for onsite DOT-equivalent packages are identified in Section 6.6.5.2 of this chapter. These requirements are developed to result in a package that produces physical performance under Hanford Site conditions equivalent to an offsite package subject to regulatory-established test conditions. Examples of Hanford Site-specific conditions that are different than DOT and NRC regulatory conditions are environmental conditions (Site-specific temperature extremes), application of artificial cooling after a 30-minute fire (assumes Site fire department response), allowance for container venting (not permitted by DOT), and specific free-drop characteristics (models the Central Waste Complex [CWC] storage pad). Specific details and justifications for Hanford Site-specific variances from the DOT and NRC regulatory conditions are provided in Appendix B of this TSD.

When full compliance with DOT cannot be achieved because of technical or economic conditions, meeting these site-specific standards and performance requirements is the preferred technique for achieving safety equivalent to that of following DOT regulations when shipping in commerce.

6.1.1.3 Risk Based Packaging

When full compliance with DOT regulations or compliance with DOT-equivalent packaging for radioactive materials cannot be achieved for onsite shipments because of technical or economic conditions, a risk based method for demonstrating an acceptable "equivalent" level of safety will be implemented.

- The requirements and method employed for risk based packaging to demonstrate equivalent safety to that resulting from following DOT regulations when shipping on site is detailed in Section 6.5.3 of this chapter. Requirements for risk based packages are developed to result in a package that under Site conditions will produce radiological and toxicological risk equivalent to an offsite package subjected to regulatory-established tests and conditions. Specific bounding accident scenarios are evaluated to demonstrate that use of risk based packaging is equivalent to the accepted national level of safety for DOT-compliant packaging. Documentation of the accident analysis demonstrates consistency with the guidance in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, and that the consequence guidelines of HNF-8739, *Hanford*

Safety Analysis and Risk Assessment Handbook (SARAH), are implemented. Before implementing the risk based packaging method, a documented evaluation showing that DOT compliance and DOT-equivalent packaging compliance are not technically or economically practical must be prepared and retained on file for the life of the package.

For risk based packages, administrative activities, including the approval of exemptions, will be conducted by the cognizant DOE Hanford Field Office Manager. Risk based packages are not generally used for transportation of nonradioactive hazardous materials.

6.2 QA PROGRAM

RL, ORP, and contractors must implement a quality assurance program (QAP). The QAP for contractors must meet contract requirements at a minimum. Where no contract requirement exists, use the applicable requirements from 10 CFR 830, Subpart A. In addition, for design, fabrication, procurement, use, or maintenance of onsite fissile and Type B packagings, the onsite packaging requirements require implementing 10 CFR 71 Subpart H or Nuclear Quality Assurance (NQA-1) or demonstrated equivalent.

6.3 INTEGRATED SAFETY MANAGEMENT SYSTEM

RL, ORP, and each Hanford Site contractor must implement a comprehensive integrated environment, safety and health management system (ISMS) plan and assess onsite T&P activities against ISMS requirements.

The ISMS plan must establish a safety and environmental management system that integrates environment, safety and health (ES&H) requirements into the work planning and execution processes to effectively protect workers, the public, and environment.

The ISMS must incorporate best practices of the following policies, standards, and initiatives:

- RL ES&H Policy
- DOE's *Safety Management System Policy* (DOE Policy 450.4)
- DOE's *Line Environment, Safety and Health Oversight* (DOE Policy 450.5)
- DOE's *Secretarial Policy Statement Environment, Safety and Health* (DOE Policy 450.6)
- International Standards Organization (ISO) 14001.

The contractor ISMS plan must be approved by the appropriate DOE office.

6.4 CONFIGURATION MANAGEMENT PROCESS

6.4.1 Package System Authorizations

Review and approval of this TSD by the Manager, DOE-RL results in a safety basis document for onsite transportation activities that establish safety bounds for onsite hazardous materials T&P activities. This TSD includes the PSSDs identified in Appendix A as an explicit part of the safety basis for shipments. The PSSDs for onsite packages demonstrate how the criteria of the TSD are met. Contractors may make physical and procedural changes and conduct tests and experiments without prior RL approval, provided changes do not explicitly or implicitly affect the safety basis identified in this TSD (including requirements in the TSD or the applicable PSSD, whichever are more restrictive), as documented via the USQ_T process.

6.4.1.1 Approval of Activities and Packagings Bounded by TSD Approval

Changes to this TSD not bounded by the supporting safety evaluation and existing supporting PSSDs must be approved by the RL Manager. Changes to PSSDs bounded by the supporting safety evaluation and existing supporting package safety analysis documentation are approved by the contractor responsible for the T&P activity. The USQ_T process identified in Section 6.6.1 of this chapter must be used to evaluate which changes or activities must be approved by the RL Manager. All new PSSDs must be approved by the RL Manager.

6.5 ONSITE T&P EQUIVALENT SAFETY REQUIREMENTS

6.5.1 DOT Compliance

For all nonradioactive (unless otherwise allowed in Chapter 8.0) and most radioactive hazardous materials, equivalent safety is achieved onsite by implementing DOT regulations. All portions of the regulations, other than those identifying the workings of the DOT, will be implemented. Equivalent administrative activities including approval of exemptions will be conducted by RL and ORP. Table 6-1 identifies methods of implementation to the subpart level of the regulations found in 49 CFR 100 through 185. Table 6-2 identifies methods of implementation to the subpart level of the regulations found in 49 CFR 350 through 399 – "Federal Motor Carrier Safety Administration." The tables differentiate which regulations are DOT administrative or other activities not applicable to onsite shipments, which regulations are written such that onsite implementation (compliance) without modification can be achieved, and which regulations are implemented onsite by emulation of the requirements. Emulation is required where regulations require an action on the part of DOT that is not applicable to onsite T&P activities. For example, DOT approval of an exemption to regulatory requirements for onsite shipments is not applicable. DOE emulation of DOT approval is used to modify requirements to meet site conditions.

Table 6-1. 49 CFR Regulations – Transportation.

49 CFR Parts 100 to 185 – Transportation	DOT Administrative	Compliance	Emulate
CHAPTER I, SUBCHAPTER A	---	---	---
Part 100 [Reserved]	---	---	---
Part 101 [Reserved]	---	---	---
Part 106, Rulemaking procedures	---	---	---
106 Subpart A, General	X		
106 Subpart B, Procedures for Adoption of Rules	X		
Part 107, Hazardous materials program procedures	---	---	---
107 Subpart A, General Provisions	X		
107 Subpart B, Exemptions			X
107 Subpart C, Preemption	X		
107 Subpart D, Enforcement			X
107 Subpart E, Designation of Approval and Certification Agencies			X
107 Subpart F, Registration of Cargo Tank and Cargo Tank Motor Vehicle Manufacturers and Repairers and Cargo Tank Motor Vehicle Assemblers			X
107 Subpart G, Registration of persons Who Offer or Transport Hazardous Materials	X		
107 Subpart H, Approvals, Registrations and Submissions			X
Part 110, Hazardous materials public sector training and planning grants	X		
CHAPTER I, SUBCHAPTER B	---	---	---
Part 130, Oil spill prevention and response plans			X
CHAPTER I, SUBCHAPTER C	---	---	---
Part 171, General information, regulations, and definitions		X	
Part 172, Hazardous materials table, special provisions, hazardous materials communications, emergency response information, and training requirements	---	---	---
172 Subpart A, General	X		
172 Subpart B, Table of Hazardous Materials and Special Provisions		X	
172 Subpart C, Shipping Papers			X
172 Subpart D, Marking			X
172 Subpart E, Labeling			X
172 Subpart F, Placarding			X
172 Subpart G, Emergency Response Information			X
172 Subpart H, Training		X	
172 App A, Office of Hazardous Materials Transportation Color Tolerance Charts and Tables		X	
172 App B, Trefoil Symbol		X	
172 App C, Dimensional Specifications for Recommended Placard Holder		X	
Part 173, Shippers – General requirements for shipments and packagings	---	---	---
173 Subpart A, General	X		
173 Subpart B, Preparation of Hazardous Materials for Transportation			X

Table 6-1. 49 CFR Regulations – Transportation.

49 CFR Parts 100 to 185 – Transportation	DOT Administrative	Compliance	Emulate
173 Subpart C, Definitions, Classification and Packaging for Class 1		X	
173 Subpart D, Definitions, Classification, Packing Group Assignments and Exceptions for Hazardous Materials Other Than Class 1 and Class 7		X	
173 Subpart E, Non-bulk Packaging for Hazardous Materials Other Than Class 1 and Class 7		X	
173 Subpart F, Bulk Packaging for Hazardous Materials Other Than Class 1 and Class 7		X	
173 Subpart G, Gases; Preparation and Packaging			X
173 Subpart H [Reserved]	---	---	---
173 Subpart I, Class 7 (Radioactive) Materials			X
173 Subpart J-O [Reserved]	---	---	---
173 App A, Appendix A - [Reserved]	---	---	---
173 App B, Appendix B – Procedure for Testing Chemical Compatibility and Rate of Permeation in Plastic Packaging and Receptacles	X		
173 App C, Appendix C – Procedure for Base-level Vibration Testing	X		
173 App D, Appendix D – Test Methods for Dynamite (Explosive, Blasting, Type A)	X		
173 App E, Appendix E – [Reserved]	---	---	---
173 App F, Appendix F – [Reserved]	---	---	---
173 App G, Appendix G – [Reserved]	---	---	---
173 App H, Appendix H to Part 173 – Method of Testing for Sustained Combustibility	X		
Part 174, Carriage by rail	N/A	N/A	N/A
174 Subpart A, General Requirements	X		
174 Subpart B, General Operating Requirements	X		
174 Subpart C, General Handling and Loading Requirements	X		
174 Subpart D, Handling of Placarded Rail Cars, Transport Vehicles and Freight Containers	X		
174 Subpart E, Class 1 (Explosive) Materials	X		
174 Subpart F, Detailed Requirements for Class 2 (Gases) Materials	X		
174 Subpart G, Detailed Requirements for Class 3 (Flammable Liquid) Materials	X		
174 Subparts H-I [Reserved]	---	---	---
174 Subpart J, Detailed Requirements for Division 6.1 (Poisonous) Materials	X		
174 Subpart K, Detailed Requirements for Class 7 (Radioactive) Materials	X		
Part 175, Carriage by aircraft	N/A	N/A	N/A
175 Subpart A, General Information and Regulations	X		
175 Subpart B, Loading, Unloading and Handling	X		
175 Subpart C, Specific Regulations Applicable According to Classification of Material	X		

Table 6-1. 49 CFR Regulations – Transportation.

49 CFR Parts 100 to 185 – Transportation	DOT Administrative	Compliance	Emulate
Part 176, Carriage by vessel	N/A	N/A	N/A
176 Subpart A, General	X		
176 Subpart B, General Operating Requirements	X		
176 Subpart C, General Handling and Stowage	X		
176 Subpart D, General Segregation Requirements	X		
176 Subpart E, Special Requirements for Transport Vehicles Loaded With Hazardous Materials and Transported on Board Ferry Vessels	X		
176 Subpart F, Special Requirements for Barges	X		
176 Subpart G, Detailed Requirements for Class 1 (Explosive) Materials	X		
176 Subpart H, Detailed Requirements for Class 2 (Compressed Gas) Materials	X		
176 Subpart I, Detailed Requirements for Class 3 (Flammable) and Combustible Liquid Materials	X		
176 Subpart J, Detailed Requirements for Class 4 (Flammable Solids), Class 5 (Oxidizers and Organic Peroxides), and Division 1.5 (Blasting Agents) Materials	X		
176 Subpart K [Reserved]	---	---	---
176 Subpart L, Detailed Requirements for Division 2.3 (Poisonous Gas) and Division 6.1 (Poisonous) Materials	X		
176 Subpart M, Detailed Requirements for Radioactive Materials	X		
176 Subpart N, Detailed Requirements for Class 8 (Corrosive Materials) Materials	X		
176 Subpart O, Detailed Requirements for Cotton and Vegetable Fibers, Motor Vehicles, and Asbestos	X		
Part 177, Carriage by public highway	---	---	---
177 Subpart A, General Information and Regulations			X
177 Subpart B, Loading and Unloading			X
177 Subpart C, Segregation and Separation Chart of Hazardous Materials			X
177 Subpart D, Vehicles and Shipments in Transit; Accidents			X
177 Subpart E, Regulations Applying to Hazardous Material on Motor Vehicles Carrying Passengers for Hire			X
Part 178, Specifications for packagings			X
178 Subpart A [Reserved]	---	---	---
178 Subpart B, Specifications for Inside Containers, and Linings		X	
178 Subpart C, Specifications for Cylinders		X	
178 Subparts D-G [Reserved]	---	---	---
178 Subpart H, Specifications for Portable Tanks		X	
178 Subpart I [Reserved]	---	---	---
178 Subpart J, Specifications for Containers for Motor Vehicle Transportation		X	
178 Subpart K, Specifications for packagings for Class 7 (Radioactive) Materials		X	

Table 6-1. 49 CFR Regulations – Transportation.

49 CFR Parts 100 to 185 – Transportation	DOT Administrative	Compliance	Emulate
178 Subpart L, Non-bulk Performance-Oriented Packaging Standards		X	
178 Subpart M, Testing of Non-bulk Packagings and Packages		X	
178 Subpart N, Intermediate Bulk Container Performance-Oriented Standards		X	
178 Subpart O, Testing of Intermediate Bulk Containers		X	
178 App A, Appendix A – Specifications for Steel		X	
178 App B, Appendix B – Alternative Leakproofness Test Methods		X	
178 App C, Appendix C – Nominal and Minimum Thickness of Steel Drums and Jerricans		X	
Part 179, Specifications for tank cars	---	---	---
179 Subpart A, Introduction, Approvals and Reports	X		
179 Subpart B, General Design Requirements			X
179 Subpart C, Specifications for Pressure Tank Car Tanks			X
179 Subpart D, Specifications for Non-Pressure Tank Car Tanks (Classes DOT-103, 104, 111AF, 111AW, and 115AW)			X
179 Subpart E, Specifications for Multi-Unit Tank Car Tanks (Classes DOT-106A and 110AW)			X
179 Subpart F, Specification for Cryogenic Liquid Tank Car Tanks and Seamless Steel Tanks (Classes DOT-113 and 107A)			X
179 App A, Appendix A to Part 179 – Procedures for Tank-Head Puncture-Resistance Test	X		
179 App B, Appendix B to Part 179 – Procedures for Simulated Pool and Torch-Fire Testing	X		
Part 180, Continuing qualification and maintenance of packagings	---	---	---
180 Subpart A, General	X		
180 Subparts B-C [Reserved]	---	---	---
180 Subparts D, Qualification and Maintenance of Intermediate Bulk Containers			X
180 Subpart E, Qualification and Maintenance of Cargo Tanks			X
180 Subpart F, Qualification and Maintenance of Tank Cars			X
180 App A, Internal Self-closing Stop Valve Emergency Closure Test for Liquefied Compressed Gasses			X
180 App B, Acceptable Internal Self-closing Stop Valve Leakage Tests for Cargo Tanks Transporting Liquefied Compressed Gasses			X
Part 185 [Reserved]	---	---	---

Table 6-2. 49 CFR Regulations - Federal Motor Carrier Safety Regulations.

49 CFR Parts 350 to 399 – Federal Motor Carrier Safety Regulations	DOT Administrative	Compliance	Emulate
CHAPTER III, SUBCHAPTER B	---	---	---
Part 350, Commercial Motor Carrier Safety Assistance Program	---	---	---
350 Subpart A, General	X		
350 Subpart B, Requirements for Participation	X		
350 Subpart C, Funding	X		
Part 355, Compatibility of State Laws and Regulations Affecting Interstate Motor Carrier Operations	---	---	---
355 Subpart A, General Applicability and Definitions	X		
355 Subpart B, Requirements	X		
Part 356, Motor Carrier Routing Regulations	X		
Part 360, Fees for Motor Carrier Registration and Insurance	X		
Part 365, Rules Governing Applications for Operating Authority	X		
365 Subpart A, How to Apply for Operating Authority	X		
365 Subpart B, How to Oppose Requests for Authority	X		
365 Subpart C, General Rules Governing the Application Process	X		
365 Subpart D, Transfer of Operating Rights Under 49 USC 10926	X		
Part 366, Designation of Process Agent	X		
Part 367, Standards for Registration with States	X		
Part 368, Applications for Certificates of Registration by Foreign Motor Carriers and Foreign Motor Private Carriers under 49 USC 10530	X		
Part 370, Principles and Practices for the Investigation and Voluntary Disposition of Loss and Damage Claims and Processing Salvage	X		
Part 371, Brokers of Property	X		
Part 372, Exemptions, Commercial Zones, and Terminal Areas	---	---	---
372 Subpart A, Exemptions	X		
372 Subpart B, Commercial Zones	X		
372 Subpart C, Terminal Areas	X		
Part 373, Receipts and Bills	---	---	---
373 Subpart A, Motor Carrier Receipts and Bills	X		
373 Subpart B, Freight Forwarders, Bills of Lading	X		
Part 374, Passenger Carrier Regulations	---	---	---
374 Subpart A, Discrimination in Operation of Interstate Motor Common Carriers of Passengers	X		
374 Subpart B, Limitation of Smoking on Interstate Passenger Carrier Vehicles	X		
374 Subpart C, Adequacy of Intercity Motor Common Carrier Passenger Service	X		
374 Subpart D, Notice of and Procedures for Baggage Excess Value Declaration	X		
374 Subpart E, Incidental Charter Rights	X		
Part 375, Transportation of Household Goods in Interstate or Foreign Commerce	X		
Part 376, Lease and Interchange of Vehicles	---	---	---
376 Subpart A, General Applicability and Definitions	X		

Table 6-2. 49 CFR Regulations - Federal Motor Carrier Safety Regulations.

49 CFR Parts 350 to 399 – Federal Motor Carrier Safety Regulations	DOT Administrative	Compliance	Emulate
376 Subpart B, Leasing Regulations	X		
376 Subpart C, Exemptions for the Leasing Regulations	X		
376 Subpart D, Interchange Regulations	X		
376 Subpart E, Private Carriers and Shippers	X		
Part 377, Handling of C.O.D. Shipments	---	---	---
377 Subpart A, Handling of C.O.D. Shipments	X		
377 Subpart B, Extension of Credit to Shippers by Motor Common Carriers, Water Common Carriers, and Household Goods Freight Forwards	X		
Part 378, Procedures Governing the Processing, Investigation, and Disposition of Overcharge, Duplicate Payment or Over Collection Claims	X		
Part 379, Preservation of Records	X		
Part 381, Waivers, Exemptions, and Pilot Programs	---	---	---
381 Subpart A, General	X		
381 Subpart B, Procedures for Requesting Waivers	X		
Part 382, Controlled Substances and Alcohol Use and Testing	---	---	---
382 Subpart A, General			X
382 Subpart B, Prohibitions			X
382 Subpart C, Tests Required			X
382 Subpart D, Handling of Test Results, Record Retention, and Confidentiality			X
382 Subpart E, Consequences for Drivers Engaging in Substance Use-Related Conduct			X
382 Subpart F, Alcohol Misuse and Controlled Substances Use Information, Training, and Referral			X
Part 383, Commercial Driver's License Standards; Requirements and Penalties	---	---	---
383 Subpart A, General		X	
383 Subpart B, Single License Requirement		X	
383 Subpart C, Notification Requirements and Employer Responsibilities		X	
383 Subpart D, Driver Disqualifications and Penalties		X	
383 Subpart E, Testing and Licensing Procedures		X	
383 Subpart F, Vehicle Groups and Endorsements		X	
383 Subpart G, Required Knowledge and Skills		X	
383 Subpart H, Tests		X	
383 Subpart I, [Reserved]	---	---	---
383 Subpart J, Commercial Driver's License Document		X	
Part 384, State Compliance With Commercial Driver's License Program	---	---	---
384 Subpart A, General	X		
384 Subpart B, Minimum Standards for Substantial Compliance by States	X		
384 Subpart C, Procedures for Determining State Compliance	X		
384 Subpart D, Consequences of State Noncompliance	X		
Part 385, Safety Fitness Procedures	X		

Table 6-2. 49 CFR Regulations - Federal Motor Carrier Safety Regulations.

49 CFR Parts 350 to 399 – Federal Motor Carrier Safety Regulations	DOT Administrative	Compliance	Emulate
Part 386, Rules of Practice for Motor Carrier Safety and Hazardous Materials Proceedings	---	---	---
386 Subpart A, Scope of Rules; Definitions	X		
386 Subpart B, Commencement of Proceedings, Pleadings	X		
386 Subpart C, Compliance and Consent Orders	X		
386 Subpart D, General Rules and Hearings	X		
386 Subpart E, Decision	X		
386 Subpart F, Injunctions and Imminent Hazards	X		
386 Subpart G, Penalties	X		
Part 387, Minimum Levels of Financial Responsibility for Motor Carriers	---	---	---
387 Subpart A, Motor Carriers of Property	X		
387 Subpart B, Motor Carriers of Passengers	X		
387 Subpart C, Surety Bonds and Policies of Insurance for Motor Carriers and Property Brokers	X		
387 Subpart D, Surety Bonds and Policies of Insurance for Freight Forwarders	X		
Part 388, Cooperative Agreements with States	X		
Part 389, Rulemaking Procedures - Federal Motor Carrier Safety Regulations	--	---	---
389 Subpart A, General	X		
389 Subpart B, Procedures for Adoption of Rules	X		
Part 390, Federal Motor Carrier Safety Regulations; General	---	---	---
390 Subpart A, General Applicability and Definitions			X
390 Subpart B, General Requirements and Information			X
390 [Removed and Reserved]	---	---	---
390 [Removed and Reserved]	---	---	---
Part 391, Qualifications of Drivers	---	---	---
391 Subpart A, General			X
391 Subpart B, Qualification and Disqualification of Drivers			X
391 Subpart C, Background and Character			X
391 Subpart D, Examinations and Tests			X
391 Subpart E, Physical Qualifications and Examinations			X
391 Subpart F, Files and Records			X
391 Subpart G, Limited Exemptions			X
Part 392, Driving of Commercial Motor Vehicles	---	---	---
392 Subpart A, General		X	
392 Subpart B, Driving of Commercial Motor Vehicles		X	
392 Subpart C, Stopped Commercial Motor Vehicles		X	
392 Subpart D, Use of Lighted Lamps and Reflectors		X	
392 Subpart E, License Revocation; Duties of Driver		X	
392 Subpart F, Fueling Precautions		X	

Table 6-2. 49 CFR Regulations - Federal Motor Carrier Safety Regulations.

49 CFR Parts 350 to 399 – Federal Motor Carrier Safety Regulations	DOT Administrative	Compliance	Emulate
392 Subpart G, Prohibited Practices		X	
Part 393, Parts and Accessories Necessary for Safe Operation	---	---	---
393 Subpart A, General		X	
393 Subpart B, Lighting Devices, Reflectors, and Electrical Equipment		X	
393 Subpart C, Brakes		X	
393 Subpart D, Glazing and Window Construction		X	
393 Subpart E, Fuel Systems		X	
393 Subpart F, Coupling Devices and Towing Methods		X	
393 Subpart G, Miscellaneous Parts and Accessories		X	
393 Subpart H, Emergency Equipment		X	
393 Subpart I, Protection Against Shifting or Falling Cargo		X	
393 Subpart J, Frames, Cab and Body Components, Wheels, Steering, and Suspension Systems		X	
Part 395, Hours of Service of Drivers			X
Part 396, Inspection, Repair, and Maintenance			X
Part 397, Transportation of Hazardous Materials; Driving and Parking Rules	---	---	---
397 Subpart A, General		X	
397 Subpart B, Not used by DOT	---	---	---
397 Subpart C, Routing of Non Radioactive Hazardous Materials			X
397 Subpart D, Routing of Class 7 (Radioactive) Materials			X
397 Subpart E, Preemption Procedures	X		
Part 398, Transportation of Migrant Workers	X		
Part 399, Employee Safety and Health Standards		X	

6.5.2 DOT-equivalent (Equivalent Packaging)

For some radioactive materials requiring IP-2, IP-3, Type A, fissile or Type B packagings, equivalent safety is achieved onsite by implementing a mixture of DOT regulations and onsite equivalent requirements. Sections 6.6.5.2.1 through 6.6.5.2.6.14 identify 49 CFR Transportation chapters, subchapters, parts, and subparts that will be met by compliance with DOT regulations and those where equivalent actions will be used.

6.5.2.1 Identification of DOT Chapters and Parts When Using DOT-Equivalent Packaging

Table 6-1 identifies to the subpart level the regulations found in 49 CFR 100 through 185. Table 6-2 identifies to the subpart level the regulations found in 49 CFR 350 through 399. The tables differentiate which regulations are DOT administrative activities not applicable to onsite shipments, which regulations are written such that onsite implementation (compliance) without modification can be achieved, and which regulations are implemented onsite by emulating the requirements.

When using alternate onsite packaging requirements, substitutions are made for regulations in Table 6-1 that identify the requirements for the following:

- DOT design and performance requirements for IP-2, IP-3, Type A, fissile and Type B packagings
- Communication requirements associated with shipment of radioactive materials.

Alternate requirements are used under the equivalent safety provision of DOE Order 460.1B.

6.5.2.2 Identification of Onsite Radioactive Materials Packaging Requirements

When using the alternate onsite packaging requirements, the substitutions identified in Sections 6.5.2.3, 6.5.2.4, 6.5.2.5, 6.5.2.6, and 6.5.3.2 are used in place of the packaging regulations identified in Table 6-1.

6.5.2.3 Performance Tests for Type A, IP-2, and IP-3 Packagings

Performance tests for DOT-equivalent Type A, IP-3, and IP-2 packagings are the same as those specified in the regulations, except in some conditions alternate Hanford Site-specific conditions are applied. The variations from the regulations are based on alterations developed for onsite Type B and fissile packaging. The description of and justification for deviations to regulatory requirements for Type B and fissile packagings are provided in Appendix B to this TSD, Justification and Basis for Equivalency to DOT Regulations for Type B and Fissile Packages Transported on the Hanford Site. The following sections are performance tests for solids, liquids, and gases to demonstrate equivalency to the regulations.

6.5.2.3.1 Evaluations and Test Conditions.

6.5.2.3.1(a) Compliance with the test requirements in Sections 6.5.2.3.2 through 6.5.2.3.9 and the design requirements in Section 6.5.2.4 must be shown by any of the methods described in this section, or by a combination of these methods appropriate for the particular feature being evaluated: The preferred method for demonstrating package compliance with performance and test conditions is by physical testing.

6.5.2.3.1(a)(1) Performance of tests with prototypes or samples of the packaging, in which case the contents of the packaging for the test must simulate as closely as practicable the expected range of physical properties of the radioactive contents or packaging to be tested, must be prepared as normally presented for transport. The use of nonradioactive substitute contents is encouraged, provided results of the testing take into account radioactive characteristics of the contents for which the package is being tested;

6.5.2.3.1(a)(2) Reference to a previous, satisfactory demonstration of compliance of a sufficiently similar nature. (When using this method, the sufficiently similar nature of previous tests will be justified by the primary content retention and shielding features, dimensions, weight, center of gravity, materials of construction, target surface, and free drop being the same as the package under evaluation);

6.5.2.3.1(a)(3) Performance of tests with models of appropriate scale incorporating those features that are significant with respect to the item under investigation when engineering experience has shown results of those tests to be suitable for design purposes. When a scale model is used, the need for adjusting certain test parameters, such as penetrator diameter or compressive load, must be taken into account. (When using this method, use of scale model test units shall be justified and defined by evidence of use for such scale modeling for other packages and the guidelines applied in International Atomic Energy Agency (IAEA) Safety Series No. 37, Advisory Material for the IAEA Regulations for the

Safe Transport of Radioactive Materials (IAEA 1990), for scale model testing shall be applied. The validity and demonstration of scale modeling shall include a definition of the scale factor, the model represents with sufficient accuracy the details of the package, list of components not in the model, justification of deletion of a component, and justification of the similitude criteria used. A scale factor of no less than 1:4 will be used.)

6.5.2.3.1(a)(4) Calculations or reasoned evaluation using reliable and conservative procedures and parameters. (When using this method, use of calculations or reasoned evaluations shall be justified and defined by providing the assumption, calculation methods, dynamic load factors, stress-strain or load-deformation information, verification and validation of any finite element analysis computer codes used, reference to source of calculations, procedures, and parameters, and verification of independent reviewer.)

6.5.2.3.1(b) With respect to the initial conditions for tests provided in Sections 6.5.2.3.2 through 6.5.2.3.9, compliance must be based on the assumption that the package is in equilibrium at an ambient temperature of 38 °C (100 °F).

6.5.2.3.2 Package Qualification and Testing.

Type A equivalent packagings must be designed to withstand all tests delineated below. IP-2 equivalent packagings must be designed to withstand the tests identified in Sections 6.5.2.3.5, 6.5.2.3.6, and 6.5.2.3.9. IP-3 equivalent packagings must be designed to meet requirements identified for IP-2 equivalent packagings plus the test identified in Section 6.5.2.3.3. Methods by which compliance with these requirements may be addressed are identified in Section 6.5.2.3.1. The Type A, IP-3, and IP-2 packagings are typically demonstrated to have acceptable performance by exposing several prototype test units to the test conditions. Tests that are to be performed for onsite equivalent packagings are described briefly below.

6.5.2.3.3 Reduced Pressure Test.

The reduced pressure test is intended to simulate the reduction of ambient (external) pressure to the package to 25 kPa (3.5 psia). This test is conducted to verify the ability of the package to meet the identified design requirement. This verification may be achieved by pressurizing the internal cavity of the packaging to 78 kPa (11.2 psig). Leak detection by visual identification of loss of material, soap bubble, pressure change, or other method will be used.

6.5.2.3.4 Water Spray Test.

The water spray test simulates exposure to rainfall of approximately 5 cm/h (2 in./h) for at least 1 hour. This test must precede each of the other tests or test sequences described in Sections 6.5.2.3.5 through 6.5.2.3.7. The time interval between the end of the water spray test and beginning of the next test shall be such that the water has soaked into the maximum extent without appreciable drying of the exterior of the package. The time interval is 2 hours if the spray is applied from four different directions simultaneously. Other tests will follow immediately if the spray is applied from each of the four directions consecutively.

6.5.2.3.5 Free Drop Test.

The free drop test consists of a fall onto a flat, horizontal, rigid surface. The rigid surface shall be reinforced concrete. The reinforced concrete surface is defined as a 20 cm (8-in.-) thick 3,000 psi concrete pad, two-way reinforced with No. 7 rebar on 30 cm (12-in.) centers. Orientation of the test package is such that the fall will cause maximum damage to the package and its safety features. The distance of the fall will be measured from the lowest part of the packaging to the upper surface of the target. The distance of the fall is determined by the gross weight of the packaging, packaging material type, and material form to be shipped. The fall distances are identified in Table 6-3.

Table 6-3. Free Drop Distance for Testing Packages to NC.

Packaging mass	**Free drop distance**	
kilograms (pounds)	**meters**	**(feet)**
<Mass 5,000 (11,000)	1.2	(4)
5,000 (11,000) Mass to 10,000 (22,000)	0.9	(3)
10,000 (22,000) Mass to 15,000 (33,000)	0.6	(2)
> 15,000 (33,000) Mass	0.3	(1)

For fiberboard or wood rectangular packages with a mass of 50 kg (110 lb) or less, a separate specimen must be subjected to a free drop onto each corner from a height of 0.3 m (1 ft).

For cylindrical fiberboard packages with a mass of 100 kg (220 lb) or less, a separate specimen must be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 m (1 ft).

6.5.2.3.6 Stacking Test.

The compression test lasts for a period of at least 24 hours. The compressive load is equivalent to either five times the mass of the actual package or 13 kPa (2 psi) multiplied by the vertically projected area of the package, whichever is greater. The load is applied uniformly to two opposite sides of the package, one of which must be the base on which the package would normally stand.

6.5.2.3.7 Penetration Test.

For the test, the package must be placed on a rigid, flat, horizontal surface that will not move significantly while the test is being performed. A bar (penetration bar), 3.2 cm (1.25 in.) in diameter with a hemispherical end, and mass of 6 kg (13 lb), with its longitudinal axis vertical, is dropped onto the center of the weakest part of the package, so that if it penetrates far enough, it will hit the containment system. The bar must not be deformed by the test.

The distance of the fall of the bar is measured from its lower end to the upper surface of the package. The determination of this distance depends on the basic physical form of the contents for which the packaging is designed. The penetration drop height for packagings designed to contain only solids is 1 m (3.3 ft).

6.5.2.3.8 Additional Tests for Type A Packagings Designed for Liquids and Gases.

6.5.2.3.8(a) In addition to the tests described in Sections 6.5.2.3.4 through 6.5.2.3.7, Type A packagings designed for liquids and gases must be capable of withstanding the following tests:

6.5.2.3.8(a)(1) Free Drop Test. The packaging specimen must drop onto the target so as to suffer the maximum damage to its containment. The height of the drop measured from the lowest part of the packaging specimen to the upper surface of the target must be 9 m (30 ft) or greater. The target must be as specified in Section 6.5.2.3.5.

6.5.2.3.8(a)(2) Penetration Test. The specimen must be subjected to the test specified in Section 6.5.2.3.7, except that the height of the drop must be 1.7 m (5.5 ft).

6.5.2.3.9 Vibration Standard.

A randomly selected sample packaging is filled and closed as for shipment. The sample packaging is placed on a vibrating platform that has a vertical or rotary double-amplitude (peak-to-peak displacement) of 2.54 cm (1 in.). The package should be constrained horizontally to prevent it from falling off the platform, but must be free to move vertically, bounce, and rotate.

The test must be performed for at least 1 hour at a frequency that causes the package to be raised from the vibrating platform so that a piece of material of approximately 1.6 mm (0.063 in.) thickness can be passed between the bottom of any package and the platform.

Immediately following the period of vibration, the package must be removed from the platform, turned on its side, and observed for any evidence of leakage. The package must be demonstrated to meet the conditions identified in paragraph 6.5.2.4.2(j), items (1) and (2).

6.5.2.4 Design and Construction Requirements for Type A, IP-3, and IP-2 Packagings

This section defines the design and construction requirements used on the Hanford Site to achieve safety equivalent to that resulting from following the DOT regulations when shipping in commerce. It should be noted that, to ensure compliance, acceptance criteria and evaluation requirements outlined in the following sections should be factored into development of the packaging design and construction.

6.5.2.4.1 General Design Requirements.

The general design requirements are applicable to Type A, IP-3, and IP-2 packagings.

6.5.2.4.1(a) The package can be easily handled and properly secured in or on a conveyance during transport.

6.5.2.4.1(b) Each lifting attachment that is a structural part of the package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting attachment under excessive load would not impair the ability of the package to meet other requirements of this TSD. Any other structural part of the package that could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport or must be designed with strength equivalent to that required for lifting attachments.

6.5.2.4.1(c) The external surface, as far as practicable, will be free from protruding features and will be easily decontaminated.

6.5.2.4.1(d) The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.

6.5.2.4.1(e) Each feature that is added to the package will not reduce the safety of the package.

6.5.2.4.1(f) The package will be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal conditions (NC) without any deterioration in the effectiveness of the closing devices on various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.

6.5.2.4.1(g) The materials of construction of the packaging and any components or structures will be physically and chemically compatible with each other and with the package contents. The behavior of the packaging and package contents under irradiation will be taken into account.

6.5.2.4.1(h) All valves through which the package contents could escape will be protected against unauthorized operation.

6.5.2.4.2 Additional Design Requirements.

All additional design requirements are applicable to Type A packagings. Only requirements in paragraphs 6.5.2.4.2(a) through (i) apply to the IP-3. The additional design requirements are not applicable to IP-2 packagings:

6.5.2.4.2(a) If required by Safeguards and Security, the outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that while intact, is evidence that the package has not been opened. In the case of packages shipped in closed transport vehicles in exclusive use, the cargo compartment, instead of the individual packages, may be sealed.

6.5.2.4.2(b) The smallest external dimension of the package is not less than 10 cm (4 in.).

6.5.2.4.2(c) Containment and shielding is maintained during transportation and storage in a temperature range of –33 °C (–27 °F) and 46 °C (115 °F). Special attention shall be given to liquid contents and to the potential degradation of the packaging materials within the temperature range.

6.5.2.4.2(d) The packaging must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form Class 7 (radioactive) material may be considered as a component of the containment system. If the containment system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package.

6.5.2.4.2(e) For each component of the containment system, account is taken, where applicable, of radiolytic decomposition of materials and generation of gas by chemical reaction and radiolysis.

6.5.2.4.2(f) The containment system will retain its radioactive contents under the reduction of ambient pressure to 25 kPa (3.6 psi).

6.5.2.4.2(g) Each valve, other than a pressure relief device, is provided with an enclosure to retain any leakage.

6.5.2.4.2(h) Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield.

6.5.2.4.2(i) Failure of any tiedown attachment that is a structural part of the packaging, under both NC and AC, must not impair the ability of the package to meet other requirements of this TSD.

6.5.2.4.2(j) When evaluated against the performance requirements of this section and tests specified in Section 6.5.2.4.1 or using any of the methods authorized by Section 6.5.2.3.1, the packaging will prevent the following:

6.5.2.4.2(j)(1) Loss or dispersal of the radioactive contents.

6.5.2.4.2(j)(2) A loss of shielding integrity which results in more than a confirmed 20% increase in the radiation level at any exterior surface of the package over the pre-test condition.

6.5.2.4.2(k) Each packaging designed for liquids will be as follows:

6.5.2.4.2(k)(1) Designed to provide for ullage (head space) to accommodate variations in temperature of the contents, dynamic effects, and filling dynamics;

6.5.2.4.2(k)(2) Meet conditions prescribed in subparagraph (j) of this section when subjected to the tests specified in Section 6.5.2.4.1 or evaluated against these tests by any of the methods authorized by Section 6.5.2.3.1; and

6.5.2.4.2(k)(3) Either:

6.5.2.4.2(k)(3)(i) Have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material must be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; or

6.5.2.4.2(k)(3)(ii) Have a containment system comprised of primary inner and secondary outer containment components designed to ensure retention of the liquid contents within the secondary outer component in the event the primary inner component leaks.

6.5.2.4.2(l) Each package designed for gases, other than tritium not exceeding 40 TBq (1,000 Ci) or noble gases not exceeding the A_2 value appropriate for the noble gas, will be able to prevent loss or dispersal of contents when the package is subjected to tests prescribed in Section 6.5.2.4.1 or evaluated against these tests by any of the methods authorized by Section 6.5.2.3.1.

6.5.2.4.3 External Radiation Requirements.

6.5.2.4.3(a) Except as provided in paragraph 6.5.2.4.3(b), each package of Class 7 (radioactive) materials offered for transportation must be designed and prepared for shipment, so that under conditions normally incident to transportation, the radiation level does not exceed 2 mSv/h (200 mrem/h) at any point on the external surface of the package, and the TI does not exceed 10.

6.5.2.4.3(b) A package that exceeds the radiation level limits specified in paragraph 6.5.2.4.3(a) must be transported onsite by exclusive-use shipment, and the radiation levels for such shipment may not exceed the following limits during transportation:

6.5.2.4.3(b)(1) 2 mSv/h (200 mrem/h) on the external surface of the package unless the following conditions are met, in which case the limit is 10 mSv/h (1,000 mrem/h):

6.5.2.4.3(b)(1)(i) The shipment is made in a closed transport vehicle or with application of other mitigating measures to restrict access to the vehicle.

6.5.2.4.3(b)(1)(ii) The package is secured within the vehicle so that its position remains fixed during transportation.

6.5.2.4.3(b)(1)(iii) There are no loading or unloading operations between the beginning and end of the transportation.

6.5.2.4.3(b)(2) 2 mSv/h (200 mrem/h) at any point on the outer surfaces of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure if used, and on the lower external surface of the vehicle.

6.5.2.4.3(b)(3) 0.1 mSv/h (10 mrem/h) at any point 2 m (6.6 ft) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 m (6.6 ft) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle).

6.5.2.4.3(b)(4) 0.02 mSv/h (2 mrem/h) in any normally occupied space, except that this provision does not apply to carriers if they operate under the provisions of a radiation protection program and if personnel under their control who are in such an occupied space wear radiation dosimetry devices.

6.5.2.4.3(c) For shipments made under the provisions of paragraph (b) of this section, instructions for maintenance, onsite transport controls and to avoid actions that will unnecessarily delay delivery or result in increased radiation levels or radiation exposure to workers or the general public shall be provided in the safety analysis documentation and operating procedures.

6.5.2.4.4 Thermal Limitations.

6.5.2.4.4(a) Heat generated within the package by the radioactive contents will not, during conditions normally incident to transport, affect the integrity of the package; and

6.5.2.4.4(b) Temperature of the accessible external surfaces of the loaded package will not, assuming still air in the shade at an ambient temperature of 38 °C (100 °F), exceed:

6.5.2.4.4(b)(1) 50 °C (122 °F) in other than an exclusive-use shipment; or

6.5.2.4.4(b)(2) 85 °C (185 °F) in an exclusive-use shipment.

6.5.2.4.5 Demonstration of Compliance with Tests.

Following the test sequences, which expose prototypes to applicable tests, performance of the packaging is evaluated. The package must show no loss or dispersal of radioactive contents and no significant increase in radiation levels recorded or calculated at the external surfaces for the conditions before the test. A 20% increase in radiation level at any external surface of the package is considered significant. If determined acceptable, the packaging is approved for use.

6.5.2.4.6 Lead Shielding Design and Construction Requirements.

Poured lead shielding, if used, must meet the following conditions:

6.5.2.4.6(a) The grade and quality of the lead shall be in accordance with ASTM B-29, "Standard Specification for Refined Lead."

6.5.2.4.6(b) The design will be such that the lead pour is continuous and free of dross.

6.5.2.4.6(c) Preheating and cooling of the shielding cavity walls will be specified to produce a sound shield and to minimize thermal stresses in the container walls.

6.5.2.4.6(d) Supports for container walls will be provided to ensure concentricity and the required lead thickness.

6.5.2.4.6(e) Impingement of molten lead on container walls will be minimized.

6.5.2.4.6(f) Provision will be provided for venting and topping off the lead.

6.5.2.4.6(g) As a minimum, gamma scanning, probing, or ultrasonic testing will be used to demonstrate soundness of the shielding.

6.5.2.4.7 Marking. Each onsite Type A package must be marked on the outside "Onsite Type A," "Radioactive Material," and with the name and address of the packaging manufacturer.

6.5.2.5 Performance Tests for Fissile and Type B Packagings

In accordance with DOE Order 460.1B and supplemental guidance from DOE Guide 460.1-1, *The Packaging and Transportation Safety Implementation Guide*, minimum requirements for Type B onsite packaging that provide an equivalent degree of safety to that provided by the DOT regulations were developed. The requirements are based on DOT regulatory requirements defined in 10 CFR 71, and NRC interpretations and supplementary guidance. However, the requirements and NRC interpretations and supplementary guidance have been modified for Hanford Site-specific conditions. In addition, Hanford Site institutional, administrative, security, procedural controls, and communication were also considered in modifying the regulatory requirements. Description of and justification for deviations to the regulatory requirements are provided in Appendix B, Justification and Basis for Equivalency to DOT Regulations for Type B and Fissile Packages Transported on the Hanford Site. Demonstration of compliance with the requirements for DOT-equivalent packaging can be by testing, analysis, or a combination of both.

Normal conditions of transport (NCT) and hypothetical accident conditions (HAC) are defined in the regulations. For DOT-equivalent packaging, to eliminate confusion between regulatory requirements and onsite shipment requirements, the terminology is normal conditions (NC) and accident conditions (AC), respectively.

Performance tests for DOT-equivalent packaging are the same as those specified in the regulations, except in some conditions, the alternate Hanford Site-specific conditions are applied. The following are performance tests for NC and AC to demonstrate equivalency to the regulations.

6.5.2.5.1 Normal Conditions.

6.5.2.5.1(a) Evaluation of each package design must include a determination of the effect on that design condition and test specified. Separate units may be used for free drop tests, compression tests, and penetration tests. However, the units must be subjected to the water spray test before being subjected to other tests.

6.5.2.5.1(b) Initial conditions of the tests and demonstration of compliance shall be based on the ambient temperature preceding and following the tests remaining constant at a Hanford Site temperature extreme value between –33 °C (–27 °F) and 46 °C (115 °F). The specified temperature shall be the most unfavorable for the feature under consideration. The initial internal pressure within the containment system must be considered to be MNOP, unless a lower internal pressure consistent with the ambient temperature considered to precede and follow the test is more unfavorable.

6.5.2.5.1(c) Conditions and Tests.

6.5.2.5.1(c)(1) Heat. An ambient temperature of 46 °C (115 °F) in still air and insolation according to that specified in Table 6-4:

Table 6-4. Insolation Table.

Form and location of surface	Total insolation for a 12-hour period (g-cal/cm^2)	Total insolation for 12-hour period (BTU/ft^2)
Flat surface/horizontal transport (base)	None	None
Flat surface/horizontal transport (other surfaces)	647	2,386
Flat surface/non-horizontal transport	162	597
Curved surfaces	324	1,193

6.5.2.5.1(c)(2) Cold. An ambient temperature of –33 °C (–27 °F) in still air and shade.

6.5.2.5.1(c)(3) Reduced External Pressure. An external pressure of 25 kPa (3.5 psia).

6.5.2.5.1(c)(4) Increased External Pressure. An external pressure of 140 kPa (20 psia).

6.5.2.5.1(c)(5) Vibration. Vibration normally incident to transport.

6.5.2.5.1(c)(6) Water Spray. A water spray that simulates exposure to rainfall of approximately 5 cm/h (2 in./h) for at least 1 hour.

6.5.2.5.1(c)(7) Free Drop. Between 1½ and 2½ hours after the conclusion of the water spray test, a free drop through the distance specified in Table 6-5 onto a reinforced concrete surface, striking the surface in a position that the package is normally transported. The reinforced concrete surface is defined as a 20 cm (8-in.) thick, 20,684 kPa (3,000 psi), concrete pad, two-way reinforced with No. 7 rebar on 30 cm (12 in.) centers.

Table 6-5. Criteria for Free Drop Test (Weight/Distance).

Package weight		**Free drop distance**	
Kilograms	**Pounds**	**Meters**	**Feet**
5,000 or less	11,000	1.2	4
5,000 to 10,000	11,000 to 22,000	0.9	3
10,000 to 15,000	22,000 to 33,000	0.6	2
More than 15,000	More than 33,000	0.3	1

6.5.2.5.1(c)(8) Compression. For packages weighing up to 5,000 kg (11,000 lb), the package shall be subjected to a compressive load applied uniformly to the top and bottom of the package in the position in which the package would be normally transported for a period of not less than 24 hours. The compressive load shall be the greater of five times the package weight or 13 kPa (2 psi) multiplied by the vertically projected area of the package.

6.5.2.5.1(c)(9) Penetration. Impact of the hemispherical end of a vertical steel cylinder of 3.2 cm (1.25 in.) diameter and 6 kg (13 lb) mass, dropped from a height of 1 m (40 in.) onto the exposed surface of the package that is expected to be most vulnerable to puncture. The long axis of the cylinder must be perpendicular to the package surface.

6.5.2.5.2 Accident Conditions.

6.5.2.5.2(a) Evaluations for AC shall be based on sequential application of the tests specified, and in the order indicated to determine their cumulative effect on a package or array of packages. Only in the case of the immersion test (paragraph 6.5.2.6.5.2[c][6]) may an undamaged unit be used for the test or evaluation.

6.5.2.5.2(b) Initial conditions for the tests, except for water immersion, to demonstrate compliance with the DOT-equivalent packaging requirements shall be as follows:

- Ambient temperature before and after the tests must remain constant at a value between Hanford Site temperature extremes of –33 °C (–27 °F) to 46 °C (115 °F)

- Specified temperature shall be the most unfavorable for the feature under consideration

- Initial internal pressure within the containment system must be considered to be the MNOP, unless a lower internal pressure consistent with the ambient temperature considered to precede and follow the test is more unfavorable.

6.5.2.5.2(c) Tests for AC shall be conducted in the following order on a single specimen:

6.5.2.5.2(c)(1) Free Drop. A free drop of 9 m (30 ft) onto a reinforced concrete surface, striking the surface in a position for which maximum damage is expected. The reinforced concrete surface is defined as a 20 cm (8-in.) thick, 20,684 kPa (3,000 psi), concrete pad, two-way reinforced with No. 7 rebar on 30 cm (12 in.) centers.

6.5.2.5.2(c)(2) Crush. The specimen is subjected to a dynamic crush test by positioning the test unit onto the concrete surface defined in paragraph 6.5.2.5.2(c)(1) with the long axis horizontal to the concrete surface. A 500 kg (1,100-lb) mass consisting of a solid mild steel plate 1 m (40 in.) by 1 m (40 in.) is dropped in a horizontal attitude onto the specimen from a height of 9 m (30 ft). This test is only required when the package has a mass not greater than 500 kg (1,100 lb), an overall density not greater than 1,000 kg/m^3 (62.4 lb/ft^3) based on external dimensions, and radioactive contents greater than 1,000 A_2 not as special form radioactive material.

6.5.2.5.2(c)(3) Puncture. A free drop of the specimen through a distance of 1 m (40 in.) in a position for which maximum damage is expected, onto the upper end of a solid, vertical, cylindrical, mild steel bar, welded to steel plate and mounted onto the concrete surface specified in paragraph 6.5.2.5.2(c)(1). The long axis of

the bar must be vertical. The bar must be 15 cm (6 in.) in diameter with the top horizontal and its edges rounded to a radius of not more than 0.6 cm (0.25 in.) and of a length as to cause maximum damage to the package. As a minimum, the bar shall be welded to a 2.5 cm (1-in.) thick by 45.7 cm (18-in.) by 45.7 cm (18-in.) square plate that is mounted to the concrete surface.

6.5.2.5.2(c)(4) Thermal. Exposure of the specimen fully engulfed in a hydrocarbon fuel/air fire of sufficient extent, and in sufficiently quiescent ambient conditions, to provide an average emissivity coefficient of at least 0.9, with an average flame temperature of at least 800 °C (1,475 °F) for a period of 30 minutes. The fuel source shall extend horizontally at a minimum of 1 m (40 in.), but not more than 3 m (10 ft) beyond the external surface of the specimen. The specimen shall be positioned 1 m (40 in.) above the surface of the fuel source. For purposes of calculation, the external surface absorptivity coefficients shall be nationally accepted published values at fire temperature. Cooling shall be applied after 30 minutes from the start of the fire.

6.5.2.5.2(c)(5) Immersion-Fissile Material. For fissile material packages where water inleakage has not been assumed for criticality analysis, the specimen shall be subjected to immersion under a water head of at least 0.9 m (3 ft) in the attitude for which maximum leakage is expected.

6.5.2.5.2(c)(6) Immersion-All Packages. This requirement is not required for Hanford on-site movements because there are no bodies of water available along any on-site transportation routes that would cause this submersion depth.

6.5.2.6 Design and Construction Requirements for Fissile and Type B Packagings

This section defines the fissile and Type B packaging design and construction requirements used on the Hanford Site to achieve safety equivalent to that resulting from following the DOT regulations when shipping in commerce. It should be noted that, to ensure compliance, the acceptance criteria and evaluation requirements outlined in the following sections should be factored into development of the packaging design and construction.

6.5.2.6.1 General Packaging Requirements.

6.5.2.6.1(a) The smallest overall dimension of a package may not be less than 10 cm (4 in.).

6.5.2.6.1(b) If required by Safeguards and Security, the outside of a package must incorporate a feature, such as a seal, that is not readily breakable and that, while intact, would be evidence that the package has not been opened by unauthorized persons.

6.5.2.6.1(c) Each package must include a containment or confinement system securely closed by a positive fastening device that cannot be opened unintentionally or by a pressure that may arise within the package.

6.5.2.6.1(d) A package must be made of materials and construction that ensures there is no significant chemical, galvanic, or other reactions among the packaging components and the package contents, including possible reactions from inleakage of water, to the maximum credible extent. Account must be taken of the behavior of materials under irradiation.

6.5.2.6.1(e) A package valve or other device, the failure of which would allow radioactive contents to escape, must be protected against unauthorized operations and, except for a pressure relief device, must be provided with an enclosure to retain any leakage.

6.5.2.6.1(f) A package must be designed, constructed, and prepared for transport so that under the NC tests specified, there would be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging.

6.5.2.6.1(g) A package must be designed, constructed, and prepared for transport so that in still air at 46 °C (115 °F) and in the shade, no accessible surface of a package would have a temperature exceeding the exclusive-use temperature of 85 °C (185 °F) or the nonexclusive-use temperature of 50 °C (122 °F).

6.5.2.6.1(h) A package may be designed, constructed, and prepared for transport with a filtered venting feature. Filtered venting devices will be provided by a high-efficiency particulate air filter capable of sustaining NC and AC loadings. The filter will have a minimum aerosol efficiency of 99.97% for 0.45 μm dioctylphthalate particle diameter. The minimum hydrogen diffusivity will be 1.90 E-06 mole/sec/mole fraction at 25 °C (77 °F). The minimum airflow rate will be 200 mL/min (12.20 in^3/min) at a pressure differential of 1.9 mmHg (1.0 in. H_2O). Filter housing seals will be manufactured from materials that have a minimum shelf life of 5 to 10 years, as specified by military specification MIL-HDBK-695, or be equivalent to the filter media. The filter housing seal will be leak tight as defined in American National Standards Institute (ANSI) N14.5.

6.5.2.6.2 Lifting Device Requirements.

6.5.2.6.2(a) Any lifting attachment that is a structural part of a package must be designed and tested in accordance with DOE/RL-92-36 and/or American National Standards Institute (ANSI) N14.6, *Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More.*

6.5.2.6.2(b) The design of the lifting device will be such that failure of the lifting device or any component under excessive load would not impair the ability of the package to meet other requirements of this section.

6.5.2.6.2(c) Any structural part of the package that could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport, or must be designed with strength equivalent to that required for the lifting attachments.

6.5.2.6.3 Tiedown Devices.

6.5.2.6.3(a) For a system of tiedown devices that is a structural part of the package, the system will be capable of withstanding a static force applied at the center of gravity of the package having a vertical component of 2 times the gross weight of the package, a horizontal component along the direction in which the conveyance travels of 10 times the gross weight of the package, and horizontal component in the transverse direction of 5 times the gross weight of the package. The application of this load will not generate stresses in any material of the package in excess of its yield strength.

6.5.2.6.3(b) Any other structural part of the package that could be used to tiedown the package must be capable of being rendered inoperable for tying down the package during transport, or must be designed with strength equivalent to that required for tiedown devices.

6.5.2.6.3(c) Each tiedown device that is a structural part of a package will be designed so that failure of the device under excessive load would not impair the ability of the package to meet other requirements of this section.

6.5.2.6.4 External Radiation Requirements.

6.5.2.6.4(a) Each radioactive material package for “nonexclusive” use onsite transport must be designed and prepared for transport such that, under NC, the radiation level does not exceed 2 mSv/h (200 mrem/h) at any point on the external surface of the package, and the TI does not exceed 10.

6.5.2.6.4(b) A package that exceeds the radiation level limits specified in paragraph 6.5.2.6.4(a) must be transported onsite by exclusive-use transport only and the radiation levels will not exceed the following limits:

6.5.2.6.4(b)(1) 2 mSv/h (200 mrem/h) on the external surface of the package unless the following conditions are met, in which case the limit is 10 mSv/h (1,000 mrem/h):

6.5.2.6.4(b)(1)(i) The shipment is made in a closed transport vehicle or with application of other mitigating measures to restrict access to the vehicle.

6.5.2.6.4(b)(1)(ii) The package will be secured to the conveyance so that its position remains fixed during NC.

6.5.2.6.4(b)(1)(iii) There will be no loading or unloading operations between the beginning and end of the onsite transport.

6.5.2.6.4(b)(2) At any point on the outer external surface of the conveyance, including top and underside, radiation levels will not exceed 2 mSv/h (200 mrem/h). In the case of a flat-bed style conveyance, the top is defined as the top of the load, the sides are defined as the vertical planes projecting from the outer edges of the conveyance, and the underside is defined as the lower external surface of the conveyance.

6.5.2.6.4(b)(3) At any point 2 m (6.6 ft.) from the outer lateral surfaces of the conveyance (excluding the top and underside of the conveyance), the radiation levels will not exceed 0.1 mSv/h (10 mrem/h). In the case of a flat-bed style vehicle, at any point 2 m (6.6 ft.) from the vertical planes projected by the outer edge of the vehicle (excluding the top and underside of the vehicle).

6.5.2.6.4(b)(4) In any normally occupied space, the radiation level will not exceed 0.02 mSv/h (2 mrem/h), except that this provision does not apply to carriers if they operate under the provisions of a State or federally regulated radiation protection program and if personnel under their control who are in such an occupied space wear radiation dosimetry devices.

6.5.2.6.4(c) Instructions for maintenance, onsite transport controls, and to avoid actions that will unnecessarily delay delivery or result in increased radiation levels or radiation exposure to workers or the general public will be provided in the safety analysis documentation and operating procedures.

6.5.2.6.5 NC Subcriticality Assurance Requirements.

All radioactive material packages containing fissile material must be designed, constructed, and contents so limited that under NC the following requirements are met to ensure subcriticality:

6.5.2.6.5(a) The contents will remain subcritical under all normal performance tests conditions. $K_{eff}<0.95$.

6.5.2.6.5(b) The geometric form of the package contents would not be substantially altered under all normal performance test conditions.

6.5.2.6.5(c) There will be no leakage of water into the containment or confinement system unless an evaluation of an undamaged package is performed which assumes that moderation is present to such an extent as to cause maximum reactivity consistent with the chemical and physical form of the material.

6.5.2.6.5(d) There will be no substantial reduction in the effectiveness of the packaging defined as follows:

6.5.2.6.5(d)(1) No more than a 5% reduction in the total effective volume of the packaging on which nuclear safety is assessed.

6.5.2.6.5(d)(2) No more than a 5% reduction in the effective spacing between the fissile contents and the outer surface of the package.

6.6.5.2.6.5(d)(3) No occurrence of an aperture in the outer surface of the packaging large enough to permit the entry of a 10 cm (4-in.) cube.

6.5.2.6.6 AC Subcriticality Assurance Requirements.

All radioactive material packages containing fissile material must be designed, constructed, and contents so limited that subcriticality is ensured under the following conditions:

6.5.2.6.6(a) The fissile material is in the most reactive credible configuration consistent with the damaged condition of the package, and the chemical and physical form of the contents.

6.5.2.6.6(b) Water moderation occurs to the most reactive credible extent consistent with the damaged condition of the package and the chemical and physical form of the contents.

6.5.2.6.6(c) There is full reflection by water on all sides, as close as is consistent with the damaged condition.

6.5.2.6.7 Package Array Subcriticality Assurance Requirements.

Radioactive material packages that are transported in arrays and contain fissile material must be designed, constructed, and contents so limited that the following requirements are met to ensure subcriticality:

6.5.2.6.7(a) Fissile material packages must be controlled by the operating procedures to ensure that an array of packages remains subcritical. To establish this control, the designer of the package shall derive a number "N" based on the following conditions and assuming packages are stacked in any arrangement and with close full reflection on all sides of the stack by water.

6.5.2.6.7(a)(1) Five times "N" undamaged packages with nothing between the packages shall be subcritical.

6.5.2.6.7(a)(2) Two times "N" damaged packages must be subcritical with optimum interspersed hydrogenous moderation.

6.5.2.6.7(a)(3) The value of "N" shall not be less than 0.5.

6.5.2.6.7(b) The Criticality Safety Index (CSI) must be obtained by dividing the number 50 by the value of "N" derived using the procedure specified above in paragraph 6.5.2.6.7(a). The value of the CSI may be zero provided that an unlimited number of packages is subcritical such that the value of "N" is effectively equal to infinity under the procedure specified in paragraph 6.5.2.6.7(a). Any CSI greater than zero must be rounded up to the first decimal place.

6.5.2.6.7(c) When a fissile material package is assigned a CSI, the following requirements shall be applied:

6.5.2.6.7(c)(1) For a package CSI less than or equal to 50, procedures must be in place to limit the sum of the CSIs to less than or equal to 50 for a nonexclusive-use onsite shipment and to less than or equal to100 in an exclusive-use onsite shipment.

6.5.2.6.7(c)(2) For a package CSI greater than 50, procedures must in be place to limit the sum of the CSIs to less than or equal to100 and must be shipped in an exclusive-use conveyance.

6.5.2.6.8 Normal Conditions.

Under NC, there shall be no loss or dispersal of radioactive material as demonstrated to a sensitivity of 10^{-6} A_2 per hour, no loss of shielding integrity which results in more than a confirmed 20% increase in the radiation level at any exterior surface of the package, and no reduction in the effectiveness of the packaging.

Note: The sensitivity requirement 10^{-6} A_2 per hour is not applicable to Type A fissile.

6.5.2.6.9 Accident Conditions.

Under AC, there shall be no release of krypton-85 exceeding 10 A_2 in 1 week, and no release of other radioactive material exceeding a total 1 A_2 in 1 week.

In addition, the external radiation dose rate shall not exceed 10 mSv/h (1 rem/h) at 1 m (40 in.) from the external surface of the package.

6.5.2.6.10 Containment or Confinement Boundary Requirements.

Confinement, in accordance with 10 CFR 72.3, means those systems and components of a package, including filtration devices, which act as barriers between radioactive substances contained by the package and the environment.

Containment, in accordance with 10 CFR 71.4, means those system and components of the packaging intended to retain radioactive material during transport with a leak testable boundary.

6.5.2.6.10(a) As a minimum, the primary containment or confinement boundary will be designed and constructed in accordance with the requirements of American Society for Mechanical Engineers (ASME) boiler and pressure vessel code (BPVC), Section VIII, Division 1. Credit may not be taken for any package meeting ASME BPVC standards unless it is ASME code stamped. Design loadings and load combination on the containment or confinement boundary will be as specified in Table 6-6.

Table 6-6. Design Loadings and Load Combination on the Containment or Confinement Boundary.

Normal or Accident Condition	Applicable Initial Conditions							
	Ambient Temperature		Insolation		Decay Heat		Maximum Internal Pressure	Maximum Weight of Contents*
	46 °C (115 °F)	-33°C (-27 °F)	Max	-17.8 °C (0 °F)	Max	-17.8 °C (0 °F)		
Normal Conditions								
Hot Ambient			X		X		X	
Cold Ambient				X	X		X	
				X		X	X	
Minimum External Pressure	X		X		X		X	
		X		X	X		X	
Vibration and Shock Normally incident to the mode of transport	X		X		X		X	
		X		X	X		X	
		X		X		X	X	
Free Drop	X		X		X		X	X
		X		X	X		X	X
		X		X		X	X	X
Accident Conditions								
Free Drop (9 m [30 ft])	X		X		X		X	X
		X		X	X		X	X

		X		X		X	X	X
Puncture	X		X		X		X	X
		X		X	X		X	X
		X		X		X	X	X
Thermal (Fire Accident)	X		X		X		X	

* It should be noted that local structural responses might be greater during an impact test if the weight of the contents is less than maximum. Subsequently, free drop testing should also be conducted at minimum content weights.

6.5.2.6.10(b) Cover plates and lids will be recessed or otherwise protected.

6.5.2.6.10(c) The containment or confinement boundary will be designed such that vessel, closures, penetration closures, and closure seals are leak testable. In addition, if full, drain or test ports utilize quick-disconnect valves, such valves will not preclude leak testing of their containment seals.

6.5.2.6.10(d) For vented packages, the containment or confinement boundary will consist of the containment vessel, closure, closure seals, filter housing, and filter housing seals, all of which must be leak testable.

6.5.2.6.10(e) Containment or confinement boundary seals will be specified to be compatible with the packaging and contents, and remain below allowable limits under both NC and AC. In addition, as a minimum, the seals must not degrade under irradiation from the contents for a period of 5 years from the time of loading.

6.5.2.6.10(f) As a minimum, containment or confinement boundary seals will have a shelf life of 10 years.

6.5.2.6.10(g) The materials of construction of seals and ancillary components will be manufactured to nationally or internationally recognized standards, such as ASTM, ANSI, and ISO.

6.5.2.6.11 Lead Shielding Design and Construction Requirements.

6.5.2.6.11(a) The grade and quality of the lead shall be in accordance with ASTM B-29.

6.5.2.6.11(b) The design will be such that the lead pour is continuous and free of dross.

6.5.2.6.11(c) Preheating and cooling of shielding cavity walls will be specified to produce a sound shield and to minimize thermal stresses in the container walls.

6.5.2.6.11(d) Supports for container walls will be provided to ensure concentricity and the required lead thickness.

6.5.2.6.11(e) Impingement of molten lead on container walls will be minimized.

6.5.2.6.11(f) Provision will be provided for venting and topping off the lead.

6.5.2.6.11(g) As a minimum, gamma scanning, probing, or ultrasonic testing will be used to demonstrate soundness of the shielding.

6.5.2.6.12 Pressure Testing Prior to Use.

Prior to initial use of the packaging, the containment/confinement boundary will be pressure tested to 150% of its rated MNOP to ensure structural integrity at that pressure.

6.5.2.6.13 Tiedown System Requirements.

6.5.2.6.13(a) For transport of all onsite packagings having a gross weight in excess of 454 kg (1,000 lb), an engineered tiedown system will be provided.

6.5.2.6.13(b) Design of the tiedown system will comply with the requirements of DOT regulations in 49 CFR 393 Subpart I.

6.5.2.6.14 Marking.

Each onsite Type B package must be marked on the outside "Onsite Type B" "Radioactive Material," and with the name and address of the packaging manufacturer. Each onsite fissile package must be marked on the outside "Onsite Fissile Type [*]," "Radioactive Material," and with the name and address of the packaging manufacturer.

6.5.2.6.15 Flammable Gas Generation.

This section defines the requirements to demonstrate acceptable performance for onsite packaging in which the concentration of flammable gases within the package void volume has the potential to exceed one –half the Lower Explosive Limit (LEL). For Hydrogen gas, the value is 5 vol%. The requirements of this section do not apply to packages that have no flammable gas generation potential. The acceptable performance requirement is that the package must maintain containment/confinement, subcriticality, and shielding of the contents under both NC and AC. The acceptable performance criterion for testing and/or analysis to be applied is to demonstrate that the packaging provides an equivalent degree of safety to the regulations. It should be noted that in any onsite PSSD, claims of adequacy of designs or design methods must be supported by technical bases; i.e., by an appropriate engineering evaluation or description of actual tests.

[*]Use A or B as applicable.

6.5.3 Risk Based (Equivalent Radiological and Toxicological Protection)

For some radioactive materials requiring IP-2, IP-3, Type A, fissile or Type B packagings, equivalent safety is achieved onsite by implementing a mixture of the DOT regulations and equivalent requirements. Sections 6.5.3.1 through 6.5.3.2.3 identify 49 CFR Transportation chapters, subchapters, parts, subparts and sections that will be met by either compliance with DOT regulations or demonstrating equivalent safety to full compliance with DOT regulations. Note, when a Type A, IP-2, or IP-3 package is used to transport Type B quantities of materials, the performance expectations will be the same as for Type B packages. Credit will not be taken automatically for a Type A or Industrial Package as meeting DOT regulations when carrying Type B quantities of radioactive material. Those regulations where equivalent actions will be used to result in radiological and toxicological safety equivalent to that resulting offsite from full compliance with DOT regulations are identified in Section 6.5.3.1.

6.5.3.1 Identification of DOT Chapters and Parts When Using Risk Based Packaging

Table 6-1 identifies to the subpart level the regulations, found in 49 CFR 100 through 185. Table 6-2 identifies to the subpart level the regulations, found in 49 CFR 350 through 399. The tables differentiate which regulations are DOT administrative activities not applicable to onsite shipments (transfers), which regulations are written such that onsite implementation (compliance) without modification can be achieved, and which regulations are implemented onsite by emulating the requirements. The alternate requirements are used under the equivalent safety provision of DOE Order 460.1B.

When using the onsite risk based packaging requirements, substitutions are made for the regulations on the Tables 6-1 and 6-2 that identify the requirements for:

- Communication requirements associated with shipment of radioactive materials.

Before implementing the risk based packaging method, a documented evaluation showing that both DOT and DOT-equivalent packaging compliance are not technically or economically practical must be prepared and retained on file for the life of the package.

6.5.3.2 Identification of Onsite Radioactive Materials Risk Based Packaging Requirements

When using the alternative onsite risk based packaging requirements, the following requirements are substituted in place of the regulations identified in Table 6-1. These requirements may be used for demonstrating equivalent safety for IP-2, IP-3, Type A, fissile and Type B packagings.

Type A, IP-3, or IP-2 risk based packagings must meet the minimum requirements listed below. Compliance with the radiation level and thermal requirements may be determined by analysis or field measurement. Note, when a Type A, IP-2, or IP-3 package is used to transport Type B quantities of materials, the performance expectations will be the same as for Type B packages.

- Requirements in 49 CFR 173.24 paragraph (b)
- General design requirements in Section 6.5.2.4.1
- External radiation requirements in Section 6.5.2.4.3
- Thermal requirements in Section 6.5.2.4.4.

Fissile and Type B risk based packagings must meet the minimum requirements listed below. Compliance with the external radiation and thermal requirements may be determined by analysis or field measurement:

- Requirements in 49 CFR 173.24 paragraph (b)

- General design requirements in Section 6.5.2.4.1

- Thermal requirements in Section 6.5.2.6.1(g)

- Tiedown device requirements in Section 6.5.2.6.3 (if the packaging has tiedown devices that are structurally part of the packaging)

- External radiation requirements in Section 6.5.2.6.4

- Subcriticality assurance requirements in Sections 6.5.2.6.5 through 6.5.2.6.7 (if the package contains fissile material that does not meet 10 CFR 71.15, "Fissile material exemptions")

- Flammable gas generation requirements in Section 6.5.2.6.15

- Tiedown system requirements in Section 6.5.2.6.13.

6.5.3.2.1 Consequence Requirements.

When compliance to DOT or onsite equivalent packaging standards cannot be demonstrated, radiological and toxicological safety, and/or acceptable risk analyses may be used to demonstrate an equivalent level of safety. Risk based packaging, by definition, maintains the same level of consequences as acceptable for DOT or onsite equivalent packaging. Therefore, packaging containment performance during conditions normally incident to transport is obtained by implementing the applicable requirements identified in Section 6.5.3.2. These performance requirements consider the specific characteristics, design features and controls of the shipment of on-site risk based packages. Limits are set for exposure and the intake of radionuclides into the body. The

intake limits are based on the same amount of intake from AC and NC releases used in evaluating shipments made in commerce.

RL has approved HNF-8739, *Hanford Safety Analysis and Risk Assessment Handbook (SARAH)* (see 05-SED-0007, *Contract Number DE-AC06-96RL13200—DOE-RL Approval of the Hanford Safety Analysis and Risk Assessment Handbook [SARAH], Draft 1C*) and RADIDOSE (see 03-ABD-0061, *Contract No. DE-AC06-96RL13200—Use of RADIDOSE Spreadsheet in Preparing 10 CFR 830 Compliant Documented Safety Analyses [DSA]*) for use in nuclear safety evaluations at Hanford. SARAH/RADIDOSE include the use of 95-percent overall site meteorology (χ/Q's) and dose conversion factors (DCF) from ICRP 68, *Dose Coefficients for Intakes of Radionuclides by Workers*; ICRP 71, *Age-dependent Dose to Members of the Public from Intake of Radionuclides: Part 4 Inhalation Dose Coefficients*; and ICRP 72, *Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 5 Compilation of Ingestion and Inhalation Dose Coefficient*, instead of the 99-percent maximum sector χ/Q's and DCFs from ICRP 26, "Recommendations of the International Commission on Radiological Protection, and ICRP 30, "Limits for the Intake of Radionuclides by Workers," used in Revision 0 of this TSD. The contractor shall use the applicable values from SARAH and RADIDOSE for the most conservative facilities in each site area involved in the shipment for determining the accident parameters for analysis of risk based shipments in the Hanford areas described in this TSD.

Use of the SARAH (HNF-8739) and RADIDOSE χ/Q' values is required for the evaluation of consequences for comparison with risk levels that are representative of those accepted by DOE in the example shown in in Appendix G of this TSD. The damage ratios (DR), airborne release fractions (ARF), and respirable fractions (RF) from SARAH and RADIDOSE corresponding to the TSD-prescribed accidents shall be conservatively selected and justified in the PSSD.

The dose consequence levels (bins) and risk classes defined in SARAH (HNF-8739) are summarized in the example shown in Appendix G, which shows the results of accident analyzed in accordance with this methodology. The revised tables in the example were developed using the SARAH/RADIDOSE methodology to determine shipment inventory limits based on maintaining frequencies and dose consequences to the MOI at the values previously approved by RL in the TSD Rev. 0-A SER. This methodology meets the expectations stated in DOE-STD-3009-94, DOE Order 460.1B, SARAH, and 10 CFR 830. The values are representative of the RL-approved risks associated with onsite transportation activities, under the specific conditions analyzed for risk based packages.

SARAH defines the consequence level guidelines shown in Tables 6-7a and risk class bins in Table 6-7b. The consequence bins are incorporated into Table 6-7b to assist in identifying the most significant risk to designated receptors.

Table 6-7a. Safety-Basis Criteria Consequence Levels (Bins).

Consequence	Public	Worker at 100 m
High	>25 rem TEDE or >ERPG-2/TEEL-2	>100 rem TEDE or >ERPG-3/TEEL-3 at facility boundary or prompt death to facility worker
Moderate	>1 rem TEDE or >ERPG-1/TEEL-1	>25 rem TEDE or >ERPG-2/TEEL-2 at facility boundary, or serious injury to facility worker, or significant radiological or chemical exposure to facility workers
Low	<moderate consequences	<moderate

ERPG = emergency response planning guideline.
TEDE =total effective dose equivalent.
TEEL = Temporary Emergency Exposure Limit.

Table 6-7b. Risk Classes—Frequency Versus Consequences.

Consequence	Frequency bin			
	Beyond extremely unlikely (below 10^{-6}/yr)	Extremely unlikely (10^{-6}/yr – 10^{-4}/yr)	Unlikely (10^{-4}/yr - 10^{-2}/yr)	Anticipated (above 10^{-2}/yr)
High	Risk Class III	Risk Class II	Risk Class I	Risk Class I
Moderate	Risk Class IV	Risk Class III	Risk Class II	Risk Class I
Low	Risk Class IV	Risk Class IV	Risk Class III	Risk Class III

In addition to the evaluation guideline in DOE-STD-3009-94, the risk based accident analyses are compared to the example shown in Appendix G to identify the level of risk associated with risk based transportation activities and to ensure sufficient controls are incorporated to maintain risk within RL expectations.

The following conditions apply when preparing a consequence evaluation to demonstrate equivalent radiological and toxicological safety. No specific numerical limits are identified for what is considered an acceptable level of risk.

- The consequence analysis shall quantitatively evaluate collision, fire, and hydrogen deflagration accidents. The initiators of these accidents shall be no more severe than the accident test conditions for certified Type B packages described in 10 CFR 71.73, "Hypothetical accident conditions," And, in accordance with Appendix A of DOE-STD-3009, provide a realistic evaluation of the postulated conditions that could be encountered onsite.

- The immediate worker is defined as any individual within a 100 m (328 ft) radius of the accident that receives an uncontrolled dose as a result of the accident.

- The co-located worker is defined as the maximally-exposed individual within the Hanford Site boundary and at or beyond a 100 m (328 ft) radius of the accident.

- The offsite receptor is defined as the maximally-exposed member of the public at or beyond the Hanford Site boundary for an exposure duration of not less than 2 hours.

- The evaluation shall account for the physical and chemical form of the waste material that leaks from the damaged package during the AC through the use of appropriate airborne release fractions and respirable fractions taken from DOE-HDBK-3010-94.

- The consequence analysis may include the mitigating effect of the damaged package after the AC through the use of damage ratios or leak path factors (LPF), provided that a structural analysis supports the mitigating effect. These factors shall be clearly identified where the results are reported. If these factors are used, then the dose consequences, with and without these mitigating factors, shall be reported.

- The consequence analysis shall determine the dose to the MOI. Furthermore, the consequence analysis shall determine the dose to the co-located worker (onsite, 100 m [328 ft]) for the applicable scenario.. The calculated frequencies and consequences will be utilized to determine the risk classification bins as defined in Tables 6-7a and 6-7b.

- Criticality requirements for risk based packaging are those identified for equivalent packaging given in Sections 6.5.2.6.5, 6.5.2.6.6, and 6.5.2.6.7 (if the fissile material does not meet 10 CFR 71.15).

The three accident scenarios that could lead to package failure and release of radioactive materials that must be quantified are as follows:

- Collision
- Collision followed by fire
- Hydrogen deflagration.

NOTE: A criticality accident shall be demonstrated to be not credible under all postulated NC and AC.

An important element of the risk based approval process is providing justification for the package failure thresholds that are used to determine the conditional probabilities of encountering ACs that are more severe. The failure thresholds will be determined in the structural and thermal analysis sections of the application for approval of a risk based package. References to the appropriate sections of the application where the failure thresholds are determined should be provided. For cases in which failure thresholds are not or cannot be determined, an appropriate conservative assumption must be provided and justified. In this case, analogy to a similar package design could provide a reasonable technical basis for the failure thresholds. The application should include references to an evaluation of a similar package design in which failure thresholds are determined, a discussion of the differences that exist between the packages, and defensible yet conservative failure thresholds. For all package applications, ensure that any controls taken to reduce the frequencies of the accident scenarios are appropriately addressed.

Because the specific accident environments encountered will lead to different release characteristics, the accident scenario frequencies must be correlated with the consequences of each specific accident scenario. For example, a package exposed to collision-only ACs may have different release characteristics than a package exposed to a collision and fire environment. The applicant must ensure that the consequences calculated using the methodology described in Section 7.3.2.1.1 correspond to the ACs for which quantitative accident frequency information has been developed.

6.5.3.2.2 Risk.

For a specific package, the consequence and frequency data are combined, to identify the risk associated with the transportation. For generic Type A drums or boxes, the example in Appendix G show the bounding consequences and frequencies of release. The tables identify essential data used in the evaluations conducted for the identified packages. The evaluation must consist of the following: An evaluation report based on the applicable equivalent package requirements of Section 6.5.2.2 containing the applicable information and formatted as identified in Section 7.3.1. This report should document the package's performance; showing both the requirements met and those failed. Where the package does not meet an applicable requirement, discuss the performance provided. To this basic report, add a risk based evaluation following the methodology identified in Section 7.3.2. The accident frequency and consequence evaluations are grouped into risk classification bins as defined by SARAH (HNF-8739). These bins are an essential element in the risk assessment methodology. Tables 6-7a and 6-7b are to be utilized to determine package-specific risk classification bins for all applicable accident scenarios.

As part of this TSD, the example shown in Appendix G has defined the risk classification bins representative of those that DOE has accepted for transportation-specific accident scenarios. It needs to be emphasized that these risk classification bins are only applicable to packages that meet the minimum requirements for a risk based package as defined in Section 6.5.3.2. Additionally, the transportation-specific hazards assessment was able to reduce the accident scenario accidents to three bounding accidents: collision, fire, and hydrogen deflagration. In the event that any other accident scenarios are determined not to be bounded by these three, their risk classification must also be determined. The risk classification will be utilized to determine if any changes to a risk based package listed in Appendix A are bounded by the previously accepted risks. Each individual administrative control will qualify for a maximum of half a bin reduction in accident frequency The maximum allowable bin reduction in accident frequency for all preventative and mitigative administrative control is one bin.

The risk assessment methodology outlined in Section 7.3.2, shall be utilized to evaluate each risk based package. Additionally, this evaluation is to be documented in the PSSD for the evaluated packaging system.

6.5.3.2.3 Flammable Gases

Flammable gases allowed in a package are generally limited to less than the Lower Explosive Limit (LEL). For Hydrogen, a limit of 5% during the shipping window is established. When properly documented and controlled, higher concentrations may be acceptable as shown in Appendix G. Projected flammable gas concentrations are to be developed using acceptable methods, such as RADCALC, or equivalent, and documented in the PSSD.

6.6 ADDITIONAL SAFETY REQUIREMENTS

Onsite T&P activities are subject to the requirements identified in 10 CFR 830 (see Section 4.0). Implementation of the QA requirements identified in 10 CFR 830, Subpart A, as applied to fissile and Type B packages, are discussed in Section 7.3.1.2.9 of the TSD. Requirements of 10 CFR 830, Subpart B, Safety Basis Requirements, for performance of work, safety basis, DSA, and RL approval are addressed by the TSD as a whole. The following sections describe how the requirements for an USQ_T process and for TSRs are implemented.

6.6.1 USQ_T Process

Each Hanford site contractor engaged in shipment of radioactive and hazardous material must implement the USQ_T process defined in this section. Appendix C, Unreviewed Safety Question for Transportation (USQ_T) Process, provides an example USQ_T evaluation process and implementation guide. The example USQ_T evaluation process identifies methods for evaluating changes to onsite T&P activities to ensure they are bounded by the TSD and existing supporting PSSD.

6.6.1.1 USQ_T Requirements

(a) Each Hanford site contractor responsible for a T&P activity that involves shipment of greater than 1 A_2 of radioactive material must establish, implement, and take actions consistent with a USQ_T process that meets the requirements of 10 CFR 830.203, and this TSD. Each contractor must submit for RL approval a procedure for its USQ_T process.

(b) Each contractor responsible for a T&P activity that involves greater than 1 A_2 of radioactive material must determine whether a USQ_T exists in situations where there is a:

(1) Temporary or permanent change in the T&P activity as described in the existing safety basis;

(2) Temporary or permanent change in the procedures as described in the existing safety basis;

(3) Test or experiment not described in the existing safety basis, or any new transportation activity not already approved by RL; or

(4) Potential inadequacy in the safety basis because the analysis potentially may not be bounding or may be otherwise inadequate.

(c) Each contractor responsible for a T&P activity that involves greater than 1 A_2 of radioactive material must obtain RL Manager approval prior to taking any action determined to involve a positive USQ_T.

(d) Each contractor responsible for a T&P activity that involves greater than 1 A_2 of radioactive material must annually submit to RL and the TSD Configuration Manager a summary of each USQ_TD performed since the prior submittal.

(e) If a contractor responsible for a T&P activity that involves greater than 1 A_2 of radioactive material discovers or is made aware of a potential inadequacy of the safety basis, it must:

(1) Take action, as appropriate, to place or maintain the T&P activity in a safe condition until an evaluation of the safety of the situation is completed;

(2) Notify RL and other contractors of the situation;

(3) Perform a USQ_TD and notify RL and other contractors promptly of the results; and

(4) Submit the evaluation of the safety of the situation to RL for approval prior to removing any operational restrictions initiated to meet paragraph (e)(1) of this section.

6.6.1.2 USQ_T Approval

The USQ_T process is an important tool to evaluate whether changes affect the safety basis. Each Hanford site contractor performing T&P activities under the TSD must use the USQ_T process to ensure that the safety basis for a T&P activity that involves greater than 1 A_2 of radioactive material is not undermined by changes in the facility, work performed, associated hazards, or other factors that support the adequacy of the safety basis.

The USQ_T process permits DOE and each prime contractor to make physical and procedural changes to a T&P activity that involves greater than 1 A_2 of radioactive material and to conduct tests and experiments without prior approval, provided these changes do not cause a positive USQ_T determination. The USQ_T process provides each prime contractor with the flexibility needed to conduct day-to-day operations by requiring only those changes and tests with a potential to impact the safety basis (and therefore the safety of the T&P activity that involves greater than 1 A_2 of radioactive material) be approved by the cognizant Hanford DOE Field Office Manager. This allows each DOE Field Office Manager to focus its review on those changes significant to safety. The USQ process helps keep the safety basis current by ensuring appropriate review of and response to situations that might adversely affect the safety basis. Appendix C, Unreviewed Safety Question for Transportation (USQ_T) Process, provides the DOE's expectations for an acceptable USQ_T process.

6.6.1.3 Margin of Safety

A margin of safety is defined as a range or safety buffer between two conditions. The first is the most adverse condition estimated or calculated in the safety analysis process to occur from an operational upset or family of related upsets including severe accidents. The second condition is the worst case value known to be safe from an engineering perspective. For example, an accident or upset may cause an overpressurization within a vessel. The vessel must be designed to safely withstand the worst postulated overpressure. This defines the first condition. The second condition is the point at which the vessel fails from overpressurization. The pressure range between these two conditions is the margin of safety in this example. This margin of safety should be identified in the PSSD. As part of the approval process, important credited margins of safety should be explicitly identified in the SER.

Credited Margin of Safety is the actual minimum characteristic performance point that is being credited. As a decrease in margin of safety, by definition results in an increase in risk, thus resulting in a positive USQ. For the purposes of the TSD, all margins of safety being considered will be the credited margin of safety. For example, seal may have maximum sustained operating temperature of 250 ^{o}F. This means that the seal can be operated continuously through its lifetime at 250 ^{o}F without loss of properties. The seal's thermal failure point may be 400 ^{o}F. The credited margin of safety is thus 250 ^{o}F to 400 ^{o}F. If the normal operating temperature of the seal is increased from 180 ^{o}F to 240 ^{o}F, the credited margin of safety has not been impacted, so no decrease in margin of safety and consequently, no increase in risk has occurred. Definitions for credited margins of safety for each area of packaging performance are described in Appendix C.

The TSD, PSSD and other appropriate documents must be reviewed to determine whether the proposed change, activity, test or experiment, or new information has or would result in the reduction of a margin of safety. The judgment on whether the margin is reduced should be based on physical parameters or conditions that can be observed or calculated.

T&P systems are either compliant, equivalent, or risk based. Those that are compliant or equivalent are considered performance-based systems. Those that are neither compliant nor equivalent are risk based systems.

The margin of safety is a key element in USQ_TDs. Proposed changes are evaluated in the USQ_T screening (USQ_TS) process by focusing on the established limits in the approved TSD and PSSD. If the USQ_TS determines that the proposed change is outside the bounds of the PSSD, then the potential for a change in the margin of safety exists and the screen is positive. An USQ_TD is then prepared. The evaluation of the proposed change is against the requirements of the TSD and PSSD. If the evaluation of safety of the proposed change shows it is within the bounds of the TSD and PSSD, including a negative evaluation of the reduction in margin of safety, a negative USQ_TD results, and approval by RL is not required for the proposed change prior to implementation.

Implicit margins of safety might arise in a risk based package. In those cases the margin of safety may include reliance on assumed or calculated parameters, such as fire department response times, etc. If these change, it may affect margin of safety.

6.6.1.3.1 Methodology For Determining Credited Margins Of Safety For USQ_T Determinations For DOT-Compliant And Hanford DOT-Equivalent Packages

Credited Margins of Safety (CMOS) for DOT-Compliant and Hanford DOT-Equivalent Packages are described in Appendix C.

6.6.1.3.2 Methodology For Determining Credited Margins Of Safety For USQ_T Determinations For Hanford Risk Based Packages

The underlying basis for onsite transportation safety of any Hanford risk based package system is to minimize the risk to the public and worker. This is done by supplementing the known performance capability of the system with preventative administrative and/or engineering controls, site transportation environment, and communication measures. Consequently, the USQ_T evaluator must view any change in the context of the entire package system, which comprises not only the packaging but also the content, conveyance, route, and transportation environment all supplemented by preventative controls and mitigating measures.

The evaluator must recognize that the risk determined in the PSSD for any risk based packaging is predicated on accident statistics, and engineering judgment of key parameters, such as packaging capabilities and failure modes, beneficial onsite transportation environment, effectiveness of administrative and institutional controls, content release fractions, and dispersal mechanisms in the event of an accident. These key parameters form the basis of the implicit and/or explicit margins of safety described in the PSSD. Consequently, the USQ_T evaluator must not only assess any change to dose consequence and probability, but also assess the impact on the implicit and/or explicit margins of safety of the packaging system described in the approved PSSD.

As a result, for any change, an increase in risk above that described in the TSD and accompanying SER, or reduction in any credited margins of safety of the package system must be considered a positive USQ_T. As an example of a reduction in margin of safety, a change of the semi-trailer required for a package system that relies on the conveyance performance under normal and accident conditions should be evaluated to ensure that the new trailer does not provide lower levels of accident resistance. The change specifies an equivalent semi-trailer by a different manufacturer with a higher rated load capacity but a narrower wheelbase. Since the wheelbase is narrower than the original semi-trailer, the margin of safety implicitly stated in the PSSD has been reduced and the USQ_T is positive. In this case the implicit margin of safety is the static rollover threshold.

6.6.2 Technical Safety Requirements (TSR)

Each Hanford site contractor responsible for a T&P activity that involves greater than 1 A_2 of radioactive material must implement the following:

- TSRs that are derived from this TSD
- Prior to use, obtain RL Manager approval of any change to TSRs
- Notify RL of any violation of a TSR.

The TSRs are identified in Appendix D, Technical Safety Requirements for Hanford Onsite T&P activities involving greater than 1 A_2 of radioactive material.

Each contractor may take emergency actions that depart from an approved TSR when no actions consistent with the TSR are immediately apparent, and when these actions are needed to protect the workers, public, or environment from imminent and significant harm. Such actions must be approved by a person in authority (e.g., certified shipper) as designated in the TSRs. Each contractor must report the emergency actions to RL as soon as practicable.

6.7 REFERENCES

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CHAPTER 7.0 - SAFETY ASSESSMENT METHODOLOGY

This chapter identifies the methodologies used for achieving and demonstrating onsite safety equivalent to that accomplished by complying with the DOT regulations. In addition, it identifies specific evaluation methodology and acceptance criteria to apply when demonstrating compliance with the requirements found in Chapter 6.0 for achieving equivalent onsite T&P activity safety.

7.1 METHODOLOGY FOR EQUIVALENT SAFETY

This TSD identifies three categories of packages, all of which achieve "equivalent safety" as required by DOE Order 460.1B for onsite shipments. This includes two categories that specifically meet the intent of 10 CFR 71. Type B quantities of radioactive materials in Type A Packaging with the exception of qualified SCO and LSA materials will not be included in these two categories. The third category of packages used for onsite shipments relies on a risk based approach consistent with DOE-STD-3009-94 to demonstrate an equivalent level of safety for the public and an acceptable level of safety for onsite workers. The following sections identify the three categories.

7.2 COMPLIANCE METHODS

7.2.1 DOT Compliance

Equivalent safety is achieved by implementing the DOT regulations onsite. For the purposes of this TSD, DOT regulations are taken to include NRC regulations in 10CFR71 for Type B quantities, and DOT is interpreted to mean either DOT or NRC as applicable. All portions of the regulations, other than those identifying the workings and administration of the DOT (e.g., enforcement), will be implemented. Equivalent administrative activities, including approval of exemptions, will be conducted by the cognizant Hanford DOE Field Officer Manager. This is the preferred technique for achieving onsite equivalent safety when conducting onsite T&P activities. By emulating the DOT regulation for onsite hazardous material T&P activities, an equivalent level of safety is achieved. Under this methodology, DOE will perform those actions identified for the DOT within the DOT regulations. RL, ORP, and PNSO and the Hanford Site contractors will implement those actions identified for the user of the DOT regulations. No alternative evaluation or acceptance criteria are needed when using this methodology.

7.2.2 DOT-Equivalent Packaging

For radioactive materials, where full compliance with DOT regulations cannot be achieved, an equivalent method for achieving the accepted national level of safety will be implemented. For these radioactive hazardous materials, equivalent safety is achieved by implementing all portions of the regulations, except for specified modifications to the regulations identifying the following:

- Workings and administration of the DOT
- How to obtain exemptions
- Communication requirements associated with shipping radioactive materials.

Equivalent administrative activities, including approval of exemptions, will be conducted by the cognizant Hanford DOE Field Officer Manager. Performance requirements for onsite DOT-equivalent packages are identified in Section 6.5.2. These requirements are developed to result in a package that produces physical performance under Hanford Site conditions equivalent to an offsite package subject to regulatory-established test conditions. Examples of Hanford Site-specific conditions that are different than DOT and NRC regulatory conditions are environmental conditions (Site-specific temperature extremes), application of artificial cooling after a 30-minute fire (assumes Site fire department response), allowance for container venting (not permitted by DOT), and specific free-drop characteristics (models the CWC storage pad). Specific details and justifications for Hanford Site-specific variances from the DOT and NRC regulatory conditions are provided in Appendix B of this TSD.

When full compliance with DOT for onsite shipments cannot be achieved because of technical or economic conditions, meeting these site-specific standards and performance requirements is the preferred technique for achieving safety equivalent to that of fully following DOT regulations. DOT-equivalent packages are not used for off-site transportation.

The alternate package requirements are chosen to produce a package, which when tested or evaluated to onsite conditions, performs equivalent to a DOT package subjected to the DOT/NRC performance requirements. The alternate packaging performance requirements are identified in Chapter 6.0, Site-Specific Standards, Procedures, and Instructions. The following sections identify the evaluation techniques and acceptance criteria developed for this methodology. Evaluation techniques, when applied to T&P activities conducted using the requirements identified in Chapter 6.0, result in achieving and demonstrating compliance with the equivalent safety requirements of DOE Order 460.1B for T&P activities.

Chapter 6.0 contains the Hanford packaging performance standards. Appendix B contains technical arguments or justification and references to documentation that validate the equivalence of packaging performance for onsite to offsite packages under their respective conditions.

7.2.3 Risk based packaging (Risk based Equivalent Radiological and Toxicological Protection)

When full compliance with DOT regulations or compliance with DOT-equivalent packaging for radioactive materials cannot be achieved, a risk based method for demonstrating the accepted national level of safety will be implemented using requirements discussed in Section 6.5.3.2. These requirements demonstrate safety equivalent to that resulting from following DOT regulations when shipping in commerce through the use of an approved RL and ORP risk based approach consistent with DOE-STD-3009-94. Specific bounding accident scenarios are evaluated to demonstrate that use of risk based packaging is equivalent to the accepted national level of safety for DOT-compliant packaging by ensuring that the DOE-STD-3009-94 evaluation guidance and the SARAH risk classification bins are maintained. For these radioactive hazardous materials, equivalent safety is achieved by implementing all portions of the regulations, except for specified modifications to the regulations identifying the following:

- Workings and administration of the DOT
- How to obtain exemptions
- Communication requirements associated with shipping radioactive materials.

For risk based packages, administrative activities, including the approval of exemptions, will be conducted by the cognizant Hanford DOE Field Officer Manager. Performance requirements for onsite risk based packages are identified in Section 6.5.3.2. These requirements are developed to result in a package, which under Hanford Site conditions will produce radiological performance equivalent to an offsite package subject to regulatory-established tests and conditions. Risk based packages are not generally used for transportation of nonradioactive hazardous materials.

Alternate package requirements are chosen to produce a package, which when tested or evaluated to onsite conditions result in radiological and toxicological safety equivalent to that resulting offsite from full compliance with DOT/NRC regulations governing the loss of material under NCs, and for Type B packages, ACs. Alternate packaging performance requirements are identified in Chapter 6.0. The following sections identify evaluation techniques and acceptance criteria developed for this methodology. Evaluation techniques, when applied to T&P activities conducted using the requirements identified in Chapter 6.0, result in achieving and demonstrating compliance with the equivalent safety requirements of DOE Order 460.1B for T&P activities.

Chapter 6.0 contains the Hanford packaging performance standards. Appendix G contains the documentation that validates the equivalence of onsite risk based packaging performance to offsite packages under their respective conditions.

7.3 EVALUATION AND ACCEPTANCE CRITERIA

When the alternate package testing and design criteria presented in Chapter 6.0 are used to design a packaging, the following evaluation methodologies and acceptance criteria must be used to demonstrate compliance. For DOT compliant packagings, the evaluation and acceptance criteria identified in the regulations must be followed.

7.3.1 DOT-Equivalent Packagings

7.3.1.1 Evaluation Requirements and Acceptance Criteria for IP-2, IP-3, and Type A Packagings

This section applies to Evaluation Requirements and Acceptance Criteria for IP-2, IP-3, and Type A Packagings when they are used to carry either Type A quantities or special form SCO and LSA radioactive materials as defined in 49 CFR 173. It does not apply to Evaluation Requirements and Acceptance Criteria for IP-2, IP-3, and Type A Packagings used to transport Type B quantities of radioactive materials. In these instances the Evaluation Requirements and Acceptance Criteria for Type B Packagings will be used. This section outlines the elements that are to be addressed for an onsite packaging safety assessment to demonstrate acceptable performance based on the performance tests in Section 6.5.2.3. It also defines the acceptable performance criteria for testing and/or analysis to be applied to demonstrate the packaging provides an equivalent degree of safety to the regulations in maintaining containment/confinement, subcriticality, and shielding. It should be noted that in any onsite packaging safety assessment, claims of adequacy of designs or design methods must be supported by technical bases; i.e., by an appropriate engineering evaluation or description of actual tests. No specific format is identified for IP-2, IP-3, and Type A onsite package safety documentation.

7.3.1.1.1 General Information.

The general information of the onsite packaging safety assessment must include a purpose, detailed packaging description, detailed definition and description of the containment/confinement boundary, contents, and assessment of the general design requirements for packaging (Section 6.5.2.4.1).

7.3.1.1.1(a) Package Description. The package description in the onsite packaging safety assessment must include the following information:

7.3.1.1.1(a)(1) Detailed description [addressed in paragraph 7.3.1.1.1(b) and (c) below] of the packaging design in sufficient detail to provide an adequate basis for evaluation.

7.3.1.1.1(a)(2) Sketches or engineering drawings of the packaging must be prepared to conform to ASME Y14.5, "Geometric Dimensioning and Tolerancing Principles," drafting requirements.

7.3.1.1.1(a)(3) Detailed description [addressed in paragraph 7.3.1.1.1(d)] of the contents in sufficient detail to provide an adequate basis for evaluation.

7.3.1.1.1(a)(4) Detailed description of the loading, unloading, and transport operations of the package.

7.3.1.1.1(a)(5) Identification of established codes and standards for package design, fabrication, assembly, testing, maintenance, and use.

7.3.1.1.1(b) Packaging Description. A detailed description of the packaging must include the following:

7.3.1.1.1(b)(1) General packaging summary, including maximum weight and overall dimensions.

7.3.1.1.1(b)(2) Containment/confinement features [see paragraph 7.3.1.1.1(c)].

7.3.1.1.1(b)(3) Shielding features.

7.3.1.1.1(b)(4) Structural and other features, including gaps and coolants, for transfer and dissipation of heat.

7.3.1.1.1(b)(5) Other structural features, including support structures, lifting and tiedown devices, and impact limiters.

7.3.1.1.1(b)(6) Description of any special fabrication processes not addressed by a nationally recognized or Hanford Site standard.

7.3.1.1.1(c) Containment/Confinement Boundary Definition and Description. A detailed description of the containment boundary must include the following:

7.3.1.1.1(c)(1) Definition of the exact boundary of the containment/confinement system. This includes containment/confinement vessel, welds, drain or fill ports, valves, seals, test ports, lids, cover plates, and other closure devices.

7.3.1.1.1(c)(2) If multiple seals are used for a single closure, the seal defined as the containment system seal must be clearly defined.

7.3.1.1.1(c)(3) A sketch of the containment/confinement system must be provided.

7.3.1.1.1(c)(4) For a vented and filtered package, the venting and filtration system must be described in detail. The manufacturer, type, model, rating, and performance characteristics of the filter and filter housing seals must be provided.

7.3.1.1.1(c)(5) All containment/confinement boundary components must be shown on the sketch or engineering drawings.

7.3.1.1.1(d) Content Description. A detailed description of the contents must include the following:

7.3.1.1.1(d)(1) Identification and maximum quantity (radioactivity or mass and specific activity) of the radioactive material.

7.3.1.1.1(d)(2) Chemical and physical form, including density and moisture content.

7.3.1.1.1(d)(3) Location and configuration of contents within the packaging.

7.3.1.1.1(d)(4) Any material subject to chemical, galvanic, radiolytic, or other reaction, including the generation of flammable gases.

7.3.1.1.1(d)(5) Maximum normal operating and design pressure.

7.3.1.1.1(d)(6) Maximum weight.

7.3.1.1.1(d)(7) Maximum decay heat.

7.3.1.1.1(e) Assessment of General Design Requirements for Packaging. General design requirements for the packaging must be demonstrated to meet the requirements outlined in Section 6.5.2.4.1.

7.3.1.1.2 Structural Evaluation.

This section outlines the elements that are to be addressed for an onsite packaging safety assessment to demonstrate acceptable structural performance based on the performance tests defined in Section 6.5.2.3 and structural requirements of Section 6.5.2.4. The section also defines the acceptable performance criteria for testing and/or analysis to be applied to demonstrate the packaging provides an equivalent degree of safety to the regulations in maintaining containment/confinement and shielding. It should be noted that in any onsite packaging safety assessment, claims of adequacy of designs or design methods must be supported by technical bases; i.e., by an appropriate engineering evaluation or description of actual tests.

7.3.1.1.2(a) Description of Structural Design. The following information must be provided in the structural description of the packaging:

7.3.1.1.2(a)(1) Dimensions, tolerances, and materials.

7.3.1.1.2(a)(2) Weights and center of gravity of the packaging and major subcomponents.

7.3.1.1.2(a)(3) Maximum weight of contents.

7.3.1.1.2(a)(4) MNOP.

7.3.1.1.2(a)(5) Closure system and containment/confinement boundary and its components must be clearly identified and described.

7.3.1.1.2(a)(6) Description of handling and transport requirements.

7.3.1.1.2(a)(7) Fabrication methods.

7.3.1.1.2(a)(8) Codes and standards for the packaging design must be identified, properly applied, and appropriate for the intended purpose.

7.3.1.1.2(b) Material Properties and Specifications. The following information must be provided and/or demonstrated in describing the materials of construction of this packaging:

7.3.1.1.2(b)(1) Appropriate specification for the materials of construction must be identified for control of the material.

7.3.1.1.2(b)(2) Materials and their properties must be consistent with the design codes or standards selected. If no standard is available, adequately documented material properties and specifications for the design and fabrication of the packaging must be provided.

7.3.1.1.2(b)(3) Materials of the containment/confinement boundary must have sufficient fracture toughness to preclude brittle fracture under NC. In demonstrating fracture toughness of a material, guidance from either ASME BPVC, Section 6.0II, Division 1; ASME BPVC, Section III; Regulatory Guide 7.11; or Regulatory Guide 7.12 may be used.

7.3.1.1.2(b)(4) Material properties must be appropriate for the load conditions (e.g., static or dynamic impact loads, hot or cold temperatures, and wet or dry conditions).

7.3.1.1.2(b)(5) Temperature at which allowable limits are defined must be consistent with minimum and maximum service temperatures.

7.3.1.1.2(b)(6) Force-deformation properties for impact limiters must be provided and must be based on appropriate test conditions and temperatures.

7.3.1.1.2(b)(7) Packaging materials and coatings must not produce a significant chemical or galvanic reaction among packaging components, packaging contents, or between the packaging components or packaging content.

7.3.1.1.2(b)(8) Changes resulting from inleakage of water must be evaluated.

7.3.1.1.2(b)(9) The potential for radiolytic or chemical generation of flammable gases must be evaluated.

7.3.1.1.2(b)(10) The possibility of galvanic interactions and the formation of eutectics must be evaluated for metallic components that may come into physical contact. Such interactions may occur with depleted uranium, lead, or aluminum.

7.3.1.1.2(b)(11) Any damaging effects of radiation on the packaging materials must be evaluated. These effects may include degradation of seals, sealing material, coatings, adhesives, and structural materials.

7.3.1.1.2(c) Fabrication. Information addressing the manufacturing process of construction (e.g., forming, fitting, aligning, welding, brazing, heat treatment, and mechanical joints) must be provided to demonstrate proper packaging fabrication.

7.3.1.1.2(c)(1) When fabrication specifications are prescribed by appropriate codes and standards, the code or standards must be identified in the engineering drawings.

7.3.1.1.2(c)(2) Unless otherwise justified, specification of the code or standard used for design must also be used for fabrication.

7.3.1.1.2(c)(3) For components in which no code or standard is applicable, the specifications on which the evaluation depends must be identified. In addition, the method of control to ensure the specifications are achieved must be described.

7.3.1.1.2(d) Examination. Information addressing the examination methods and criteria by which the fabrication of the packaging is determined to be acceptable must be provided.

7.3.1.1.2(d)(1) Unless otherwise justified, the specification of the code or standard used for fabrication must also be used for examination.

7.3.1.1.2(d)(2) For components in which no code or standard is applicable, the method and acceptance criteria must be provided herein.

7.3.1.1.2(e) Lifting Devices. When lifting devices are a structural part of the package, their connection with the package body, and the package body in the local area around the lifting devices must be evaluated.

7.3.1.1.2(e)(1) The lifting devices must be demonstrated to comply with the design requirements of Section 6.5.2.4.1(b).

7.3.1.1.2(f) Tiedown Devices. When tiedown devices are a structural part of the package, their connection with the package body and the package body in the local area around the tiedown device must be evaluated.

7.3.1.1.2(f)(1) The tiedown devices must be demonstrated to comply with the design requirements of Section 6.5.2.4.2(i).

7.3.1.1.2(g) General Consideration. The structural evaluation must demonstrate that the package meets the performance test requirements defined in Section 6.5.2.3 and the design requirements defined in Section 6.5.2.4. The evaluation must also address the following:

The most limiting initial conditions must be used as defined in Section 6.5.2.3.1.

The evaluation methods are appropriate for the loading conditions considered and accepted practices and precepts are followed.

The most damaging orientations have been considered. It should be noted that the most damaging orientation for one component may not be the most damaging for another component.

7.3.1.1.2(g)(1) Evaluation by Testing. If the package performance is demonstrated by testing, the onsite packaging safety assessment must include the following:

7.3.1.1.2(g)(1)(i) Description of the test surface (e.g., material, mass, dimensions) used for the free drop, penetration, and crush tests. The test surface must be, as a minimum, in accordance with Section 6.5.2.3.5. The total mass of the test surface must be greater than 10 times the mass of the package.

7.3.1.1.2(g)(1)(ii) Description of the steel bar (e.g., material, dimension, orientation) used for the penetration test.

7.3.1.1.2(g)(1)(iii) The test bar must have sufficient length to cause maximum damage to the package and meet the requirements of Section 6.5.2.3.7.

7.3.1.1.2(g)(1)(iv) The test specimen must have been fabricated using the same materials, methods, and QA as specified in the design. Any differences must be

identified and the effects evaluated. Substitutes for the contents should have the same representative weight as the actual contents.

7.3.1.1.2(g)(1)(v) Selected free drop orientations must be in the orientation for which maximum damage to the feature being tested is expected. These selections must be justified.

7.3.1.1.2(g)(1)(vi) All test results must be evaluated and their implications interpreted, including interior and exterior damage of the test specimen. Unexpected or unexplained test results indicating possible testing problems or non-reproducible specimen behavior must be described and evaluated.

7.3.1.1.2(g)(1)(vii) Videos and photographs of tests should be provided as records and maintained available for review.

7.3.1.1.2(g)(1)(viii) Margins of safety of the package design must be evaluated against the test results.

7.3.1.1.2(g)(1)(ix) Criteria for evaluating pass/fail for the test conditions must be provided and used as a comparison with the test results.

7.3.1.1.2(g)(2) Evaluation by Analysis. If the package performance is demonstrated by analysis, the onsite packaging safety assessment must include the following:

7.3.1.1.2(g)(2)(i) A clear description of calculations and all assumptions must be provided.

7.3.1.1.2(g)(2)(ii) The response of the package to loads, in terms of stress and strain to the components and structural members must be provided, and the structural stability of individual members must be demonstrated.

7.3.1.1.2(g)(2)(iii) The analytical methods must evaluate impact at any angle, rigid-body rotation, and secondary impacts (slapdown).

7.3.1.1.2(g)(2)(iv) When used, computer codes must be appropriately used, verified, and benchmarked.

7.3.1.1.2(g)(2)(v) When using quasi-static analysis techniques, appropriate dynamic amplification factors must be developed and applied.

7.3.1.1.2(g)(2)(vi) Material properties and models must be appropriate for the load combinations evaluated. Material properties must be consistent with the analytical methods. The strain rate at which the properties are given must be justified.

7.3.1.1.2(g)(2)(vii) A summary of results must be provided which compare results of the analyses with the acceptable performance criteria established below in paragraph 7.3.1.1.2(g)(3).

7.3.1.1.2(g)(3) Acceptable Performance Criteria for Evaluation by Analysis. The following methods may be used for evaluation. Alternate benchmarked methods may be used provided they meet requirements identified in paragraph 7.3.1.1.2(g)(2).

NC acceptable packaging performance shall be assessed in accordance with the ASME BPVC, Section III, Subsection NE requirements for Service Level A and C Limits. Combined stress intensities from temperature, pressure, and free drop are evaluated against the requirements defined for Service Level C Limits. Stress intensities from all other load combinations are to be evaluated against the requirements defined for Service Level A Limits. For structural evaluation purposes, maintenance of containment/confinement is defined as the ability of the packaging systems to sustain applied loading without exceeding ASME allowable stress intensity values. In addition, at closure locations, the seals must be demonstrated to remain sufficiently compressed under NC loads to maintain containment/confinement.

Onsite equivalent packaging requirements also allow plastic deformation of the packaging when it is demonstrated by either testing or analysis that containment/confinement and shielding are maintained under NC. If plastic analysis methods are used to demonstrate maintenance of containment/confinement and shielding, the loads cannot be superimposed. Because ASME BPVC criteria are inappropriate for plastic analysis, packaging performance will be assessed by the combination of the following two methods.

The first and simplest acceptance criteria screening is strain energy density (SED). The maximum SED of the material is also known as toughness and at material failure can be conservatively estimated from the results of uniaxial tensile test data. A conservative estimate of SED at material failure is as follows:

$$\mathrm{SED} = \frac{(\sigma_y + \sigma_u)}{2}\varepsilon_f$$

where: σ_y = yield strength of the material
σ_u = ultimate strength of the material
ε_f = ultimate tensile elongation.

These parameters are available from engineering stress-strain data. Use of the SED also minimizes concerns over unavoidable material variations such as heat-to-heat variations in yield strength and strain hardening behavior.

To ensure against ductile failure of the material, the maximum SED on the package is limited to 70% of the SED failure of the material or material toughness. This is in keeping with the intent of Regulatory Guide 7.6 to prevent large unconfined strain plasticity and system failure due to loss of dimensional stability at key locations. The limit is based on applying the 70% Service Level D stress limit for material loading specified in ASME BPVC, Section III, Appendices to the ultimate elongation specified in ASME BPVC, Section II material properties at operating temperatures. This results in

the SED limit of 70% of the maximum material toughness at operating temperature. The allowable SED in equation form is defined as:

$$SED_{all} = 0.70\frac{(\sigma_y + \sigma_u)}{2}\varepsilon_f$$

This is compared against the von Mises stress times the cumulative strain at the location of evaluation. It is used for global assessment of package performance under dynamic impact loading conditions and identifying high loading areas for detail assessment. Consequently, as a second screening at critical location and in areas of high SED values, a more comprehensive measure of performance is used to assess equivalent cumulative strains against a limiting value.

The most comprehensive criteria demonstrating acceptable cumulative strain levels to prevent material rupture are based on establishing limits on the maximum equivalent cumulative strain. The strain limits are developed based on Manjoine (1983), *Transaction of the ASME, Journal of Pressure Vessel Technology*, that the tensile elongation measured in a tension test can be adjusted to predict multi-axial failure strain by the following relation:

$$\frac{\varepsilon}{e_t} = 2^{(1-TF)} \quad \text{for} \quad TF \geq 0 \quad \text{and} \quad \frac{\varepsilon}{e_t} = 2 \quad \text{for} \quad TF \leq 0$$

where: ε = the effective strain at failure
e_t = the ultimate tensile elongation of the material from tension tests, and
TF = the triaxiality factor.

The triaxiality factor is defined by the principal stresses (σ_1, σ_2, σ_3) as:

$$TF = \frac{\sqrt{2}\,(\sigma_1 + \sigma_2 + \sigma_3)}{\sqrt{\left[(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2\right]}}$$

Based on the ductility versus triaxiality factor curve presented in Manjoine (1983), the following conservative failure strain limits, termed the Triaxial Strain Limit (TSL), can be established for any ductile material under multi-axial loading. Additionally, in keeping with the intent of Regulatory Guide 7.6 to prevent large unconfined strain plasticity and system failure due to loss of dimensional stability at key locations, the ultimate strain is limited to 70% of the reported ultimate tensile elongation of the material. In addition, welds do not have the ductility of the base metal and the presence of residual weld stresses, in weld areas the TSL is one-half the limit established above. Consequently, to demonstrate acceptable performance in non-weld areas, the TSL is established as equal to the triaxiality factor times 70% of the ultimate tensile elongation of the material. The TSL in weld areas is established as one-half times the triaxiality factor times 70% of the ultimate tensile elongation of the material.

In equation form, the TSLs are:

$$TSL = 0.70 \times TF \times e_t \text{ in nonweld areas}$$

and

$$TSL = 0.35 \times TF \times e_t \text{ in weld areas}$$

To demonstrate acceptable performance of the packaging, the cumulative strain at all locations must remain below the established TSL at the location of evaluation. Also, at closure locations, the cumulative strains must be demonstrated not to result in loss of containment or decompression of the seals by flange distortion or closure bolt elongation.

7.3.1.1.2(h) Structural Evaluation of NC. Evaluation of the package under NC is based on the effects of tests and conditions specified in Section 6.5.2.3.1. These tests must not result in any decrease in package effectiveness in maintaining containment/confinement and shielding. Under these test conditions, ambient air temperature before and after the test must remain constant at that specified in Section 6.5.2.3.1(b). Initial internal pressure on containment components must be

considered normal operating pressure, unless a lower internal pressure consistent with the selected ambient temperature is more severe.

7.3.1.1.2(h)(1) Heat Condition. Adequacy of the packaging under heat conditions must be demonstrated by the following evaluations at the hot temperature specified in Section 6.5.2.4.2(c).

7.3.1.1.2(h)(1)(i) Maximum temperatures under heat conditions must be consistent with the thermal section [Section 6.5.2.4.2(c)].

7.3.1.1.2(h)(1)(ii) Normal operating pressure, in combination with the maximum internal heat load and any residual fabrication stresses, must be evaluated.

7.3.1.1.2(h)(1)(iii) Any differential thermal expansion and possible geometric interference must be evaluated.

7.3.1.1.2(h)(1)(iv) The containment/confinement boundary must be evaluated.

7.3.1.1.2(h)(2) Cold Condition. Adequacy of the packaging under cold conditions must be demonstrated by the following evaluations at the cold temperature specified in Section 6.5.2.4.2(c):

7.3.1.1.2(h)(2)(i) Minimum temperatures with no internal heat loading must be consistent with the Thermal section (Section 6.5.2.4.2(c)).

7.3.1.1.2(h)(2)(ii) The evaluation must consider minimum internal pressure with minimum internal heat load and any residual fabrication stresses.

7.3.1.1.2(h)(2)(iii) Any differential thermal expansion and possible geometric interference must be evaluated.

7.3.1.1.2(h)(2)(iv) Evaluate effects of the possible freezing of liquids.

7.3.1.1.2(h)(2)(v) The containment/confinement boundary must be evaluated.

7.3.1.1.2(h)(3) Reduced External Pressure. Adequacy of the packaging under reduced external pressure conditions specified in Section 6.5.2.3.3 must be demonstrated by the following evaluations:

7.3.1.1.2(h)(3)(i) The packaging must be evaluated to demonstrate the containment components are capable of sustaining the differential pressure loading specified in Section 6.5.2.4.2(f) without loss of containment capability. The evaluations must consider the greatest possible pressure differential between the inside and outside of the containment components.

7.3.1.1.2(h)(3)(ii) The containment/confinement boundary must be evaluated.

7.3.1.1.2(h)(4) Vibration. Adequacy of the packaging under the effects of vibration normally incident to transport tests as specified in Section 6.5.2.3.9 must be demonstrated by the following evaluations:

7.3.1.1.2(h)(4)(i) Fatigue must be evaluated at highly stressed components, considering the combined stresses due to vibration, temperature, and pressure loads.

7.3.1.1.2(h)(4)(ii) If closure bolts are reused, the bolts must be evaluated for fatigue and the bolt preload must be included.

7.3.1.1.2(h)(4)(iii) Evaluations must include demonstration that resonant vibration conditions, which may cause rapid fatigue damage, are not present in the packaging components.

7.3.1.1.2(h)(4)(iv) Effects of package internal components and contents must be considered in the evaluations.

7.3.1.1.2(h)(4)(v) The containment/confinement boundary must be evaluated.

7.3.1.1.2(h)(4)(vi) Guidance for vibrational loading parameters is provided in ANSI N14.23, "(Draft) Design Basis/Resistance to Shock/Vibration," and ASTM D4169, "Standard Practice for Performance Testing of Shipping Containers and Systems."

7.3.1.1.2(h)(5) Water Spray. Adequacy of the packaging under the effects of the water spray test as specified in Section 6.5.2.3.4 must be demonstrated by evaluating the effects on material properties of the package. The evaluation must also demonstrate that the water spray results in no loss of radioactive material from the package or increase in radiation levels at the surface of the package.

7.3.1.1.2(h)(6) Free Drop. Adequacy of the packaging under the effects of the free drop tests as specified in Section 6.5.2.3.5 must be demonstrated by the following evaluations:

7.3.1.1.2(h)(6)(i) Design of the packaging must be evaluated for the structural response for the specified free drop height in combination with internal pressure.

7.3.1.1.2(h)(6)(ii) Closure system design with the combined effects of free drop impact force, internal pressure, gasket compression force, and bolt preload must be evaluated.

7.3.1.1.2(h)(6)(iii) Other important components, such as the port-cover, port-cover plates, and shielding enclosures must be demonstrated not to decrease in effectiveness when subjected to the combination of impact force and internal pressure.

7.3.1.1.2(h)(6)(iv) The containment/confinement boundary must be evaluated for the combination of impact force and internal pressure.

7.3.1.1.2(h)(6)(v) The closure system design seals must be demonstrated not to decompress from bolt stretch or flange deflection to the extent that containment/confinement is lost under the combined loadings.

7.3.1.1.2(h)(7) Compression (Stacking). Adequacy of the packaging under the effects of the stacking test as specified in Section 6.5.2.3.6 must be demonstrated by evaluating the structural response of the package to the static loads specified.

7.3.1.1.2(h)(8) Penetration. Adequacy of the packaging under the effects of the penetration test as specified in Section 6.5.2.3.7 must be demonstrated by evaluating the effects of the package at the most vulnerable location.

7.3.1.2 Evaluation Requirements and Acceptance Criteria for Fissile and Type B Packagings

This section describes elements that are to be addressed for an onsite PSSD to demonstrate acceptable performance based on performance tests and design requirements presented in Sections 6.5.2.5 and 6.5.2.6. It also defines acceptable performance criteria for testing and/or analysis to be applied to demonstrate the packaging provides an equivalent degree of safety to the regulations in maintaining containment/ confinement, subcriticality, and shielding. It should be noted that in any onsite PSSD, claims of adequacy of designs or design methods must be supported by technical bases; i.e., by an appropriate engineering evaluation or description of actual tests. The techniques and methodology provided in this section must be used to demonstrate compliance with the requirements from Sections 6.5.2.5 and 6.5.2.6.

Guidance for formatting and preparing the onsite PSSD report is provided in Appendix E, Package-Specific Safety Document Contents and Format. The PSSD is divided into 11 chapters. The contents of the chapters correspond to contents identified in Sections 7.3.1.2.1 through 7.3.1.2.11 below.

7.3.1.2.1 General Information.

General information of the onsite PSSD must include purpose, detailed packaging description, detailed definition and description of the containment/ confinement boundary, contents, and assessment of the general design requirements for packaging (Section 6.5.2.6.1).

7.3.1.2.1(a) Package Description. The package description in onsite PSSDs must include the following information:

7.3.1.2.1(a)(1) A detailed description [addressed in paragraph 3.1.2.1(b) and (c) below] of the packaging design in sufficient detail to provide an adequate basis for evaluation.

7.3.1.2.1(a)(2) Engineering drawings of the packaging must be prepared in accordance with NUREG/CR-5502.

7.3.1.2.1(a)(3) A detailed description [addressed in paragraph 3.1.2.1(d)] of the contents in sufficient detail to provide an adequate basis for evaluation.

7.3.1.2.1(a)(4) A detailed description of loading, unloading, and transport operations of the package.

7.3.1.2.1(a)(5) Identification of established codes and standards for package design, fabrication, assembly, testing, maintenance, and use.

7.3.1.2.1(b) Packaging Description. A detailed description of the packaging must include the following:

7.3.1.2.1(b)(1) General packaging summary, including maximum weight and overall dimensions.

7.3.1.2.1(b)(2) Containment/confinement features [see paragraph 3.1.2.1(c)].

7.3.1.2.1(b)(3) Shielding features.

7.3.1.2.1(b)(4) Criticality control features, including neutron poisons, moderators, and spacers.

7.3.1.2.1(b)(5) Structural and other features, including gaps and coolants, for transfer and dissipation of heat.

7.3.1.2.1(b)(6) Other structural features, including support structures, lifting and tiedown devices, and impact limiters.

7.3.1.2.1(b)(7) A description of any special fabrication processes not addressed by a nationally recognized or Hanford Site standard.

7.3.1.2.1(c) Containment/Confinement Boundary Definition and Description. A detailed description of the containment boundary must include the following:

7.3.1.2.1(c)(1) Definition of the exact boundary of the containment/confinement system. This includes containment/confinement vessel, welds, drain or fill ports, valves, seals, test ports, lids, cover plates, and other closure devices.

7.3.1.2.1(c)(2) If multiple seals are used for a single closure, the seal defined as the containment system seal must be clearly defined.

7.3.1.2.1(c)(3) A sketch of the containment/confinement system must be provided.

7.3.1.2.1(c)(4) For vented and filtered packages, the venting and filtration system must be described in detail. The manufacturer, type, model, rating, and performance characteristics of the filter and filter housing seals must be provided.

7.3.1.2.1(c)(5) All containment/confinement boundary components must be shown on the engineering drawings.

7.3.1.2.1(d) Content Description. A detailed description of the contents must include the following:

7.3.1.2.1(d)(1) Identification and maximum quantity (radioactivity or mass) of the radioactive material.

7.3.1.2.1(d)(2) Identification and maximum quantity of fissile material.

7.3.1.2.1(d)(3) Identification and minimum quantity of solid nonfissile material for every gram of fissile material. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package, but must not be included in determining the required mass for solid nonfissile material.

7.3.1.2.1(d)(4) Chemical and physical form, including density and moisture content, and the presence of other moderating constituents.

7.3.1.2.1(d)(5) Location and configuration of contents within the packaging.

7.3.2.2.1(d)(6) Identification and quantity of nonfissile materials used as neutron absorbers or moderators.

7.3.1.2.1(d)(7) Any material subject to chemical, galvanic, radiolytic, or other reaction, including generation of flammable gases.

7.3.1.2.1(d)(8) Maximum normal operating and design pressure.

7.3.1.2.1(d)(9) Maximum weight.

7.3.1.2.1(d)(10) Maximum decay heat.

7.3.1.2.1(e) Assessment of General Design Requirements for Packaging. General design requirements for packaging must be demonstrated to meet the requirements outlined in Section 6.5.2.6.1.

7.3.1.2.2 Structural Evaluation.

This section outlines the elements that are to be addressed for an onsite PSSD to demonstrate acceptable structural performance based on the performance tests defined in Section 6.5.2.5 and structural requirements of Section 6.5.2.6. The section also defines acceptable performance criteria for testing and/or analysis to be applied to demonstrate the packaging provides an equivalent degree of safety to the regulations in maintaining containment/confinement, subcriticality, and shielding. It should be noted that in any onsite PSSD, claims of adequacy of designs or design methods must be supported by technical bases; i.e., by an appropriate engineering evaluation or description of actual tests.

7.3.1.2.2(a) Description of Structural Design. The following information must be provided in the structural description of the packaging:

7.3.1.2.2(a)(1) Dimensions, tolerances, and materials.

7.3.1.2.2(a)(2) Weights and center of gravity of the packaging and major subcomponents.

7.3.1.2.2(a)(3) Maximum weight of contents.

7.3.1.2.2(a)(4) MNOP.

7.3.1.2.2(a)(5) Closure system and containment/confinement boundary and its components must be clearly identified and described.

7.3.1.2.2(a)(6) Description of handling and transport requirements.

7.3.1.2.2(a)(7) Fabrication methods.

7.3.1.2.2(a)(8) Codes and standards for the packaging design must be identified and must be properly applied and appropriate for the intended purpose.

7.3.1.2.2(b) Material Properties and Specifications. The following information must be provided and/or demonstrated in describing the materials of construction of this packaging:

7.3.1.2.2(b)(1) Appropriate specification for the materials of construction must be identified for control of the material.

7.3.1.2.2(b)(2) Materials and their properties must be consistent with the design codes or standards selected. If no standard is available, adequately documented material properties and specifications for design and fabrication of the packaging must be provided.

7.3.1.2.2(b)(3) Materials of the containment/confinement boundary must have sufficient fracture toughness to preclude brittle fracture under NC and AC. In demonstrating fracture toughness of a material, guidance from ASME BPVC, Section VIII, Division 1; ASME BPVC, Section III; Regulatory Guide 7.11; or Regulatory Guide 7.12 may be used.

7.3.1.2.2(b)(4) Material properties must be appropriate for the load conditions (e.g., static or dynamic impact loads, hot or cold temperatures, and wet or dry conditions).

7.3.1.2.2(b)(5) Temperature at which allowable limits are defined must be consistent with minimum and maximum service temperatures.

7.3.1.2.2(b)(6) Force-deformation properties for impact limiters must be provided and must be based on appropriate test conditions and temperatures.

7.3.1.2.2(b)(7) Packaging materials and coatings must not produce a significant chemical or galvanic reaction among packaging components, among packaging contents, or between the packaging components or packaging content.

7.3.1.2.2(b)(8) Reactions resulting from the inleakage of water must be evaluated.

7.3.1.2.2(b)(9) The potential for radiolytic or chemical generation of flammable gases must be evaluated.

7.3.1.2.2(b)(10) The possibility of galvanic interactions and the formation of eutectics must be evaluated for metallic components that may come into physical contact. Such interactions may occur with depleted uranium, lead, or aluminum.

7.3.1.2.2(b)(11) Any damaging effects of radiation on the packaging materials must be evaluated. These effects may include degradation of seals, sealing material, coatings, adhesives, and structural materials.

7.3.1.2.2(c) Fabrication. Information addressing the manufacturing process of construction (e.g., forming, fitting, aligning, welding, brazing, heat treatment, and mechanical joints) must be provided to demonstrate proper packaging fabrication.

7.3.1.2.2(c)(1) When fabrication specifications are prescribed by appropriate codes and standards, the code or standards must be identified in engineering drawings.

7.3.1.2.2(c)(2) Unless otherwise justified, the specification of the code or standard used for design must also be used for fabrication.

7.3.1.2.2(c)(3) For components in which no code or standards are applicable, the specifications on which the evaluation depends must be identified. In addition, the method of control to ensure specifications are achieved must be described.

7.3.1.2.2(d) Examination. Information addressing examination methods and criteria by which fabrication of the packaging is determined to be acceptable must be provided.

7.3.1.2.2(d)(1) Unless otherwise justified, the specification of the code or standard used for fabrication must also be used for examination.

7.3.1.2.2(d)(2) For components in which no code or standards are applicable, the method and acceptance criteria must be provided herein and a summary provided in Section 3.1.2.11.

7.3.1.2.2(e) Lifting Devices. When lifting devices are a structural part of the package, their connection with the package body, and the package body in the local area around the lifting devices, must be evaluated.

7.3.1.2.2(e)(1) Lifting devices must be demonstrated to comply with the design requirements of Section 6.5.2.6.2.

7.3.1.2.2(f) Tiedown Devices. When tiedown devices are a structural part of the package, their connection with the package body and the package body in the local area around the tiedown device must be evaluated.

7.3.1.2.2(f)(1) Tiedown devices must be demonstrated to comply with the design requirements of Section 6.5.2.6.3.

7.3.1.2.2(g) General Consideration. The structural evaluation must demonstrate the package meets the performance test requirements defined in Section 6.5.2.5 and design requirements defined in Section 6.5.2.6. The evaluation must also address the following.

The most limiting initial conditions must be used as defined in Table 6-6 of Section 6.5.2.6.10(a).

The evaluation methods are appropriate for the loading conditions considered and follow accepted practices and precepts.

The most damaging orientations have been considered. It should be noted that the most damaging orientation for one component may not be the most damaging for another component.

7.3.1.2.2(g)(1) Evaluation by Testing. If the package performance is demonstrated by testing, the onsite PSSD must include the following:

Description of the test surface (e.g., material, mass, dimensions) used for the free drop and crush tests. As a minimum, the test surface must be in accordance with Section 6.5.2.5.1(c)(7). The total mass of the test surface must be at least 10 times the mass of the package.

Description of the steel bar (e.g., material, dimension, orientation, method of mounting) used for the puncture test. The test bar must have sufficient length to cause maximum damage to the package and meet the requirements of Section 6.5.2.5.2(c)(3).

The test specimen must have been fabricated using the same materials, methods, and QA as specified in the design. Any differences must be identified and the effects evaluated. Substitutes for the contents should have the same representative weight as the actual contents.

Of the selected free drop orientations, one must be in the orientation for which maximum damage is expected. This selection must be justified.

All test results must be evaluated and their implications interpreted, including interior and exterior damage, for the test specimen. Unexpected or unexplained test results indicating possible testing problems or non-reproducible specimen behavior must be described and evaluated.

Videos and photographs of the tests must be provided as records and maintained available for review for the life of the package.

Criteria for evaluating pass/fail for the test conditions must be provided and used as a comparison with the test results.

7.3.1.2.2(g)(2) Evaluation by Analysis. If the package performance is demonstrated by analysis, the onsite PSSD must include the following:

A clear description of calculations and all assumptions must be provided.

Response of the package to loads, in terms of stress and strain to the components and structural members, must be provided and the structural stability of individual members must be demonstrated.

Analytical methods must evaluate impact at any angle, rigid-body rotation, and secondary impacts (slapdown).

Computer codes must be appropriately used, verified, and benchmarked.

When using quasi-static analysis techniques, appropriate dynamic amplification factors must be developed and applied.

Material properties and models must be appropriate for the load combinations evaluated. Material properties must be consistent with the analytical methods. The strain rate at which the properties are given must be justified.

A summary of results must be provided which compare results of the analyses with the acceptable performance criteria established in paragraph 7.3.1.2.2(g)(3).

7.3.1.2.2(g)(3) Acceptable Performance Criteria for Evaluation by Analysis. NC acceptable packaging performance will be assessed in accordance with the ASME BPVC, Section III, Subsection NE requirements for Service Level A and C Limits. The combined stress intensities from temperature, pressure, and free drop are evaluated against the requirements defined for Service Level C Limits. Stress intensities from all other load combinations are to be evaluated against the requirements defined for Service Level A Limits. For structural evaluation purposes, maintenance of containment/confinement is defined as the ability of the packaging system to sustain the applied loading without exceeding ASME allowable stress intensity values. Also, at closure locations, the seals must be demonstrated to remain sufficiently compressed under NC loads as to maintain containment/confinement.

Under AC, the package must be subjected to the sequence of performance tests in the following order: free drop, crush (when applicable), puncture, fire, and immersion (fissile packages). Where the package loading is linear elastic, loads can be combined by superimposition and the performance assessed to the requirements of ASME BPVC, Subsection NE, Service Level D Limits.

Onsite equivalent package requirements also allow plastic deformation of the packaging when it is demonstrated by either testing or analysis that containment/confinement, shielding, and subcriticality are maintained under AC. When packaging performance is demonstrated by elastic plastic analysis, the loads are required to be applied in the sequence as specified in Section 6.5.2.5.2(c) to assess cumulative damage of the packaging. If plastic analysis methods are used to demonstrate maintenance of containment/confinement, shielding, and subcriticality, the loads cannot be superimposed and cumulative damage must be assessed after application of all the loads to the worst case locations. Because ASME BPVC criteria are inappropriate for plastic analysis, packaging performance will be assessed by the combination of the following two methods:

The first and simplest acceptance criteria screening is SED. The maximum SED of the material is also known as toughness and at material failure can be conservatively estimated from the results of uniaxial tensile test data. A conservative estimate of SED at material failure is as follows:

$$\mathrm{SED} = \frac{(\sigma_y + \sigma_u)}{2}\varepsilon_f$$

where: σ_y = yield strength of the material
σ_u = ultimate strength of the material
ε_f = ultimate tensile elongation.

These parameters are available from engineering stress-strain data. Use of the SED also minimizes concerns over unavoidable material variations such as heat-to-heat variations in yield strength and strain hardening behavior.

To ensure against ductile failure of the material, the maximum SED on the package is limited to 70% the SED to failure of the material or material toughness. This is in keeping with the intent of the Regulatory Guide 7.6 to prevent large unconfined strain plasticity and system failure due to loss of dimensional stability at key locations. The limit is based on applying the 70% Service Level D stress limit for material loading,

$$\mathrm{SED}_{all} = 0.70\frac{(\sigma_y + \sigma_u)}{2}\varepsilon_f$$

specified in ASME BPVC, Section III, Appendices to the ultimate elongation specified in ASME BPVC, Section II material properties at operating temperatures. This results in the SED limit of 70% of the maximum material toughness at operating temperature. The allowable SED in equation form is defined as:

This is compared against the von Mises stress times the cumulative strain at the location of evaluation. It is used for global assessment of package performance under dynamic impact loading conditions and identifying high loading areas for detail assessment. Consequently, as a second screening at critical locations and in areas of high SED values, a more comprehensive measure of performance is used to assess equivalent cumulative strains against a limiting value.

The most comprehensive criteria demonstrating acceptable cumulative strain levels to prevent material rupture are based on establishing limits on the maximum equivalent cumulative strain. The strain limits are developed based on Manjoine (1983) observation that the tensile elongation measured in a tension test can be adjusted to predict multi-axial failure strain by the following relation:

$$\frac{\varepsilon}{e_t} = 2^{(1-TF)} \quad \text{for} \quad TF \geq 0 \quad \text{and} \quad \frac{\varepsilon}{e_t} = 2 \quad \text{for} \quad TF \leq 0$$

where: ε = the effective strain at failure
e_t = the ultimate tensile elongation of the material from tension tests
TF = the triaxiality factor.

The triaxiality factor is defined by the principal stresses (σ_1, σ_2, σ_3) as:

$$TF = \frac{\sqrt{2}(\sigma_1 + \sigma_2 + \sigma_3)}{\sqrt{\left[(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2\right]}}$$

Based on the ductility versus triaxiality factor curve presented in Manjoine (1983), the following conservative failure strain limits, termed the TSL, can be established for any ductile material under multi-axial loading. In addition, in keeping with the intent of the Regulatory Guide 7.6 to prevent large unconfined strain plasticity and system failure due to loss of dimensional stability at key locations, the ultimate strain is limited to 70% of the reported ultimate tensile elongation of the material. Also, welds do not have the ductility of the base metal and the presence of residual weld stresses, in weld areas the TSL is half the limit established above. Consequently, to demonstrate acceptable performance in non-weld areas, the TSL is established as equal to the triaxiality factor times 70% of the ultimate tensile elongation of the material. The TSL in weld areas is established as one-half times the triaxiality factor times 70% of the ultimate tensile elongation of the material. In equation form, the TSLs are:

$$TSL = 0.70 \times TF \times e_t \text{ in nonweld areas}$$

and

$$TSL = 0.35 \times TF \times e_t \text{ in weld areas}$$

To demonstrate acceptable performance of the packaging, the cumulative strain at all locations must remain below the established TSL at the location of evaluation. Also, at closure locations, the cumulative strains must be demonstrated not to result in loss of containment or decompression of the seals by flange distortion or closure bolt elongation.

7.3.1.2.2(g)(4) Pressure Loading. The following pressure evaluations must be provided in the onsite PSSD to demonstrate the structural integrity of the packaging containment components under pressure:

As stated in Section 6.5.2.6.12 the packaging must be demonstrated to sustain a pressure of 150% of the rated MNOP.

The package must be evaluated to demonstrate that the containment components are capable of sustaining the differential pressure loading specified in Sections 6.5.2.5.1(c)(3) and 6.5.2.5.1(c)(4) without loss of containment capability.

The evaluations must consider the greatest possible pressure differential between the inside and outside of the containment components.

7.3.1.2.2(h) Structural Evaluation of NC. Evaluation of the package under NC is based on the effects of tests and conditions specified in Section 6.5.2.5.1. These tests must not result in any decrease in package effectiveness in maintaining containment/confinement, shielding, and subcriticality. Under these test conditions, the ambient air temperature before and after the test must remain constant at that value between the specified temperatures in Sections 6.5.2.5.1(c)(1) and 6.5.2.5.1(c)(2) which is the most unfavorable for the feature being evaluated. Initial internal pressure on the containment components must be considered to be MNOP, unless a lower internal pressure consistent with the selected ambient temperature is more severe.

7.3.1.2.2(h)(1) Heat Condition. The adequacy of the package under heat conditions must be demonstrated by the following evaluations at the hot temperature specified in Sections 6.5.2.5.1(c)(1):

The maximum temperatures under heat conditions must be consistent with the thermal evaluation section (7.3.1.2.3).

The MNOP, in combination with the maximum internal heat load and any residual fabrication stresses, must be evaluated.

Any differential thermal expansion and possible geometric interference must be evaluated.

The containment/confinement boundary must be evaluated for the load combinations specified in Sections 6.5.2.6.10(a), and Table 6-6.

7.3.1.2.2(h)(2) Cold Condition. The adequacy of the package under cold conditions must be demonstrated by the following evaluations at the cold temperature specified in Section 6.5.2.5.1(c)(2):

The minimum temperatures with no internal heat loading must be consistent with the thermal evaluation section (7.3.1.2.3).

The evaluation must consider the minimum internal pressure with the minimum internal heat load and any residual fabrication stresses.

Any differential thermal expansion and possible geometric interference must be evaluated.

Evaluate the effects of the possible freezing of liquids.

The containment/confinement boundary must be evaluated for the load combinations specified in Section 6.5.2.6.10(a), and Table 6-6.

7.3.1.2.2(h)(3) Reduced External Pressure. The adequacy of the package under reduced external pressure conditions specified in Section 6.5.2.5.1(c)(3) must be demonstrated by the following evaluations:

The greatest possible pressure difference between the inside and outside of the containment components must be evaluated.

The containment/confinement boundary must be evaluated for the load combinations specified in Section 6.5.2.6.10(a), and Table 6-6.

7.3.1.2.2(h)(4) Increased External Pressure. Adequacy of the package under increased external pressure conditions specified in Section 6.5.2.5.1(c)(4) must be demonstrated by the following evaluations:

The evaluation must consider the loading condition in combination with the minimum internal pressure.

The greatest possible pressure difference between the inside and outside of the containment components must be evaluated.

The possibility of buckling must be evaluated.

The containment/confinement boundary must be evaluated for the load combinations specified in Section 6.5.2.6.10(a), and Table 6-6.

7.3.1.2.2(h)(5) Vibration. Adequacy of the package under the effects of vibration normally incident to transport tests as specified in Section 6.5.2.5.1(c)(5) must be demonstrated by the following evaluations:

Fatigue must be evaluated at highly stressed components, considering the combined stresses due to vibration, temperature, and pressure loads.

If the closure bolts are reused, the bolts must be evaluated for fatigue and the bolt preload must be included.

Evaluations must include a demonstration that resonant vibration conditions, which may cause rapid fatigue damage, are not present in the package components.

The effects of package internal components and contents must be considered in the evaluations.

The containment/confinement boundary must be evaluated for the load combinations specified in Section 6.5.2.6.10(a), and Table 6-6.

Guidance for vibrational loading parameters is provided in ANSI N14.23 and ASTM D4169.

7.3.1.2.2(h)(6) Water Spray. Adequacy of the package under the effects of water spray test as specified in Section 6.5.2.5.1(c)(6) must be demonstrated by evaluating the effects on the material properties of the package.

7.3.1.2.2(h)(7) Free Drop. Adequacy of the package under the effects of the free drop tests as specified in Section 6.5.2.5.1(c)(7) must be demonstrated by the following evaluations:

Design of the package must be evaluated for the structural response for the specified free drop height in combination with internal pressure, thermal stress, and residual stresses.

The closure system design with the combined effects of the free drop impact force, internal pressure, thermal stress, residual stress, O-ring compression force, and bolt preload must be evaluated.

Other important components (such as the port-cover, port-cover plates, and shielding enclosures) must be demonstrated not to decrease in effectiveness when subjected to the combination of impact force, internal pressure, residual stress, and thermal stress.

The containment/confinement boundary must be evaluated for the load combinations specified in Section 6.5.2.6.10(a), and Table 6-6.

The closure system design seals must be demonstrated not to decompress from bolt stretch or flange deflection to the extent that containment/confinement is lost under the combined loadings.

7.3.1.2.2(h)(8) Compression. Adequacy of the package under the effects of the compression test as specified in Section 6.5.2.5.1(c)(8) must be demonstrated by evaluating the structural response of the package to the static loads specified.

7.3.1.2.2(h)(9) Penetration. Adequacy of the package under the effects of the penetration test as specified in Section 6.5.2.5.1(c)(9) must be demonstrated by evaluating the effects of the package at most the vulnerable location.

7.3.1.2.2(i) Structural Evaluation of AC. Evaluation of the package under AC is based on the sequential application of tests and conditions specified in Section 6.5.2.5.2, in the order indicated, to determine their cumulative effect on the package. The evaluation of the ability of a package to withstand any one of these tests must consider the damage that resulted from the previous test. In addition, the NC tests must not affect the package's ability to withstand the AC tests. Under these test conditions, the ambient air temperature before and after the test must remain constant as specified in Sections 6.5.2.5.1(c)(1) and 6.5.2.5.1(c)(2), which is the most unfavorable for the feature being evaluated. The initial internal pressure on the containment components must be considered to be the MNOP, unless a lower internal pressure consistent with the selected ambient temperature is more severe.

The evaluation must demonstrate the package has sufficient structural integrity to maintain containment/confinement, shielding, and subcriticality under the AC specified. Results of this evaluation must also be considered for the following areas:

Deformation of shielding components must be included in the shielding evaluation.

Deformation of components required for heat transfer must be included in the thermal evaluation.

Deformation of components required for subcriticality must be included in the criticality evaluation.

7.3.1.2.2(i)(1) Free Drop. In demonstrating the adequacy of the package under the effects of the free drop tests as specified in Section 6.5.2.5.2(c)(1), the following must be included:

The free drop orientation that causes the most severe damage, including center of gravity over corner, oblique orientation with secondary impact, side drop, and free drop onto the closure must be evaluated.

It must be noted that the most damaging orientation for one component may not be the most damaging orientation for another component.

When a feature such as a tiedown component is a structural part of the package, it must be included in the selection of the free drop test configuration and the free drop orientation.

For a package with lead shielding, the effects of lead slump must be evaluated. The lead slump determined must be consistent with that used in the shielding evaluation.

7.3.1.2.2(i)(2) Crush. When required, the adequacy of the package under the effects of the dynamic crush test as specified in Section 6.5.2.5.2(c)(2) must be demonstrated by evaluating the structural response of the package to the loads specified. The package must have been previously subjected to the free drop test.

7.3.1.2.2(i)(3) Puncture. In demonstrating adequacy of the package under the effects of the puncture tests as specified in Section 6.5.2.5.2(c)(3), the following must be included:

Position for which maximum damage would be expected must be evaluated.

Any damage from the free drop and crush conditions must be considered.

Punctures at oblique angles, near a support, at a valve, and at a penetration must be considered.

7.3.1.2.2(i)(4) Thermal. In demonstrating the adequacy of the package under the effects of the fully engulfing fire thermal test as specified in Section 6.5.2.5.2(c)(4), the following must be included:

Any damage resulting from the free drop, crush, and puncture conditions must be incorporated into the initial conditions of the package for the fire test.

Determination of the maximum pressure in the package during and after the test considers the temperature resulting from the fire and any increase in gas inventory caused by combustion, radiolysis, or other decomposition processes.)

Evaluate maximum thermal stresses that can occur either during or after the fire.

7.3.1.2.2(i)(5) Immersion-Fissile Material. When water in-leakage is not assumed in the criticality evaluation, the adequacy of the package under the effects of immersion for fissile material packages as specified in Section 6.5.2.5.2(c)(5) must be demonstrated by evaluating the package for in-leakage of water. A water head of 0.9 m (3 ft) in the orientation that maximum leakage is expected must be applied to the package.

7.3.1.2.2(i)(6) Immersion-All Packages. In demonstrating the adequacy of the package under the effects of the immersion tests as specified in Section 6.5.2.5.2(c)(6), the following must be included:

An undamaged specimen must be subjected to a water pressure equivalent to immersion under a head of water of at least 15 m (50 ft). This is equivalent to an external pressure of 150 kPa (21.7 psig).

The evaluation must consider the loading condition in combination with the minimum internal pressure.

The greatest possible pressure difference between the inside and outside of the containment components must be evaluated.

The possibility of buckling must be evaluated.

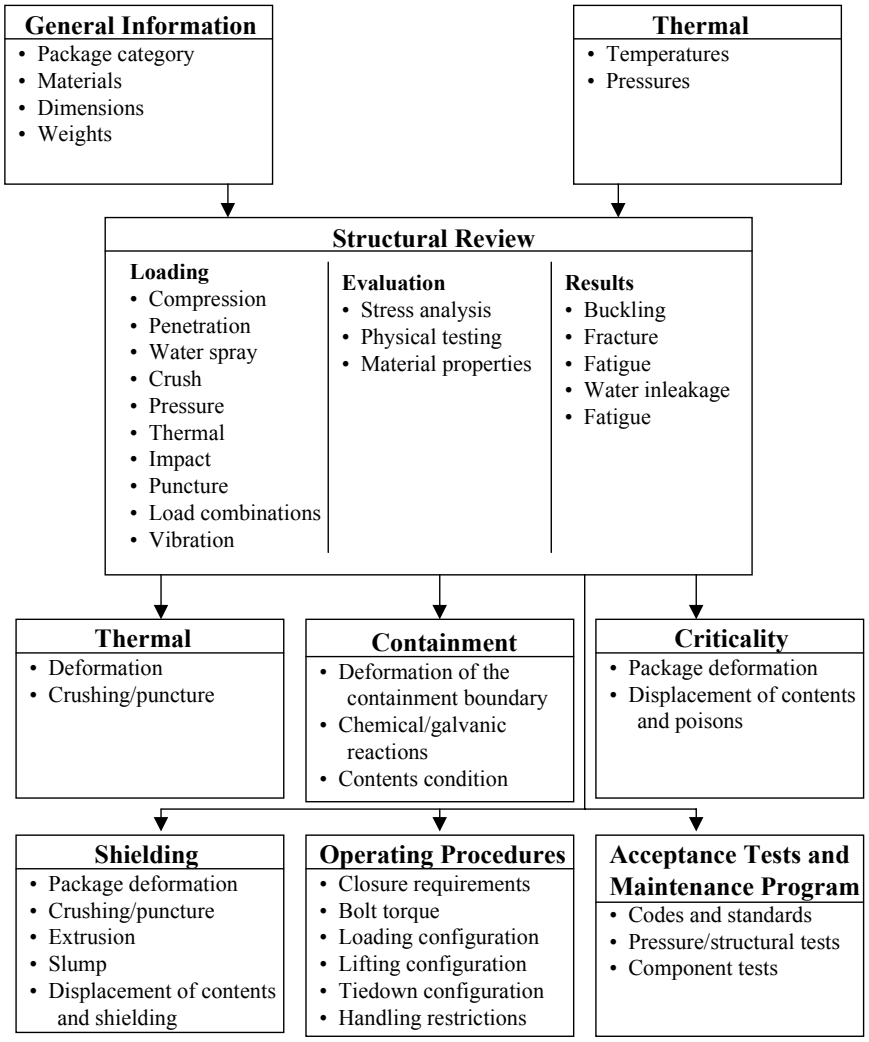
7.3.1.2.2(j) Evaluation Procedures. Structural evaluation of a package is based in part on the description and evaluations presented in the general information and thermal evaluation sections. In addition, results of the structural evaluation are considered in the evaluation of all other sections. As an aid to the user, an information flow diagram for the structural evaluation is presented in Figure 7-1.

7.3.1.2.3 Thermal Evaluation.

This section outlines elements that are to be addressed in an onsite PSSD to demonstrate acceptable thermal performance based on performance tests defined in Section 6.5.2.5. The section also defines the acceptable performance criteria for testing and/or analysis to be applied to demonstrate the package provides an equivalent degree of safety to the regulations in maintaining containment, subcriticality, and shielding. It should be noted that in any onsite PSSD, claims of adequacy of designs or design methods must be supported by technical bases; i.e., by an appropriate engineering evaluation or description of actual tests.

The package shall be evaluated for all NC thermal evaluation events -- heat, cold, reduced external pressure, and increased external pressure -- by either testing or analysis. These tests do not need to be performed in a specific sequence. The package shall also be evaluated for the AC thermal condition (fire) by either testing or analysis, and must be preceded by the free drop, crush (when applicable), and puncture performance tests.

Figure 7-1. Structural Evaluation Flow Diagram.



7.3.1.2.3(a) Description of Thermal Design.

7.3.1.2.3(a)(1) Design Features. Design features that are important to the thermal performance include the following:

Package geometry and materials of construction.

Structural and mechanical features that may affect heat transfer, such as cooling fins, insulating materials, surface conditions of the package components, and gaps or physical contacts between internal components.

7.3.1.2.3(a)(2) Contents Decay Heat. The decay heat will be determined from the maximum allowed radioactive contents.

7.3.1.2.3(a)(3) Summary Tables of Temperatures. Summary tables of the maximum or minimum temperatures that affect structural integrity, containment, shielding, and criticality will be presented for both NC and AC. For fire test conditions, the tables will also include the following:

Maximum temperatures and the time at which they occur after fire initiation
Maximum temperatures of the post-fire steady-state condition.

The temperatures will be consistent with the structural evaluation (7.3.1.2.2) and containment/confinement (7.3.1.2.4) sections.

7.3.1.2.3(a)(4) Summary Tables of Maximum Pressures in the Containment System. The summary tables will include the MNOP and the maximum pressure under AC. These pressures will be consistent with those in the general information (7.3.1.1.1), structural evaluation (7.3.1.2.2), containment/confinement (7.3.1.2.4), and acceptance tests and maintenance program (7.3.1.2.11) sections.

7.3.1.2.3(b) Material Properties and Component Specification.

7.3.1.2.3(b)(1) Material Properties. Appropriate thermal properties will be specified for materials that affect heat transfer both within the package and from the package to the environment. These materials include any liquids or gases within the package and gases external to the package for AC.

Thermal absorptivities and emissivities must be appropriate for the package surface conditions and each thermal condition being evaluated. If a property is reported as a single value, this value must bound the equivalent temperature-dependent property.

7.3.1.2.3(b)(2) Component Specifications.

Maximum allowable service temperatures or pressures will be specified for each package component, as appropriate.

Minimum allowable service temperature of all the package components will be less than or equal to -33°C (-27 °F).

Technical specifications for applicable package components (such as pressure relief valves and fusible plugs) will be provided.

7.3.1.2.3(c) General Considerations.

Thermal evaluation of the package design can be performed by analysis or testing, or by a combination of both.

A packaging may be tested or evaluated in accordance with the requirements of Chapter 6.0 or the regulations.

Because Chapter 6.0 provides an equivalent degree of safety to the regulations, the performance test conditions and parameters are not interchangeable. In other words, the package is either analyzed or tested to the test conditions and parameters of Chapter 6.0 or the regulations, not a combination of the two.

Testing of the package will be conducted, as a minimum, in accordance with performance test conditions defined in Chapter 6.0.

7.3.1.2.3(c)(1) Evaluation by Test. For evaluation by testing, the test package, test facility, and test procedures must be described in detail. An approved QAP must be in place for the fabrication of the test package, operation of the test facility, and the gathering and evaluation of the test data. To ensure adequate prototypical testing in accordance with the performance test conditions set forth in Chapter 6.0 or the regulations:

Thermal performance of the test package, including simulated contents, test instrumentation, and attachment hardware, will be representative of the actual package design.

Temperature-sensing instrumentation will be located to measure the maximum temperature of critical package components and to characterize the significant heat transfer pathways.

Test instrumentation will be mounted at locations that minimize their effects on local test temperatures.

The pre-fire condition for testing will be the maximum NC steady-state temperature.

For performance tests, quenching and fire suppression of the AC fire will be initiated after a minimum fire duration of 30 minutes.

Test results, as a minimum, will include the following:

Initial conditions (e.g., temperature, pressure) and changes in the package resulting from structural tests.

Maximum steady-state temperatures and pressures (e.g., pre-fire conditions).

Maximum temperature and pressure during the fire and post-fire periods.

Physical changes in the package condition resulting from the test, such as changes in packaging material properties caused by combustion or melting of packaging components.

Conditions, such as ambient temperature, decay heat, and packaging absorptivity and emissivity, may not be exactly represented in thermal testing. Corrections or evaluations to account for these differences must be provided in the safety assessment report. For

example, a thermal evaluation must be provided to correct for temperature if the ambient temperature at the onset of the fire test is lower than 46 °C (115 °F).

7.3.1.2.3(c)(2) Evaluation by Analysis. If the package performance is demonstrated by analysis, the onsite PSSD must include the following:

The methods used are properly referenced or developed, and correctly applied.

Assumptions in modeling heat sources and heat transfer paths and modes must be clearly stated and justified.

The appropriate thermal properties for the package materials are correctly incorporated.

The evaluation considers changes in package geometry and material properties resulting from structural and thermal tests under NC and AC.

The required temperature and thermal boundary conditions for NC and AC are applied correctly.

The time interval after the fire test is adequate to ensure the maximum component temperatures and post-fire steady-state temperature has been achieved.

The maximum temperature and pressure of each component do not exceed their allowable values.

Combustion of the package components is considered, including the heat produced.

Thermal evaluation should assume the heat transfer medium is air, and effects of air on the contents and packaging components (e.g., oxidation of depleted uranium shielding) should be addressed.

If analysis is chosen in lieu of testing, the analysis will demonstrate satisfactory performance of the package to the performance test conditions defined in Chapter 6.0. The analysis performed will meet the following requirements:

Computer numerical simulations of package performance under the specified test conditions will have been benchmarked and properly documented.

Thermal quenching will be applied 30 minutes after initiation of the fully engulfing fire.

Combustion of package components will be accounted for in the evaluation, including the heat produced.

The thermal evaluation will assume that the heat transfer medium is air, and the effects of air on the contents and packaging components (e.g., oxidation) must be addressed.

7.3.1.2.3(c)(3) Acceptance Criteria for Evaluation by Analysis.

Under NC, structural integrity and safe performance of the package will demonstrate that the package maintains containment, shielding, and subcriticality for the specified performance tests.

In addition, packages will be demonstrated to maintain an exterior packaging temperature of 50 °C (122 °F) for nonexclusive use and 85 °C (185 °F) for exclusive use shipments under the hot extremes of Hanford Site conditions in the shade.

Maximum seal and shielding material temperatures will be demonstrated to be below the rated maximum continuous use temperature of the material for NC.

Also, component material temperatures will be demonstrated to be above the rated minimum continuous use temperature of the material for NC.

Maximum normal pressures and temperatures will be established for key packaging components and will be consistent with the pressures and material temperatures used in the structural section.

Structural integrity and safe performance of the package is demonstrated by evaluating the cumulative damage from the previous AC free drop, crush (when applicable), and puncture loads combined with the thermal stresses, pressure, and differential thermal expansion loadings from the fire. This evaluation is to be provided in the structural section.

Maximum accident pressures and temperatures will be established for key packaging components and will be consistent with the pressures and material temperatures used in the structural section. In the case of the package closure mechanisms, such as bolts, the cumulative strains from the entire sequence of accident loads will be evaluated to demonstrate that containment is maintained.

Under fire conditions, the limiting value to demonstrate containment by the primary seals is based on the manufacturers stated high temperature operation and duration being below the maximum fire accident temperature and duration at the seal.

Maintenance of package shielding and criticality control will be demonstrated by the ability of the package to maintain structural integrity and effectiveness under accident loading conditions after the sequence of accidents specified in Chapter 6.0.

As an example, lead-shielding effectiveness will be demonstrated in this section, as well as the structural and shielding sections, by demonstrating no loss of shielding effectiveness from lead slump resulting from the sequence of accident loads.

7.3.1.2.3(c)(4) Margins of Safety.

Margins of safety must be established for temperature, pressure, and thermal stresses for all packaging components important to safety.

In establishing the margins of safety, the evaluation of package performance must address the effects of uncertainties in thermal properties, test conditions, diagnostics, and analytical methods.

If package performance is assessed by testing, it must be demonstrated that the test results are reliable and repeatable.

7.3.1.2.3(c)(5) Thermal Evaluation under NC. The thermal evaluation should demonstrate that the tests for NC do not result in significant reduction in packaging effectiveness, including the following:

Degradation of the heat-transfer capability of the packaging (such as creation of new gaps between components).

Changes in material conditions or properties (e.g., expansion, contraction, gas generation, and thermal stresses) that affect the structural performance.

Changes in the package that affect containment, shielding, or criticality such as thermal decomposition or melting of materials.

Ability of the packaging to withstand the tests under NC.

It will be verified that the component temperatures and pressures do not exceed their allowable values.

7.3.1.2.3(c)(5)(i) Heat.

The Hanford Site extreme hot temperature is 46 °C (115 °F).

The maximum allowable package external temperature in the shade is 85 °C (185 °F) for exclusive use and 50 °C (122 °F) for nonexclusive use shipments.

7.3.1.2.3(c)(5)(ii) Cold. The Hanford Site cold temperature extreme is -33 °C (-27 °F).

7.3.1.2.3(c)(5)(iii) MNOP. The MNOP shall be determined when the package has been subjected to the steady-state heat condition. The MNOP calculation will consider all possible sources of gases such as the following:

Gases initially present in the package.

Saturated vapor, including water vapor from the contents or packaging.

Helium from the radioactive decay of the contents.

Hydrogen or other gases resulting from chemical reaction or thermal- or radiation-induced decomposition of materials such as water or organics.

7.3.1.2.3(c)(5)(iv) Hydrogen or other flammable gases comprising greater than 5% by volume of the total gas inventory within any confined volume will be evaluated.

7.3.1.2.3(c)(5)(v) Evaluation of the effects of flammable gas contents will include deflagration, deflagration to detonation transition, and the resultant pressures as described in the gas generation section.

7.3.1.2.3(c)(5)(vi) Thermal stresses that are caused by constrained interfaces among package components resulting from temperature gradients and different thermal expansions will be evaluated. The evaluation will include thermal stresses as well as cyclic stresses during the service life of the package.

7.3.1.2.3(d) Thermal Evaluation under AC.

7.3.1.2.3(d)(1) Initial Conditions. Prior to the fire test, the package design should be evaluated for the effects of the drop, crush (if applicable), and puncture tests. The initial physical condition of the package design used in the thermal evaluation should consider these effects. The most unfavorable conditions will be used:

An ambient temperature between –27 °C and 115 °C (-16 °F and 239 °F).

An internal pressure of the package equal to the MNOP unless a lower internal pressure, consistent with the ambient temperature, is less favorable.

Contents at its maximum decay heat unless a lower heat, consistent with the temperature and pressure, is less favorable.

The initial steady-state temperature distribution should be consistent with the thermal evaluation under NC.

7.3.1.2.3(d)(2) Thermal Performance Test. The following conditions should be met for the thermal performance test:

The package will be fully engulfed in a fire with an average emissivity coefficient of at least 0.9, with an average flame temperature of at least 800 °C (1,475 °F) for a period of 30 minutes.

The fuel source must extend horizontally at least 1 m (40 in.), but may not extend more than 3 m (10 ft) beyond any external surface of the package.

The package must be positioned 1 m (40 in.) above the surface of the fuel source.

For purposes of calculation, the surface absorptivity coefficient must be the value that the package may be expected to possess when exposed to the fire specified, and the

convective coefficient must be that value which may be demonstrated to exist if the package were exposed to the fire specified.

Artificial cooling (quenching) may be applied 30 minutes after the initiation of the fire.

Thermal insolation must be applied before and after the fire.

7.3.1.2.3(d)(3) Maximum Temperature and Pressure.

The evaluation will appropriately determine both the transient peak temperatures of the package components as a function of time after the fire, and the maximum temperatures from the post-fire, steady-state condition.

The lead shielding will not reach melting temperature.

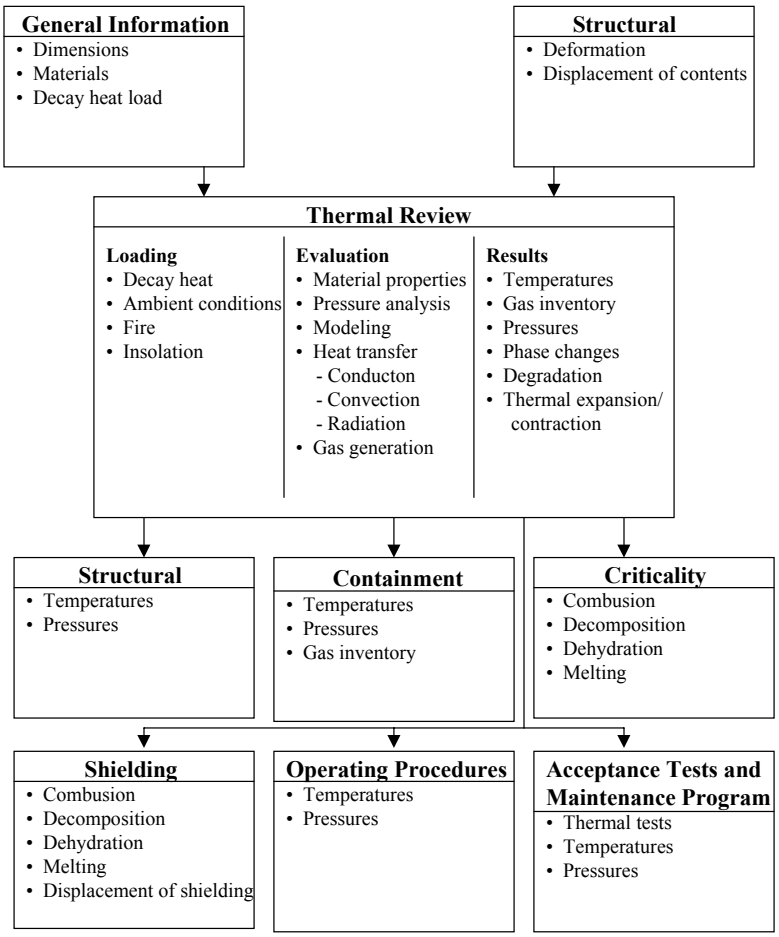
The evaluation of the maximum pressure in the package design will be based on the MNOP as it is affected by fire-caused increases in package component temperatures.

Possible increases in the gas inventory, caused by fire-induced thermal combustion or decomposition processes, will be accounted for in the pressure determination and in the gas generation section.

7.3.1.2.3(d)(4) Maximum Thermal Stresses. There will be an evaluation of the thermal stresses caused by constrained interfaces among the package components resulting from temperature gradients and differential thermal expansions.

7.3.1.2.3(e) Evaluation Procedures. The thermal evaluation of a package is based in part on the description and evaluations presented in the general information (3.1.1.1) and the structural evaluation (3.1.2.2) sections. In addition, results of the thermal evaluation are considered in the evaluation of all other sections. As an aid to the user, an information flow diagram for the thermal evaluation is presented in Figure 7-2.

Figure 7-2. Thermal Evaluation Flow Diagram.



7.3.1.2.4 Containment/Confinement Evaluation.

This section outlines the elements that are to be addressed for an onsite PSSD to demonstrate acceptable containment/confinement performance based on the performance tests defined in Section 6.5.2.5 and containment/confinement requirements of Section 6.5.2.6. The section also defines the acceptable performance criteria for testing and/or analysis to be applied to demonstrate the package provides an equivalent degree of safety to the regulations in maintaining containment/confinement, subcriticality, and shielding. It should be noted that in any onsite PSSD, claims of adequacy of designs, or design methods must be supported by technical bases; i.e., by an appropriate engineering evaluation or description of actual tests.

7.3.1.2.4(a) Description of Containment/Confinement System. The following information must be provided in the containment/confinement system description of the packaging.

7.3.1.2.4(a)(1) The exact containment/confinement boundary must be defined. This includes the containment/confinement vessel, welds, seals, lids, cover plates, valves, and other closure devices. In the case of filtered confinement system packages, containment/confinement components such as the vessel, closure lid, filter housing, and seals must be defined as the containment/confinement boundary.

7.3.1.2.4(a)(2) All components of the containment/confinement boundary must be shown and specified on the drawings.

7.3.1.2.4(a)(3) The following information provided on the containment/confinement boundary must be consistent with that provided in the structural and thermal evaluations:

Material of construction
Welds
Applicable codes and standards (e.g., ASME BPVC code specifications for the vessel)
Bolt torques required to maintain positive closure
Maximum and minimum allowable temperatures of components, including seals
Maximum and minimum temperatures of components under the tests for NCs and ACs.

7.3.1.2.4(a)(4) All containment/confinement boundary penetrations and their method of closure must be adequately described.

7.3.1.2.4(a)(5) Performance specifications for components such as filters, valves, and pressure relief devices must be identified.

7.3.1.2.4(a)(6) If penetration into the containment/confinement boundary are closed by two seals (e.g., to enable leak testing), the containment/confinement boundary component seal must be defined.

7.3.1.2.4(a)(7) The radionuclides and physical form of the contents must be provided and consistent with Section 3.1.2.1. Any significant daughter products must be provided.

7.3.1.2.4(a)(8) The constituents of the releasable source term, including radioactive gases, liquids, and powdered aerosols must be identified and described.

7.3.1.2.4(b) General Requirements.

7.3.1.2.4(b)(1) Acceptable performance can be demonstrated either by testing or analytically.

7.3.1.2.4(b)(2) The package must be demonstrated to satisfy the quantified release rates specified in Sections 6.5.2.6.8 and 6.5.2.6.9.

7.3.1.2.4(b)(3) The maximum permissible volumetric leakage rates based on the allowed release rates specified in Sections 6.5.2.6.8 and 6.5.2.6.9 must be determined for both NC and AC. ANSI N14.5 provides an acceptable method for this determination.

7.3.1.2.4(b)(4) The volumetric leakage rates must be converted to standard air leakage in accordance with ANSI N14.5.

7.3.1.2.4(b)(5) The evaluation of any combustible gas generation is to be performed in accordance with Section 3.1.2.7, Gas Generation.

7.3.1.2.4(c) Acceptance Criteria. The package design must be demonstrated to meet the release requirements specified in Sections 6.5.2.6.8 and 6.5.2.6.9 for both filtered and sealed packages. The package must be demonstrated to satisfy the following requirements:
7.3.1.2.4(c)(1) Any filters and valves (except pressure relief valves) on the package must be demonstrated to be protected against unauthorized operation.

7.3.1.2.4(c)(2) For filtered packages, the filter must be demonstrated to meet the requirements of Section 6.5.2.6.1(h). The filters must also be demonstrated to maintain confinement effectiveness under both NC and AC.

7.3.1.2.4(c)(3) Cover plates and lids must be demonstrated to be protected by recessing or other methods.

7.3.1.2.4(c)(4) All containment seals and penetrations, including drain and vent ports, must be demonstrated to be leak testable. If fill, drain, or test ports utilize quick-disconnect valves they will be demonstrated not to preclude leak testing of the containment seals.

7.3.1.2.4(c)(5) Demonstrate no galvanic, chemical, or other reactions will occur between the seal and the packaging or its contents, and that the seal will not degrade due to irradiation.

7.3.1.2.4(c)(6) Demonstrate that the proper dimensions of the seal grooves are specified for the type and size of seal specified.

7.3.1.2.4(c)(7) Demonstrate that the temperature of the containment boundary component seals will remain within their specified allowable limits under both NC and AC.

7.3.1.2.4(c)(8) Demonstrate that the containment system components are securely closed by a positive fastening device that cannot be opened unintentionally or by a pressure that may arise within the package.

7.3.1.2.4(c)(9) If less than 100% of the contents are considered releasable a justification for the lower fraction must be provided.

7.3.1.2.4(c)(10) Elastomeric seal compression must be maintained under both NC and AC loading conditions so as to prevent a permanent compression set of the elastomeric material.

7.3.1.2.4(c)(11) The containment/confinement system must be demonstrated to satisfy the requirements of Section 6.5.2.6.10.

7.3.1.2.4(c)(12) For packages equipped with filters, the total release rate must be demonstrated to be with the limits specified in Sections 6.5.2.6.8 and 6.5.2.6.9.

This includes accounting for the leakage rate from the containment components of the confinement system.

7.3.1.2.4(d) Containment under NCs.

7.3.1.2.4(d)(1) The package must be demonstrated to satisfy the allowable release rate requirements specified in Section 6.5.2.6.8.

7.3.1.2.4(d)(2) The MNOP and maximum temperature must be consistent with those determined in Sections 3.1.2.2, 3.1.2.3, and 3.1.2.7.

7.3.1.2.4(d)(3) Using the above pressure and temperature, the maximum permissible leakage rate must be converted to the reference air leakage rate in standard cubic centimeters per second (std cc/s), as defined in ANSI N14.5.

7.3.1.2.4(d)(4) If compliance is demonstrated by testing, the leakage rate of the package subjected to the tests specified in Section 6.5.2.5.1 must not exceed the maximum allowable leakage rate for NC. Leakage testing of scale-model package may be applicable, but is not necessarily sufficient demonstration of compliance.

7.3.1.2.4(d)(5) If compliance is demonstrated by analysis, it must be demonstrated that the package containment boundary components, seal regions, and closure bolts do not undergo any deformations that could result in a breach of the containment boundary or loss of elastomeric seal compression of less than 0.018 cm (0.007 in.). In addition, the materials of the containment/confinement system must be demonstrated not to exceed their maximum allowable temperature limits when subjected to the conditions specified in Section 6.5.2.5.1.

7.3.1.2.4(d)(6) As specified in Section 3.1.2.11, a leak test must be performed during acceptance testing to demonstrate that the package meets the maximum allowable leakage rate.

7.3.1.2.4(d)(7) The amount of decompression of the seal, when subjected to the conditions specified in Section 6.5.2.5.1 must be determined and must be sufficient to maintain containment of the contents.

7.3.1.2.4(e) Containment under ACs.

7.3.1.2.4(e)(1) The packaging must be demonstrated to satisfy the allowable release rate requirements specified in Section 6.5.2.6.9.

7.3.1.2.4(e)(2) The temperatures, pressures, and physical conditions of the package (including contents) must be consistent with those determined in Sections 3.1.2.2, 3.1.2.3, and 3.1.2.7.

7.3.1.2.4(e)(3) Using the above pressure and temperature, the maximum permissible leakage rate must be converted to the air leakage rate in standard cubic centimeters per second (std cc/s), as defined in ANSI N14.5.

7.3.1.2.4(e)(4) If compliance is demonstrated by testing, the leakage rate of the package subjected to the tests specified in Section 6.5.2.5.2 must not exceed the maximum allowable leakage rate for AC. Leakage testing of scale-model package may be applicable, but is not necessarily sufficient demonstration of compliance.

7.3.1.2.4(e)(5) If compliance is demonstrated by analysis, it must be demonstrated that the package containment boundary components, seal regions, and closure bolts do not undergo any deformations that could result in a breach of the containment boundary or loss of elastomeric seal compression of less than 0.018 cm (0.007 in.). In addition, the materials of the containment/confinement system must be demonstrated not to exceed their maximum allowable temperature limits when subjected to the conditions specified in Section 6.5.2.5.2.

7.3.1.2.4(e)(6) The amount of decompression of the seal when subjected to the conditions specified in Section 6.5.2.5.2 must be determined and must be sufficient to maintain containment of the contents.

7.3.1.2.4(f) Leakage Rate Tests.

7.3.1.2.4(f)(1) Based on the reference air leakage rate, it will be demonstrated by providing data that the allowable leakage rate for the following conditions is determined in accordance with ANSI N14.5:

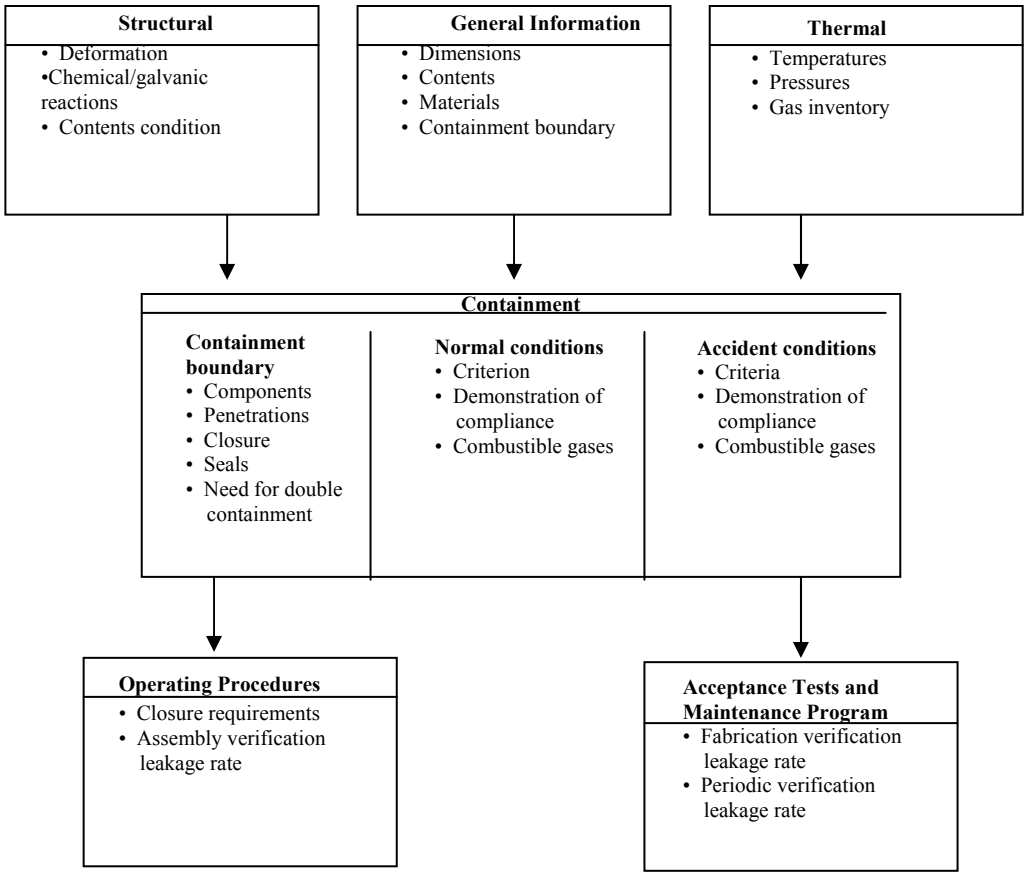
Fabrication leakage rate test
Periodic leakage rate tests
Assembly (pre-shipment) leakage rate tests.

7.3.1.2.4(f)(2) The fabrication and periodic leakage rate tests must be included in Section 7.3.1.2.11.

7.3.1.2.4(f)(3) The pre-shipment leakage rate test for assembly verification must be included in Section 7.3.1.2.11.

7.3.1.2.4(g) Evaluation Procedures. The containment/confinement evaluation of a package is based in part on the description and evaluations presented in the general information and the structural, thermal, and gas generation evaluations. In addition, results of the containment/ confinement evaluation are considered in the evaluation of all other sections. As an aid to the user, an information flow diagram for the containment/confinement evaluation is presented in Figure 7-3.

Figure 7-3. Containment/Confinement Evaluation Flow Diagram.



7.3.1.2.5 Shielding Evaluation.

7.3.1.2.5(a) Chapter 6.0 Requirements. This section outlines the elements that are to be addressed for an onsite PSSD to demonstrate shielding performance.

7.3.1.2.5(b) Description of Shielding System Design. The description of the shielding system design will include the following:

Dimensions, tolerances, and densities of material for neutron or gamma shielding, including those packaging components considered in the shielding evaluation.

Mass density, atomic density, or a real density of materials used as neutron absorbers.

Structural components that maintain the contents in a fixed position within the package.

Dimensions of the transport vehicle that are to be considered in the evaluation.

Maximum dose rates shall be presented for NC and AC at the appropriate locations. If the package is designed for multiple types of contents, the contents producing the highest external dose rate at each location will be clearly identified and evaluated.

7.3.1.2.5(c) Radiation Source.

7.3.1.2.5(c)(1) Gamma Source. The maximum gamma source strength and spectra will be calculated in the evaluation. The source contribution from radioactive daughter products will be accounted for. The production of secondary gamma reactions (e.g., from [n, γ] reactions in the shield material) will also be included in the source term.

7.3.1.2.5(c)(2) Neutron Source. The calculation for the neutron source will consider both spontaneous fission and (α,n) reactions, as appropriate. If either of these source contributions is considered negligible, an appropriate justification will be provided. The production of neutrons from subcritical multiplication will be calculated as part of the evaluation or otherwise appropriately included in the source term. The contribution from spontaneous fission and (α,n) will be separately identified, along with the actinides or light nuclei that are significant for these processes.

7.3.1.2.5(d) Shielding Model. If the contents of the package can be positioned at varying locations or with varying densities, the location and physical properties of the contents used in the evaluation will be those resulting in the maximum external radiation levels. Any changes in configuration (e.g., displacement of source or shielding, reduction in shielding) that result under NC or AC will be included, as appropriate.

7.3.1.2.5(d)(1) Material Properties. The appropriate material properties (e.g., mass densities and atom densities) will be used in the shielding models of the packaging, contents, and conveyance (if applicable). Any changes resulting under NC and AC will be included as appropriate. For example, the melting of lead is not acceptable under either NC or AC. Shielding properties will not degrade during the service life of the packaging (e.g., degradation of foam or dehydration of hydrogenous materials).

If the shielding model considers a homogeneous source region, rather than a detailed heterogeneous model of the contents, the approach will be justified. It will also be verified that the homogenized mass densities are correct for NC and AC.

7.3.1.2.5(e) Shielding Evaluation.

7.3.1.2.5(e)(1) Methods. The methods used for the shielding evaluation will be appropriate. Standard computer programs used will be referenced and evidence

of verification and benchmarking shall be provided. Other codes or methods will be described in the document, and the appropriate supplemental information shall be provided. The number of dimensions of the code will be appropriate for the package geometry.

The cross-section library used by the code will be applicable for the shielding calculations. The code will account for subcritical multiplication and secondary gamma production unless these conditions have been considered elsewhere (e.g., in the source term specification).

7.3.1.2.5(e)(2) Input and Output Data. Key input data for the shielding calculations will be identified. The key input data depend on the type of code, as well as the code itself. The document will include representative input files used in the analyses.

Representative output files will be included in the PSSD. The calculated dose rates from the output files will agree with those called out in the text. For computer programs that are based on the Monte Carlo method, proper convergence will be achieved.

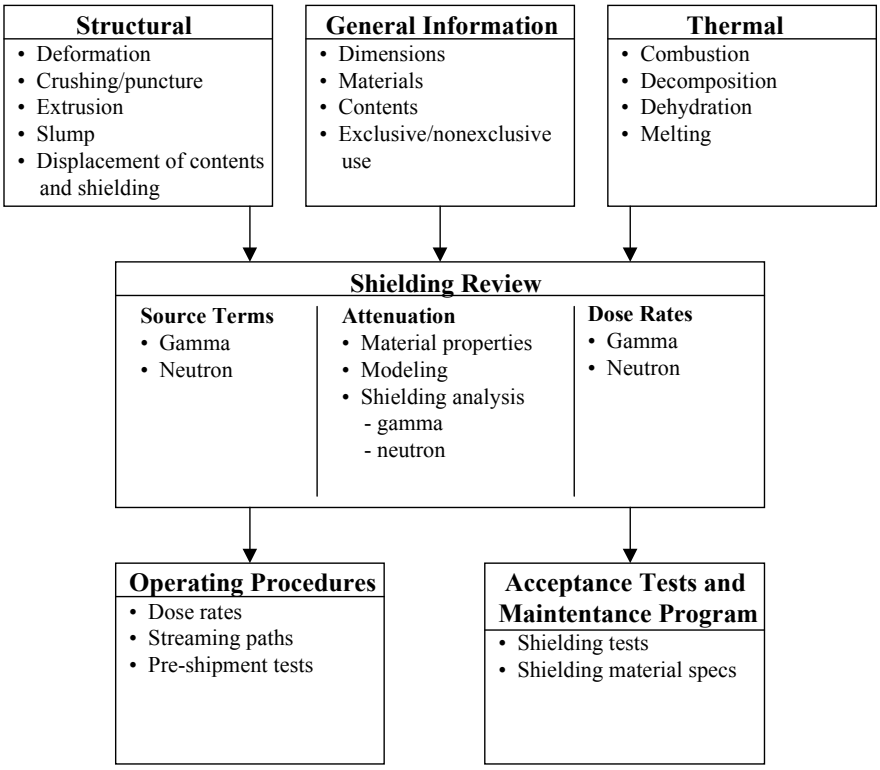
7.3.1.2.5(e)(3) Flux to Dose Rate Conversion. Gamma and neutron flux will be properly converted to dose rates. This conversion should generally use ANSI/ANS 6.1.1-1977, "Neutron and Gamma-Ray Flux-to-Dose-Rate Factors," although other conversions may be used for point-kernel gamma calculations. Note that use of the conversions in ANSI/ANS 6.1.1-1991 can result in a significant underestimation of external dose rates. Additionally, the dose rates determined with the 1991 standard do not correspond physically to dose rates measured by typical radiation monitoring instruments.

7.3.1.2.5(e)(4) External Radiation Levels. External radiation levels under NC and AC will meet the appropriate limits. The analyses will show the locations selected are those with the maximum dose rates. To determine maximum dose rates, radiation levels may be averaged over the cross-sectional area of a probe of reasonable size. For packages with streaming paths or voids, averaging should not be used to reduce the radiation levels resulting from such features.

The evaluation will address damage to the shielding under NC and AC. Any damage under NC will not exceed allowable limits. Any increase will be explained and justified as not significant.

7.3.1.2.5(e)(5) Evaluation Procedures. The shielding evaluation of a package is based in part on the description and evaluations presented in paragraph 3.1.2.5(e). In addition, results of the shielding evaluation are considered in the evaluation of all other sections. As an aid to the user, an information flow diagram for the shielding evaluation is presented in Figure 7-4.

Figure 7-4. Shielding Evaluation Flow Diagram.



7.3.1.2.6 Criticality Evaluation.

7.3.1.2.6(a) Equivalent and Risk based Packaging Requirements. A package used for the shipment of fissile material must be designed and constructed, and its contents limited so that it would be subcritical if water were to leak into the containment system, or liquid contents were to leak out of the containment system. Consequently, the contents shall be demonstrated to remain subcritical under the following conditions:

1. The most reactive credible configuration consistent with the chemical and physical form of the material.

2. Moderation by water to the most reactive credible extent.

Close full reflection of the containment system by water on all sides, or such greater reflection of the containment system as may additionally be provided by the surrounding material of the packaging.

A package that is used for the shipment of fissile material will be demonstrated to remain subcritical under NC by demonstrating that:

1. The contents will be subcritical.

2. The geometric form of the package contents will not be substantially altered.

3. There will be no leakage of water into the containment system unless, in the evaluation of undamaged packages, it has been assumed that moderation is present to such an extent as to cause maximum reactivity consistent with the chemical and physical form of the material.

4. There will be no substantial reduction in the effectiveness of the packaging including:

No more than 5% reduction in the total effective volume of the packaging on which nuclear safety is assessed.

No more than 5% reduction in the effective spacing between the fissile contents and the outer surface of the packaging.

No occurrence of an aperture in the outer surface of the packaging large enough to permit the entry of a 10 cm (4-in.) cube.

A package that is used for the shipment of fissile material will be demonstrated to remain subcritical under AC. To demonstrate this, the following assumptions will be made:

1. The fissile material is in the most reactive credible configuration consistent with the damaged condition of the package, and the chemical and physical form of the contents.

2. Water moderation occurs to the most reactive credible extent consistent with the damaged condition of the package, and the chemical and physical form of the contents.

3. There is full reflection by water on all sides, as close as is consistent with the damaged condition of the package.

A fissile material package must be controlled by the shipper or the carrier during transport to ensure that the array of packages remains subcritical. To verify this control, the fissile material package will be demonstrated to have a number “N” based on the following conditions being satisfied, assuming the packages are stacked together in any arrangement and with close full reflection on all sides of the stack by water:

1. Five times "N" undamaged packages with nothing between the packages would be subcritical.

2. Two times "N" damaged packages, if each package were subjected to the AC tests would be subcritical with optimum interspersed hydrogenous moderation.

3. The value of "N" cannot be less than 0.5.

7.3.1.2.6(b) Description of Criticality Control Design. Design features that will be included in the criticality evaluation are as follows:

Dimensions and tolerance of the containment system for fissile material.

Structural components that maintain the fissile material or neutron poisons in a fixed position within the package or in a fixed position relative to each other.

Location, dimensions, and concentration of neutron absorbing materials and moderating materials, including neutron poisons and shielding material.

Dimensions and tolerances of floodable voids and flux traps within the package.

Dimensions and tolerances of the overall package that affect the physical separation of the fissile material contents in package arrays.

The following cases will be addressed: (1) a single package; (2) an array of undamaged packages; and (3) an array of damaged packages. Based on the number of packages evaluated in the arrays, the appropriate N should be determined and the CSI calculated.

7.3.1.2.6(c) Fissile Content. Specifications that will be included in the criticality evaluation include fissile material mass, dimensions, enrichment, physical and chemical composition, density, moisture, and other characteristics that are dependent on the specific contents. Because a partially filled container may allow more room for moderators (e.g., water), the most reactive case may be for a mass of fissile material that is less than the maximum allowable contents.

If the package is designed for multiple types of contents, a separate criticality evaluation and proposal for different criticality controls for each content type may be included. Any assumptions that certain contents need not be evaluated because they are less reactive than evaluated contents will also be properly justified.

7.3.1.2.6(d) General Considerations. The following considerations are applicable to the criticality evaluations of a single package and arrays of packages under NC and AC.

7.3.1.2.6(d)(1) Model Configuration. The models used in the criticality calculation will be consistent with the effects on the packaging and its contents during NC and AC. The dimensions of the contents and the packaging used in the model will be correct. For some types of packagings and contents (e.g., powders), the contents can be positioned at varying locations and densities. The relative location and physical properties of the contents within the packaging will be justified as those resulting in the maximum multiplication factor. Dimensional tolerances (e.g., for cavity sizes and poison thickness) will be considered in a manner that maximizes reactivity.

7.3.1.2.6(d)(2) Material Properties. The appropriate mass densities and/or atom densities will be provided for materials used in the models of the packaging and contents. Material properties will be consistent with the condition of the package under the NC and AC tests, and any difference between the NC and AC will be addressed.

The materials will be relevant to the criticality design (e.g., poisons, foams, plastics, and other hydrocarbons) and properly specified. No more than 75% of the specified minimum neutron poison concentration should generally be considered in the criticality evaluation. The materials will not degrade during the service life of the packaging.

7.3.1.2.6(d)(3) Computer Codes and Cross-Section Libraries. An appropriate computer code, or other acceptable method, will be used for the criticality evaluation. Standard codes will be referenced. Other codes or methods will be described and any appropriate supplemental information will be provided.

Criticality evaluations will also use an appropriate cross-section library. If multi-group cross sections are used, it will be confirmed that the neutron spectrum of the package has been appropriately considered and that the cross sections are properly processed to account for resonance absorption and self-shielding.

The code will be properly used for the criticality evaluation. Key input data for the criticality calculations will be identified. These include the number of neutrons per generation, number of generations, convergence criteria, mesh selection, etc., depending on the code that is used. At least one representative input file for a single package, undamaged array, and damaged array evaluation will be included in the document. It will be verified that the information from the criticality model, material properties, and cross sections is properly input into the code, and that the calculation has properly converged.

7.3.1.2.6(d)(4) Demonstration of Maximum Reactivity. The analysis will demonstrate that the most reactive configuration for a single package, an array of undamaged packages, and an array of damaged packages has been analyzed. Any assumptions and approximations will be clearly identified and justified.

The analysis will determine the optimum combination of internal moderation (within the package) and interspersed moderation (between packages), as applicable. It will be confirmed that preferential flooding of different regions within the package is considered

as appropriate. Note that the maximum allowable fissile material quantity is not necessarily the most reactive contents.

7.3.1.2.6(e) Single Package Evaluation.

7.3.1.2.6(e)(1) Configuration. The criticality evaluation will demonstrate that a single package is subcritical under both NC and AC. The evaluations will consider the following:

Fissile material in its most reactive credible configuration consistent with the condition of the package, and the chemical and physical form of the contents.

Water moderation to the most reactive credible extent, including water inleakage to the containment system.

Full water reflection on all sides of the containment system, or reflection by the package materials, whichever results in the maximum reactivity.

7.3.1.2.6(e)(2) Results. The package shall meet the requirements outlined in paragraph 7.3.1.2.6(a). If a package can be shown to be subcritical by reference to a standard in lieu of calculations, it will be verified that the standard is applicable to the package conditions.

7.3.1.2.6(f) NC Evaluation of Package Arrays.

7.3.1.2.6(f)(1) Configuration. The criticality evaluation will demonstrate that an array of 5N packages is subcritical under NC. The evaluation will consider the following:

The most reactive configuration of the array (e.g., pitch and package orientation) with nothing between the packages.

The most reactive credible configuration of the packaging and its contents under NC. The analysis for the array of undamaged packages may assume that the packages are dry internally, provided that there is no water leakage into the package, including the containment system, when the package is subjected to the tests specified in 10 CFR 71.71.

Full water reflection on all sides of a finite array.

7.3.1.2.6(f)(2) Results. The most reactive array conditions will be clearly identified and the results of the evaluation consistent with information presented in the document.

The appropriate N value will be used to determine the CSI. The appropriate N should be the smaller value, which ensures subcriticality for 5N packages under NC or 2N packages under AC.

7.3.1.2.6(g) AC Evaluation of Package Arrays.

7.3.1.2.6(g)(1) Configuration. The criticality evaluation will demonstrate that an array of 2N packages is subcritical under AC. The evaluation will consider the following:

The most reactive configuration of the array (e.g., pitch, package orientation, and internal moderation).

Optimum interspersed hydrogenous moderation.

The most reactive credible configuration of the packaging and its contents under AC, including inleakage of water.

Full water reflection on all sides of a finite array.

7.3.1.2.6(g)(2) Results. The most reactive array conditions will be clearly identified and the results of the evaluation will be consistent with information presented in the document.

The appropriate N value will be used to determine the CSI. The appropriate N should be the smaller value that ensures subcriticality for 2N packages under AC or 5N packages under NC.

7.3.1.2.6(h) Benchmark Evaluations. Computer codes for criticality calculations will be benchmarked against critical experiments. The analysis of the benchmark experiments will use the same computer code, hardware, and cross-section library as those used to calculate the k_{eff} values for the package.

7.3.1.2.6(h)(1) Applicability of Benchmark Experiments. Benchmark experiments will be applicable to the actual packaging design and contents. Benchmark experiments will have, to the maximum extent possible, the same materials, neutron spectra, and configuration as the package evaluations. Key package parameters that will be compared with those of the benchmark experiments include type of fissile material, enrichment, hydrogen/uranium ratio, poison, and configuration. Differences between the package and benchmarks will be identified and properly considered.

Furthermore, overall quality of the benchmark experiments and uncertainties in the experimental data (e.g., mass, density, dimensions) will be addressed.

7.3.1.2.6(h)(2) Bias Determination. Results of the calculations for the benchmark experiments and the method used to account for the biases will be discussed, including the contribution from uncertainties in the experimental data.

A sufficient number of appropriate benchmark experiments will be analyzed, and the results of the benchmark calculations will be used to determine an appropriate bias for the

package calculations. The benchmark evaluations will address trends in the bias with respect to parameters such as pitch-to-rod diameter, assembly separation, neutron absorber material, etc. Only negative biases (results that under predict k_{eff}) will be considered, with positive bias results treated as zero bias.

Statistical and convergence uncertainties of benchmark calculations will also be considered. The uncertainties will not significantly affect the results.

7.3.1.2.6(i) Evaluation Criteria for Subcriticality.

7.3.1.2.6(i)(1) Summary. The CFR does not define the evaluation criteria to determine what is safely subcritical; subsequently, the following criteria are to be used for onsite transport evaluations:

For equivalency with NRC regulatory guidelines, a k_{eff} limit of 0.95, including consideration of bias and uncertainties, will be used in the criticality evaluation of packages for transportation on the Hanford Site. Packages that are demonstrated to have a k_{eff} limit that exceeds 0.95 require RL approval, except under the following conditions:

- A k_{eff} limit of 0.965 and 0.98 will be used for unirradiated uranium systems enriched to ≤1.25 and ≤0.95 weight % ^{235}U, respectively.
- For systems in which the total mass of fissile material per shipment is less than the minimum critical mass of ^{239}Pu (or ^{235}U if no plutonium is present) in aqueous mixtures as specified in ANSI/ANS-8.1-1998 ("Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," p. 5), the criticality evaluation will not include extensive computer evaluations because of the wide acceptance of the limits in ANSI/ANS-8.1-1998.
- For all other systems, the use of a k_{eff} limit greater than 0.95 requires that the criticality safety margin of the system be defined in terms of a parametric curve of the maximum calculated k_{eff} vs the number of packages per shipment. If an increase in the number of packages per shipment results in a small increase in k_{eff}, then the system is on the plateau of the parametric curve, and a higher k_{eff} limit may be justified; however, a k_{eff} limit greater than 0.98 shall not be used.

7.3.1.2.6(i)(2) Systems With a Small Fissile Mass Content. Based on ANSI/ANS-8.1-1998, extensive computer evaluations of systems are not required when the total fissile mass content per shipment is less than the subcritical limit for fissile isotopes in solution as shown in Table 1 of ANSI/ANS-8.1-1998. For ^{239}Pu, this limit is 0.48 kg (480 g). For ^{235}U this limit is .76 kg (760 g). For mixtures of fissile isotopes, the limit for ^{239}Pu may be used. An administrative safety margin may be used to reduce the maximum allowable fissile mass to account for uncertainties in the fissile mass measurement or for other uncertainties.

7.3.1.2.6(j) Evaluation Procedures. The criticality evaluation relies on other inputs/evaluations. In addition, results of the criticality evaluation are considered in the evaluation of other sections. As an aid to the user, an information flow diagram for the criticality evaluation is presented in Figure 7-5.

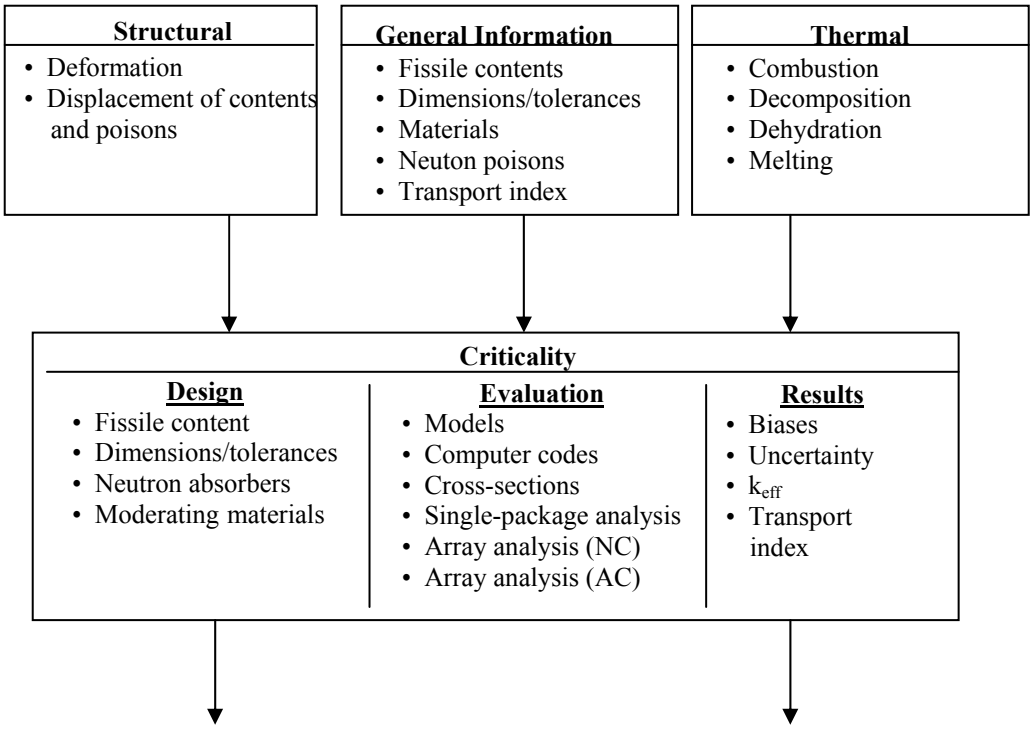
7.3.1.2.7 Gas Generation.

This section defines the requirements to demonstrate acceptable performance for onsite packaging in which the concentration of flammable gases within the package void volume has the potential to exceed one half of the Lower Explosive Limit (LEL). For Hydrogen gas, the LEL value is 5 vol%. The requirements of this section do not apply to packages that have no flammable gas generation potential. The acceptable performance requirement is that the package must maintain containment/confinement, subcriticality, and shielding of the contents under both NC and AC. The section also defines the acceptable performance criteria for testing and/or analysis to be applied to demonstrate the packaging provides an equivalent degree of safety to the regulations. It should be noted that in any onsite PSSD, claims of adequacy of designs or design methods must be supported by technical bases; i.e., by an appropriate engineering evaluation or description of actual tests.

7.3.1.2.7(a) Description of the Package. The following information must be provided in the description of the package:

7.3.1.2.7(a)(1) The containment/confinement boundary must be exactly defined and confined spaces must be identified.

Figure 7-5. Criticality Evaluation Flow Diagram.



Operating Procedures
• Transport index • Neutron poisons or moderators

Acceptance Tests and Maintenance Program
• Dimensions/tolerances • Neutron poison specs

7.3.1.2.7(a)(2) Design pressure of the containment components must be identified.

7.3.1.2.7(a)(3) Content of the package and sources of flammable gas generation must be identified.

7.3.1.2.7(a)(4) Radioactive material source terms and moisture content of the payload must be identified.

7.3.1.2.7(a)(5) Rate of flammable gas generation.

7.3.1.2.7(a)(6) Any venting features of the containment/confinement boundary to prevent pressurization.

7.3.1.2.7(a)(7) Any operational controls such as purging with inert gas prior to shipment or use of getters and/or recombiners shall be identified.

7.3.1.2.7(a)(8) The void volume of the package must be defined.

7.3.1.2.7(b) Material Properties and Characteristics. The following information must be provided and/or demonstrated in describing the material properties of the contents and the materials of construction of the packaging:

7.3.1.2.7(b)(1) Material properties of the packaging must be provided.

7.3.1.2.7(b)(2) Description of the gas generating sources of the contents must be provided.

7.3.1.2.7(b)(3) Any potentially flammable mixture of vapors or gases that could form in the containment vessel of a package must be identified and chemical characteristics provided.

7.3.1.2.7(c) Acceptable Performance Criteria. The fundamental approach is to allow for shipment of potentially flammable mixtures inside a shipping package, provided the primary requirements of containment/confinement, subcriticality, and shielding are satisfied.

7.3.1.2.7(c)(1) Acceptable performance can be demonstrated either by testing or by analysis using the gas generation evaluation methodology in Appendix G or equivalent.

7.3.1.2.7(c)(2) Evaluate the package gas generation potential under NC, by testing or by analysis using the methodology in Appendix G or equivalent, to determine whether the package void exceeds one half of the Lower Explosive Limit (LEL). For Hydrogen gas, the LEL value is 5 vol% flammable gas during a period of one year consistent with NUREG-1609.

The one-year period begins when the package is prepared for transport.

The initial flammable gas concentration, which by default must be less than one half of the Lower Explosive Limit (LEL). (For Hydrogen gas, the LEL value is 5 vol%), is taken as the concentration at the time of preparation for transport.

7.3.1.2.7(c)(2)(i) For packages shown to exceed one half of the Lower Explosive Limit (LEL). (For Hydrogen gas, the LELvalue is 5 vol%) flammable gas within one year after preparation for transport:

The expected transport time, or shipping window, must be one half of the time to reach the Lower Explosive Limit (LEL) consistent with NRC Information Notice 84-72, *Clarification of Conditions for Waste Shipments Subject to Hydrogen Gas Generation*.

In the event that transport is not completed within the shipping window per NRC Information Notice 84-72, one of the following must occur:

The package atmosphere may be inerted (sealed packages only).

The package atmosphere may be periodically purged to reset the shipping window clock.

The package may be reevaluated for a new shipping window starting at a higher flammable gas concentration.

The package may be designed to withstand a bounding deflagration.

The package contents may be repackaged into a package of different design or one that is risk based.

For packages that <u>will</u> exceed one half of the Lower Explosive Limit (LEL) flammable gas within one year from date of preparation for transport: If the package cannot be transported within one half of the time to reach the Lower Explosive Limit

(LEL) vol% from its flammable gas concentration at the time of preparation for transport, either the package atmosphere must be inerted (sealed packages only) or the package must be designed to withstand a deflagration (sealed or vented packages).

7.3.1.2.7(c)(2)(ii) For packages that do not exceed one half of the Lower Explosive Limit (LEL) vol% flammable gas within one year after preparation for transport:

The shipping window is conservatively set for one year.

In the event that transport is not completed within the one-year period, reevaluate the package in accordance with Section 3.1.2.7(c)(2) above.

7.3.1.2.7(c)(2)(iii) Evaluation procedures: As an aid to the user, an information flow diagram for flammable gas generation evaluation is presented in Figure 7-6.

7.3.1.2.7(c)(3) MNOP, including the maximum gas generated over the life of the package, must be less than the design pressure for the package containment boundary.

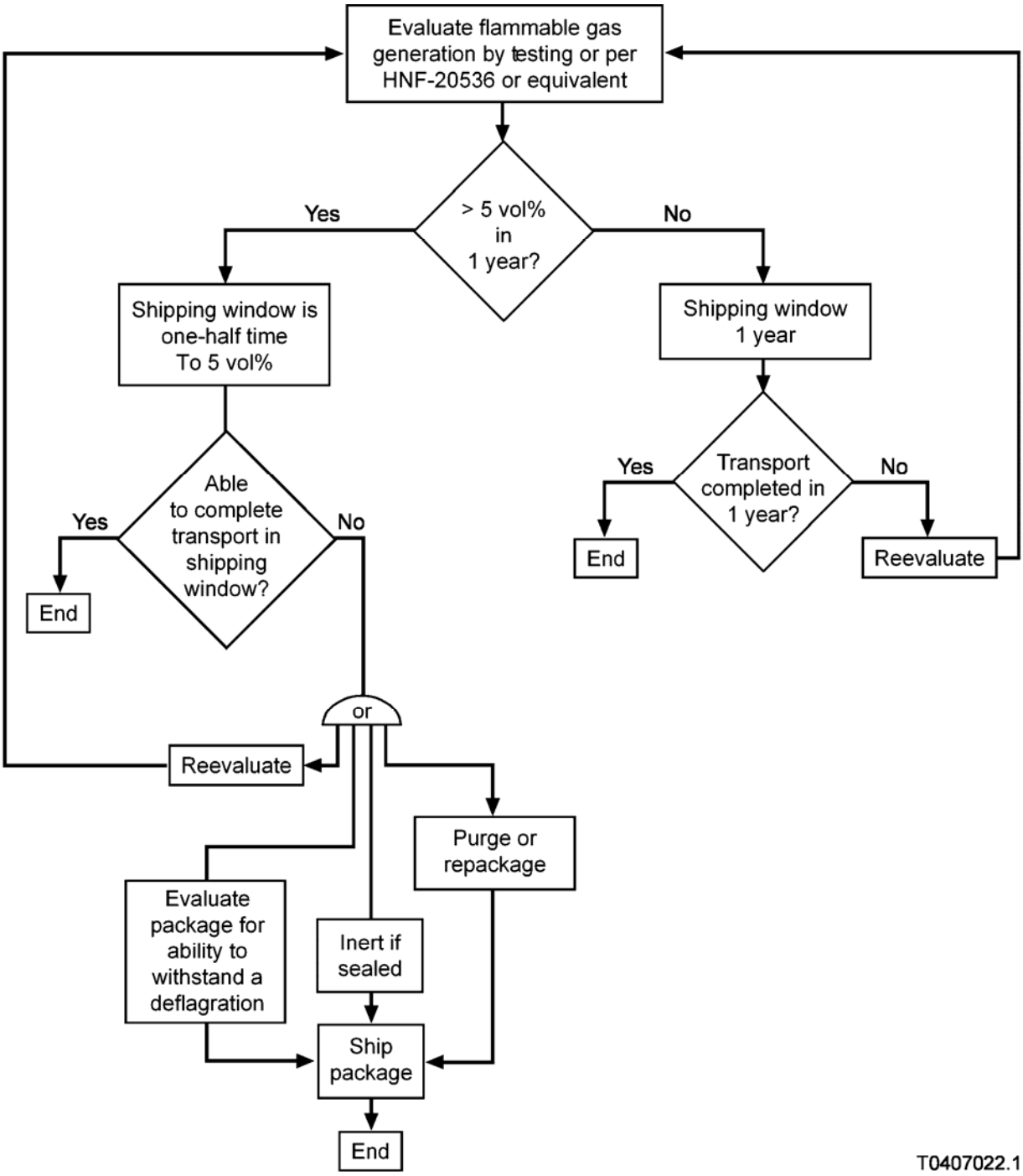
7.3.1.2.7(c)(4) Maximum design pressure for the package containment boundary or the confinement boundary with a sealed vent must be less than the burst pressure.

7.3.1.2.7(c)(5) Containment boundary components must be demonstrated to maintain containment/confinement, shielding, subcriticality under the sequence of AC performance tests specified in Section 6.5.2.5.2.

7.3.1.2.7(c)(6) Maximum deflagration pressure from the worst case flammable gas mixture must be less than the containment vessel design pressure at normal operating temperatures.

7.3.1.2.7(c)(7) Containment/confinement boundary burst pressure must not be exceeded under ACs.

Figure 7-6. Flammable Gas Generation Evaluation Flow Diagram.



7.3.1.2.7(c)(8) The internal pressure increase from potential flammable gas generation within containment/confinement boundary must not exceed the design pressure under normal operating conditions.

7.3.1.2.7(c)(9) A deflagration to detonation transition (DDT) must not occur under worst case flammable gas generation conditions under NC.

7.3.1.2.7(c)(10) Filter and other pressure relieving components must be capable of sustaining deflagration pressures as well as all NCs and ACs without loss of effectiveness.

7.3.1.2.7(d) General Considerations. The evaluation of flammable gas mixtures within shipping packages is primarily a gas generation and structural evaluation of the containment/confinement boundary. In general, the evaluation of radiation shielding and criticality should not be impacted by the gas mixture inside the containment/confinement boundary. The evaluation must demonstrate that the package meets the performance test requirements defined in Section 6.5.2.5; design requirements defined in Section 6.5.2.6; and the requirements provided in paragraph 7.3.1.2.7(c) above. The evaluation must also address the following:

The most limiting initial conditions must be used as defined in Section 6.5.2.6.10(a), and Table 6-6.

Evaluation methods are appropriate for the loading conditions considered and follow accepted practices and precepts.

When filtered venting devices are used, the minimum airflow rate must be 200 mL/min (12.20 in^3/min) at a pressure differential of 1.9 mm Hg (1.0 in. water gage). Filtered venting devices will have a minimum aerosol efficiency of 99.97% at 0.45 μm dioctylphthalate particle diameter.

When getters and/or recombiners are used, issues and/or conditions that must be addressed include, but are not limited to, the following:

- Bounding credible scenarios for calculations and/or testing must be assumed.

- Getter and/or recombiner operational life and capacity before and after shipment must be identified. Communication pathways between the getter and/or recombiner and hydrogen gas (e.g., the pathway for hydrogen gas in a bag inside the package to the getter located in the inner containment vessel headspace) must be identified.

- Getters and/or recombiners must be compatible with the payload and packaging.

- Generation of free liquids (water) from the getter and/or recombiner must be addressed.

- Temperature effects of getter and/or recombiner reaction on the packaging and payload must be considered.

- Gettering reversibility must be addressed.

- Minimum operating pressure related to the getter and/or recombiner performance must be addressed.

- Getter materials and/or recombiner must be engineered into a form (i.e., matrix, structure, and package) so that it can be located within the confines of the package or inner containment vessel.

It must be shown that any increase in pressure or chemical reactions within the containment vessel due to these vapors or gases could not significantly reduce package effectiveness.

The maximum quantity of fission gas products that could be available for release in the containment vessel shall be identified. The source term shall be specified, all parameters and assumptions pertinent to the calculation of fission gas products presented, and any data used supported by appropriate references. When it is appropriate, sample calculations will be presented.

7.3.1.2.7(d)(1) Evaluation by Testing. If the package performance is demonstrated by testing, the onsite PSSD must include the following:

Objective and description of the test and procedures used. The description must also include initial pressure and temperatures. For packages equipped with filters, ambient pressure may be used. However, normal operating temperature must be used.

Description of the test equipment used (i.e., ranges, accuracy, gas mixing devices, gas mixture, gas generate rate, and response time).

Deflagration tests on the containment/confinement vessel may be performed on a separate undamaged unit.

The sequence of tests specified in Section 6.5.2.5.2 must be performed with the initial pressure of the deflagration pressure.

The test specimen must have been fabricated using the same materials, methods, and QA as specified in the design. Any differences must be identified and the effects evaluated. Substitutes for the contents should have the same representative weight as the actual contents.

All test results must be evaluated and their implications interpreted, including interior and exterior damage of the test specimen. Unexpected or unexplained test results indicating

possible testing problems or non-reproducible specimen behavior must be described and evaluated.

Videos, photographs, and test data of the tests must be provided as records and maintained available for review.
Margins of safety of the package design must be evaluated against the test results.

Criteria for evaluating pass/fail for the test conditions must be provided and used as a comparison with the test results.

7.3.1.2.7(d)(2) Evaluation by Analysis. If the package performance is demonstrated by analysis, the onsite PSSD must include the following:

A clear description of the calculations and all assumptions must be provided.

A clear description of the calculational parameters and methods used to determine gas generation rate and heat generated.

The methods used for the gas generation evaluation will be appropriate. Any computer programs used will be referenced and evidence of verification and benchmarking shall be provided. Other codes or methods will be described in the document, and the appropriate supplemental information will be provided. The number of dimensions of the code will be appropriate for the package geometry. The models used in the gas generation calculation will be consistent with the effects on the packaging and its contents during NC and AC.

All source terms will be specified, all parameters and assumptions pertinent to the calculation of the internal pressure presented, and any data used supported by appropriate references. When it is appropriate, sample calculations will be presented.

The response of the package to loads, in terms of stress, strain, pressure, and temperature to the components and structural members must be provided, and the structural stability of individual members must be demonstrated.

When used, computer codes must be appropriately used, verified, and benchmarked.

When using quasi-static analysis techniques, appropriate dynamic amplification factors must be developed and applied.

Material properties and models must be appropriate for the load combinations evaluated. The material properties must be consistent with the analytical methods. The strain rate at which the properties are given must be justified.

A summary of results must be provided that compare results of the analyses with the acceptable performance criteria established in paragraph 7.3.1.2.2(g)(3). For deflagration only, ASME BPVC, Section III, Service Level C limits must be applied as a minimum.

7.3.1.2.7(e) NC Evaluation.

7.3.1.2.7(e)(1) Flammable gas generation under NC must be evaluated per the requirements of Section 7.3.1.2.7(c)(2) and subsections thereof.

7.3.1.2.7(e)(2) The MNOP, including the maximum gas generated over the life of the package, must be demonstrated to be less than the design pressure for the package containment boundary.

7.3.1.2.7(e)(3) Design pressure on the containment boundary or a sealed confinement boundary must be demonstrated to be less than the burst pressure of the system.

7.3.1.2.7(e)(4) A DDT must be demonstrated not to occur under the worst case NC flammable gas generation conditions.

7.3.1.2.7(e)(5) The maximum deflagration pressure from the worst case flammable gas mixture must be less than the design pressure of the containment boundary or a sealed confinement boundary under normal operating conditions.

7.3.1.2.7(f) AC Evaluation.

7.3.1.2.7(f)(1) Containment boundary or sealed components of a confinement boundary must be demonstrated to maintain containment, subcriticality, and shielding under the sequence of AC performance tests.

7.3.1.2.7(f)(2) Containment boundary or sealed components of a confinement boundary burst pressure must be demonstrated not to be exceeded under ACs. This evaluation must be based on the greatest possible pressure difference.

7.3.1.2.7(f)(3) Initial pressure at which the sequence of AC tests are to be evaluated must be equal to at least the MNOP under ambient conditions.

7.3.1.2.8 Tiedown and Load Securement.

This section outlines the elements that are to be addressed for an onsite PSSD to demonstrate acceptable tiedown system performance based on the requirements defined in Section 6.5.2.6.13. The section also defines the acceptable performance criteria for analysis to be applied. It should be noted that in any tiedown performance assessment, claims of adequacy of designs or design methods must be supported by technical bases; i.e., by an appropriate engineering evaluation or description of actual tests.

7.3.1.2.8(a) Description of Tiedown System. The following information must be provided in the tiedown description for the package:

7.3.1.2.8(a)(1) Description of the tiedown system securing the package to the conveyance.

7.3.1.2.8(a)(2) Weights and center of gravity of the package.

7.3.1.2.8(a)(3) Description of all tiedown hardware and system for blocking and bracing the package.

7.3.1.2.8(a)(4) Tiedown system design drawings, sketches, and free body diagrams will be provided for all but the simplest tiedowns used for packages with a small mass.

7.3.1.2.8(a)(5) Restrictions and other concerns for securing the package will be stated in this section.

7.3.1.2.8(b) Evaluation Requirements. The following information must be provided in the tiedown evaluation for the package:

7.3.1.2.8(b)(1) All assumptions will be clearly identified in the evaluation. The basis for and justification of the conservatism for the assumptions shall be provided.

7.3.1.2.8(b)(2) Required working load limits and ratings for all tiedown assembly components will be determined based on the loadings established by DOT regulations specified in 49 CFR 393, Subpart I.

7.3.1.2.8(b)(3) Working load limits and/or ratings of all tiedown components (including the conveyance attachment points) and the margins of safety will be provided in tabulated form.

7.3.1.2.8(b)(4) Minimum load capacity of the conveyance will be established.

7.3.1.2.8(b)(5) Flexibility of the conveyance and road induced vibration may cause loosening or failure of the tiedowns. As a consequence, the tiedown load paths will be demonstrated to be direct as possible without compromising any required configuration constraints.

7.3.1.2.8(b)(6) The evaluation will identify all restrictions to the tiedown system and conveyance that must be incorporated into the operating procedures. These restrictions may include interface materials, blocking restrictions, allowable bearing surfaces, feasibility of placing cargo on the package, stacking, temperature restrictions, center of gravity locations, package orientation, or electrical power, pneumatic, or hydraulic requirements.

7.3.1.2.8(b)(7) The evaluation will identify when a direct tiedown (low pretension, stretching permitted) is being used and when an indirect tiedown (high pretension, limited stretching) is being used.

7.3.1.2.8(b)(8) As part of the evaluation, an inspection checklist will be developed for incorporation into Section 3.1.2.10 of the safety documentation. As a minimum, the inspection will include a visual inspection of the main conveyance beam, web to flange welds, beam webs, and tiedown components for any signs of distortion or failure prior to release of the package for shipment.

7.3.1.2.8(b)(9) The evaluation will address the conveyance tiedown points. As conveyance tiedown points are not always rated, the evaluation must identify or determine the load capacity and geometry of loading. The evaluation must also demonstrate conservatism of and basis for any assumptions concerning the capacity of the tiedown points.

7.3.1.2.9 Quality Assurance.

This section identifies the quality requirements to be used when implementing the equivalent packaging requirements. DOE QA requirements for onsite T&P activities are identified in 10 CFR 830, Subpart A; DOE Order 414.1A, and other older orders. The use of alternatives to DOT packagings for onsite shipments is authorized in DOE Order 460.1B. The following paragraphs identify QA requirements to be included in the PSSD and in QAPs for activities associated with the design fabrication, maintenance, storage, and use of onsite Type B and fissile packages.

7.3.1.2.9(a) Quality Requirements. The QAP should contain the following information:

1. A requirement to develop a QAP by applying the QA criteria specified in paragraph 3.1.2.9(b)(2). The QAP shall include a discussion of how the criteria of paragraph 3.1.2.9(b)(2) will be satisfied. The criteria of paragraph 3.1.2.9(b)(2) shall be applied using a graded approach. The implementing organization(s) shall use appropriate standards, wherever applicable, to develop and implement its QAP. For fissile and Type B quantity packagings, the standard should be NQA-1. The implementing QAP will have the approval of the applicable DOE organization. If the implementing QAP has not been approved by DOE, it will be submitted for approval.

2. An implementing organization may, at any time, make changes to an approved QAP. Changes made over the previous year will be submitted annually to the applicable DOE organization for review. A submittal will identify the changes, the pages affected, the reason for the changes, and the basis for concluding that the revised QAP continues to satisfy the requirements of this section. Changes made to correct spelling, punctuation, or other editorial items do not require explanation.

3. Implementation plans and QAPs will be regarded as approved by DOE 90 days after submittal, unless approved or rejected by DOE at an earlier date, and shall include any modification made or directed by DOE.

7.3.1.2.9(b) Quality Program and Acceptance Criteria. The package safety documentation will identify that the following criterion are to be implemented by a QAP that implements the quality requirements necessary to ensure the safety associated with the package.

7.3.1.2.9(b)(1) QA Organization. The users of a packaging are responsible for the establishment and execution of the QAP. The user may delegate to others, such as contractors, agents, or consultants, the work of establishing and executing the QAP, or any part of the QAP, but shall retain responsibility for the program. The user will clearly establish and delineate, in writing, the authority and duties of persons and organizations performing activities affecting the safety-related functions of structures, systems, or components (SSC). These activities include performing the functions associated with attaining quality objectives and the QA functions.

The QA functions are as follows:

- Ensuring that an appropriate QAP is established and effectively executed

- Verifying, by procedures such as checking, auditing, and inspection, that activities affecting the safety-related functions have been performed correctly.

The persons and organizations performing QA functions must have sufficient authority and organizational freedom to:

- Identify quality problems
- Initiate, recommend, or provide solutions
- Verify implementation of solutions.

The persons and organizations performing QA functions will report to a management level that ensures the required authority and organizational freedom, including sufficient independence from cost and schedule, when opposed to safety considerations, are provided.

Because of the many variables involved, such as the number of personnel, the type of activity being performed, and the location or locations where activities are performed, the organizational structure for executing the QAP may take various forms, provided that the persons and organizations assigned the QA functions have the required authority and organizational freedom.

Irrespective of the organizational structure, the individual(s) assigned the responsibility for assuring effective execution of any portion of the QAP, at any location where activities subject to this section are being performed, must have direct access to the levels of management necessary to perform this function.

7.3.1.2.9(b)(2) QAP. The user will establish, at the earliest practicable time consistent with the schedule for accomplishing the activities, a QAP that complies

with the requirements of the paragraph. The user shall document the QAP by written procedures or instructions and will carry out the program in accordance with those procedures throughout the period during which the packaging is used. The user will identify the material and components to be covered by the QAP, the major organizations participating in the program, and the designated functions of these organizations.

The user, through its QAP, will provide control over activities affecting the quality of the identified materials and components to an extent consistent with their importance to safety, and as necessary to ensure conformance to the approved design of each individual package used for the shipment of radioactive material. The user will ensure that activities affecting quality are accomplished under suitably controlled conditions. Controlled conditions include the use of appropriate equipment; suitable environmental conditions for accomplishing the activity, such as adequate cleanliness; and assurance that all prerequisites for the given activity have been satisfied. The user will take into account the need for special controls, processes, test equipment, tools, and skills to attain the required quality, and the need for verification of quality by inspection and test.

The user will base the requirements and procedures of its QAP on the following considerations concerning the complexity and proposed use of the package and its components:

Impact of malfunction or failure of the item to safety
Design and fabrication complexity or uniqueness of the item
Need for special controls and surveillance over processes and equipment
Degree to which functional compliance can be demonstrated by inspection or test
Quality history and degree of standardization of the item.

The user will provide for indoctrination and training of personnel performing activities affecting quality, as necessary, to ensure that suitable proficiency is achieved and maintained. The user will review the status and adequacy of the QAP at established intervals. Management of other organizations participating in the QAP will regularly review the status and adequacy of that part of the QAP they are executing.

7.3.1.2.9(b)(3) Package Design Control. The user will establish measures to ensure that applicable regulatory requirements and the package design, as specified in the approval for those materials and components to which this section applies, are correctly translated into specifications, drawings, procedures, and instructions. These measures must include provisions to ensure that appropriate quality standards are specified and included in design documents and that deviations from standards are controlled. Measures must be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the materials, parts, and components of the packaging.

The user will establish measures for the identification and control of design interfaces and for coordination among participating design organizations. These measures must include the establishment of written procedures, among participating design organizations, for the review, approval, release, distribution, and revision of documents

involving design interfaces. The design control measures must provide for verifying or checking the adequacy of design by methods such as design reviews, alternate or simplified calculational methods, or by a suitable testing program. For the verifying or checking process, the user will designate individuals or groups other than those who were responsible for the original design, but who may be from the same organization. Where a test program is used to verify the adequacy of a specific design feature in lieu of other verifying or checking processes, the user shall include suitable qualification testing of a prototype or sample unit under the most adverse design conditions. The user shall apply design control measures to items such as the following:

Criticality physics, radiation shielding, stress, thermal, hydraulic, and accident analyses
Compatibility of materials
Accessibility for in-service inspection, maintenance, and repair
Features to facilitate decontamination
Delineation of acceptance criteria for inspections and tests.

The user will subject design changes, including field changes, to design control measures commensurate with those applied to the original design.

7.3.1.2.9(b)(4) Procurement Document Control. The user will establish measures to ensure that adequate quality is required in the documents for procurement of material, equipment, and services, whether purchased by the user or by its contractors or subcontractors. To the extent necessary, the user will require contractors or subcontractors to provide a QAP consistent with the applicable provisions of this TSD.

7.3.1.2.9(b)(5) Instructions, Procedures, and Drawings. The user will prescribe activities affecting quality by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall require that these instructions, procedures, and drawings be followed. The instructions, procedures, and drawings must include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.

7.3.1.2.9(b)(6) Document Control. The user will establish measures to control the issuance of documents such as instructions, procedures, and drawings, including changes, which prescribe all activities affecting quality. These measures must ensure that documents, including changes, are reviewed for adequacy, approved for release by authorized personnel, and distributed and used at the location where the prescribed activity is performed. These measures must ensure that changes to documents are reviewed and approved.

7.3.1.2.9(b)(7) Control of Purchased Material, Equipment, and Services. The user will establish measures to ensure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. These measures must include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products on delivery.

The user will have available documentary evidence that material and equipment conform to the procurement specifications before installation or use of the material and equipment. The user will retain, or have available, this documentary evidence for the life of the package to which it applies. The user will ensure that the evidence is sufficient to identify the specific requirements met by the purchased material and equipment.

The user will assess the effectiveness of the control of quality by contractors and subcontractors at intervals consistent with the importance, complexity, and quantity of the product or services.

7.3.1.2.9(b)(8) Identification and Control of Materials, Parts, and Components. The user will establish measures for the identification and control of materials, parts, and components. These measures must ensure that identification of the item is maintained by heat number, part number, or other appropriate means, on the item or on records traceable to the item, as required throughout fabrication, installation, and use of the item. These identification and control measures must be designed to prevent the use of incorrect or defective materials, parts, and components.

7.3.1.2.9(b)(9) Control of Special Processes. The user will establish measures to ensure that special processes, including welding, heat treating, and nondestructive testing, are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.

7.3.1.2.9(b)(10) Internal Inspection. The user will establish and execute a program for inspection of activities affecting quality by or for the organization performing the activity, to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity. The inspection must be performed by individuals other than those who performed the activity being inspected. Examination, measurements, or tests of material or products processed must be performed for each work operation where necessary to ensure quality. If direct inspection of processed material or products is not carried out, indirect control by monitoring processing methods, equipment, and personnel must be provided. Both inspection and process monitoring must be provided when quality control is inadequate without both. If mandatory inspection hold points, which require witnessing or inspecting by the user's designated representative and beyond that work should not proceed without the consent of its designated representative are required, the specific hold points must be indicated in appropriate documents.

7.3.1.2.9(b)(11) Test Control. The user will establish a test program to ensure that all testing required to demonstrate that the packaging components will perform satisfactorily in service is identified and performed in accordance with written test procedures that incorporate the requirements of this TSD and the requirements and acceptance limits contained in the package approval. The test procedures must include provisions for ensuring that all prerequisites for the given test are met, that adequate test instrumentation is available and used, and that the test is performed under suitable environmental conditions. The user will document and evaluate the test results to ensure that test requirements have been satisfied.

7.3.1.2.9(b)(12) Control of Measuring and Test Equipment. The user will establish measures to ensure that tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified times to maintain accuracy within necessary limits.

7.3.1.2.9(b)(13) Handling, Storage, and Shipping Control. The user will establish measures to control, in accordance with instructions, the handling, storage, shipping, cleaning, and preservation of materials and equipment to be used in packaging to prevent damage or deterioration. When necessary for particular products, special protective environments, such as inert gas atmosphere, and specific moisture content and temperature levels, must be specified and provided.

7.3.1.2.9(b)(14) Inspection, Test, and Operating Status. The user will establish measures to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the packaging. These measures must provide for the identification of items that have satisfactorily passed required inspections and tests where necessary to preclude inadvertent bypassing of the inspections and tests.

The user will establish measures to identify the operating status of components of the packaging, such as tagging valves and switches, to prevent inadvertent operation.

7.3.1.2.9(b)(15) Nonconforming Materials, Parts, or Components. The user will establish measures to control materials, parts, or components that do not conform to the user's requirements to prevent their inadvertent use or installation. These measures must include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification to affected organizations. Nonconforming items must be reviewed and accepted, rejected, repaired, or reworked in accordance with documented procedures.

7.3.1.2.9(b)(16) Corrective Action. The user will establish measures to ensure that conditions adverse to quality, such as deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of a significant condition adverse to quality, the measures must ensure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken must be documented and reported to appropriate levels of management.

7.3.1.2.9(b)(17) Quality Assurance Records. The user will maintain sufficient written records to describe the activities affecting quality. The records must include the instructions, procedures, and drawings required by paragraph 7.3.1.2.9(b)(5) to prescribe QA activities and must include closely related specifications such as required qualifications of personnel, procedures, and equipment. The records must include the instructions or procedures that establish a records retention program that is consistent with applicable regulations and designates factors such as duration, location, and assigned responsibility. The user will retain these records for 3 years beyond the date when the user last engages in the activity for which the QAP was developed. If any portion of the

written procedures or instructions is superseded, the user will retain the superseded material for 3 years after it is superseded.

7.3.1.2.9(b)(18) Audits. The user will carry out a comprehensive system of planned and periodic audits to verify compliance with all aspects of the QAP, and to determine the effectiveness of the program. The audits must be performed in accordance with written procedures or checklists by appropriately trained personnel not having direct responsibilities in the areas being audited. Audited results must be documented and reviewed by management having responsibility in the area audited. Follow-up action, including reaudit of deficient areas, must be taken where indicated.

7.3.1.2.9(c) Quality Program Contents and Format.

7.3.1.2.9(c)(1) Graded Application of the QAP. For fissile and Type B quantity packaging, the package safety documentation will (using NQA-1 including the supplements as the bases) provide a cross-referencing index, which demonstrates that each of the 18 criteria identified in paragraphs 7.3.1.2.9(b)(1) through (18) are addressed by written procedures. An example of such a matrix is presented in Table 1, Regulatory Guide 7.10. Because of the inter-relationship of the 18 criteria, more than one quality procedure generally will be applicable to each criterion.

The graded application process shall determine the appropriate level of analysis, documentation, and actions necessary to comply with the requirements through the consideration of prescribed factors, such as the following:

Nuclear safety classification or hazard category of the item or activity
Relative importance to safety, safeguards, and security
Magnitude of any hazard or risk involved
Adequacy of existing safety documentation
Impact/consequences of failure on programmatic mission of a facility
Particular characteristics of a package or activity
Life-cycle stage of a package
Complexity of items, services, or processes involved
History of problem at a facility, or with an item, service, or process.

The graded application process will not be used to circumvent applicable QA, legal, or contractual requirements. Rather, the grading determines the extent to which controls within the QA criteria are applied. The graded application of QAP requirements is normally achieved through a combination of the following:

Extent to which procedures, instructions, or specifications define the processes or work methods involved

Extent of assessment, verification, review, or oversight activities

Extent of documentation required

Degree of control over activities.

For all packagings, the importance to safety should be based primarily on the ability of the package to provide the following:

Containment of radioactive material
Subcriticality of fissile material
Shielding of radiation.

The graded approach should consider the complexity and proposed use of the package and its components as described in the following:

Impact of malfunction or failure of the item to safety
Design and fabrication complexity or uniqueness of the item
Need for special controls and surveillance over processes and equipment
Degree to which functional compliance can be demonstrated by inspection or test
Quality history and degree of standardization of the item.

7.3.1.2.9(c)(2) Graded Approach for SSCs Important to Safety. For all fissile and Type B quantity packaging, the package safety documentation will provide a package-specific listing (Q-List) of all SSCs important to safety. The listing for SSCs will be consistent with the parts list or similar information presented in the packaging drawings. Justification should be provided for any item identified on the drawings, but not defined as important to safety in the Q-list. The package safety documentation will identify a quality category (e.g., A, B, C) for each SSC important to safety and these categories will be appropriately defined. The assigned categories will be properly justified based on their definition, the package type, and the safety function of each SSC. Guidance on the application of categories and QA requirements is provided in paragraph 7.3.1.2.9(c)(1). Additional guidance can be found in Appendix A of Regulatory Guide 7.10. Definitions of typical categories and representative safety classifications for SSCs of transportation packagings are also presented in Table 2 and Table 5, respectively, of NUREG/CR-6407.

7.3.1.2.9(c)(3) Package-Specific Quality Criteria and Package Activities. For fissile and Type B quantity packages, the package safety documentation will address each of the 18 quality criteria in NQA-1 as they apply to the proposed package. The package safety documentation will identify for each criterion, as applicable, the appropriate level of effort for package activities based on their importance to safety. Guidance on QA requirements applicable to each category is provided in Appendix A of Regulatory Guide 7.10. Other guidance is presented in Chapter 4 of NUREG/CR-6407, which also describes typical design and fabrication records maintained for each QA category. Table 7-1 identifies typical levels of effort for each of the 18 criteria of NQA-1 that should be considered in the review, based on quality category. Note that the omission of Category C items from the QA effort may not be appropriate if they involve a condition of approval specified in the package approval document.

Table 7-1. Typical Level of QA Effort by Quality Category.

QA Element/Level of Effort	**Category A**	**Category B**	**Category C**
1. QA Organization			
Responsibility established	X	X	X
Authority and duties written	X	X	X
QA functions executed	X	X	X
Reporting levels clearly defined	X	X	X
Independence from cost and schedule assured	X	X	X
2. QA Program			
Procedures written	X	X	X
Activities affecting quality controlled	X	X	X
Graded approach established	X	X	X
Indoctrination and training provided	X	X	X
3. Design Control			
Most stringent codes and standards	X		
Codes and standards	X	X	
Prototype test and/or analysis	X	X	
Formal design review	X	X	
Internal peer review	X	X	
Off-the-shelf items			X
Conditions of approval controlled	X	X	X
4. Procurement Document Control			
Traceability	X	X	
Qualified vendor lists	X		
Off-the-shelf items			X
5. Instructions, Procedures, and Drawings			
Written and documented	X	X	
Qualitative or quantitative acceptance criteria	X	X	
Changes to conditions of approval listed in certificate controlled	X	X	X
6. Document Control			
Controlled issue	X	X	
Controlled changes	X	X	
7. Control of Purchased Material, Equipment, and Services			
Source evaluation and selection	X		
Inspection at contractor	X		

Table 7-1. Typical Level of QA Effort by Quality Category.

QA Element/Level of Effort	**Category A**	**Category B**	**Category C**
Formal receiving inspection	X	X	
Audits or surveillance at vendor plants	X		
Evidence of QA at contractor	X	X	
Objective proof that all specifications are met	X	X	X
Incoming inspection for damage only			X
8. Identification and Control of Materials, Parts, and Components			
Positive identification and traceability	X		
Identification and traceability to heats, lots, or other groupings		X	
Identification to end use drawings			X
9. Control of Special Processes			
Welding, heat treating, and nondestructive examination performed by qualified personnel	X		
Qualification records and training of personnel	X		
Only specified critical operations by qualified persons		X	
No special processes			X
10. Internal Inspection			
Documented inspection of all specifications	X		
Process monitoring if required by quality	X		
Examination, measurement, or test of material or processed product to assure quality	X	X	
Inspectors independent of those performing operations	X	X	
Qualified inspectors only	X	X	
Visual receiving inspection only			X
11. Test Control			
Written test program	X	X	
Written test procedures	X	X	
Documentation of testing and evaluation	X	X	
Observation of supplier acceptance tests as appropriate	X		
12. Control of Measuring and Test Equipment			
Tools, gauges, and instruments in formal calibration program	X	X	
13. Handling, Storage, and Shipping Control			
Written plans and procedures	X	X	
Routine handling			X
14. Inspection, Test, and Operating Status			
Individual items identified as to status or condition	X	X	
Status indicated by stamps, tags, labels, etc.	X	X	
Visual examination only			X
15. Nonconforming Materials, Parts, or Components			
Written procedures to prevent inadvertent use	X	X	
Nonconformance documented and closed	X	X	
Disposal without records			X
16. Corrective Action			
Conditions adverse to quality identified and corrected	X	X	X
Cause and corrective action documented	X	X	
Safety significant events reported	X	X	X
17. QA Records			
Design and use records	X	X	
Results of reviews, inspections, tests, audits, surveillances, and materials analysis	X	X	

Table 7-1. Typical Level of QA Effort by Quality Category.

QA Element/Level of Effort	**Category A**	**Category B**	**Category C**
Personnel qualifications	X	X	
Records of fabrication retained for life of package plus 3 years	X	X	
Records of acceptance testing retained for life of package plus 3 years	X	X	
Records of maintenance retained for life of package plus 3 years	X	X	
Shipping records retained for 3 years after shipment	X	X	X
Records managed by a written procedure for retention and disposal	X	X	X
18. Audits			
Written plan of periodic audits	X	X	X
Implementation by written procedures	X	X	X
Lead auditor certified	X	X	
All auditors certified	X		

7.3.1.2.9(c)(4) Requirements for Quality Categories for Packagings. Quality categories will be based on the relative safety significance of each Q component and item and, where appropriate, their subcomponent parts. The category should be identified as "A" for components and items that are critical to safe operation. For components and items with a major impact on safety, the category will be identified as "B." Category C should be used for components and items with a minor impact on safety. Examples of Category A items are SSCs whose failure or malfunction could result directly in a condition adversely affecting public or worker health and safety. Adverse conditions are defined as loss of containment, loss of shielding, or unsafe geometry compromising criticality control. Category B items could be SSCs whose failure or malfunction could indirectly result in a condition adversely effecting public or worker health and safety. For the failure of a Category B item to result in an adverse condition, a second failure of a component or item would need to occur. Category C items would be those SSCs whose failure or malfunction would not significantly reduce the packaging effectiveness and would be unlikely to create a condition adversely affecting public or worker health and safety. Each component, item, structure, or subsystem of a packaging will be tabulated and designated with the proper category. The QA requirements will also be identified for each component, item, structure, or subsystem.

7.3.1.2.10 Operating Procedures.

This section addresses the contents of the operating procedures that are to be provided.

7.3.1.2.10(a) Operating Procedures for DOT-Equivalent Packaging. The guidance outlines the elements that are to be addressed for an onsite PSSD to demonstrate the operating procedures for safe operations of Type B and fissile

packages. The guidance, when applied using a graded approach, is appropriate for any packagings requiring safety documentation.

7.3.1.2.10(b) Summary of Operation Requirements and Restrictions. This section will provide requirements and restrictions related to package operations. All requirements and restrictions related to package operations will be provided including: drawing and revision numbers for all package components; a description of the form (solid, liquid, powder, etc.) and fissile load of the contents; any package handling restrictions (such as lifting height limits or dual load path requirements; any neutron poison, moderator, and gap requirements; expected gamma and neutron radiation levels, and locations of any streaming paths; and any closure (such as closure lid bolt torques necessary for containment) and component testing (such as pressure taps) requirements.

7.3.1.2.10(c) General Information. The operation procedures will list any special equipment required for handling the particular package and include all pertinent details listed below:

7.3.1.2.10(c)(1) The operating procedures will include appropriate quantitative and qualitative criteria for determining that important activities have been satisfactorily accomplished.

7.3.1.2.10(c)(2) Detailed implementing procedures will be provided. It is recommended that the packaging safety documentation identify NUREG/CR-4775 as guidance for preparation of those procedures.

7.3.1.2.10(d) Package Loading. Loading of the package will include inspections, tests, and special preparations. Inspections will include those made prior to loading the package to determine that the package is not damaged and surface contamination levels are within the allowable limits. The procedures will discuss the inspection of the gaskets, criteria for replacement, and, if applicable, procedures for repair. The inspection of each closure device and criteria for replacement will also be included.

The operating procedures will provide instructions on package loading. Instructions about the following items (as applicable) will be included in the loading instructions:

7.3.1.2.10(d)(1) Preparation.

Appropriate documents to be reviewed by operating personnel

The package will be loaded and closed in accordance with written procedures

Describe any special controls and precautions for handling

Verify that the package is in unimpaired physical condition and that all required periodic maintenance has been performed

Ensure that the package is conspicuously and durably marked with the model number, serial number, gross weight, and package identification number, as applicable

Ensure use of the package complies with all other conditions of approval

Determine the package is proper for the contents to be shipped, including the need for canning of damaged fuel or for a second containment vessel, if applicable

Ensure packaging sealing surfaces have been properly prepared and protected

Check that all payload treatment processes performed subsequent to package loading are appropriate for the particular payload in question, and process equipment operators are familiar with both processing procedures and task operating procedures

Check that packaging interior contamination levels are not so excessive that significant contamination could be imparted to the payload itself

Check that all components operate as designed and have been tested as necessary

Identify and list any special equipment that may be needed when loading the package.

7.3.1.2.10(d)(2) Loading of Contents.

Describe any special controls and precautions for loading

Indicate the method of loading the contents

Ensure that any required moderator or neutron absorber is present and in proper condition

When applicable, specify the method to remove water from the package, as appropriate

Vent flammable gases from the package or add fill gas, as appropriate

Ensure that each closure device of the package, including seals and gaskets, is properly installed, secured, and free of defects

Identify bolt torques consistent with those identified by the design, and/or shown on the drawings

Confirm the package has been loaded and closed appropriately

Conduct any required package testing prior to release for transport

Decontaminate exterior surfaces of the packaging and transport vehicle.

7.3.1.2.10(e) Shipment Preparation. The operation procedures will provide instructions on shipment preparation. The instructions will include the following items, as a minimum:

Securing the package to vehicle, including acceptable tiedown configurations

Rendering unused lifting devices inoperable

Conducting the package radiation survey, including a determination of surface contamination

When applicable, conducting the temperature survey to verify that limits specified are not exceeded

Specify the assembly verification leakage rate, and how to ensure package closures are leak tested in accordance with applicable closure standards such as ANSI N14.5

Ensure that any system for containing liquid is properly sealed and has adequate space or other specified provision for expansion of the liquid

Verify that any pressure relief device is operable and set

Ensure that any structural component that could be used for lifting or tiedown during transport is rendered inoperable for those purposes unless it meets the required design requirements

Ensure that the tamper-indicating device is installed

Specify the attachment of impact limiters, personnel barriers, or similar devices, as applicable

For a fissile material shipment, identify any special controls and precautions for transport, loading, unloading, and handling, and any appropriate actions in case of an accident or delay

Identify any special controls that will be provided to the carrier for a package shipped by exclusive use under the provisions

Identify any special controls that will be provided to the carrier for a fissile-material package

Describe any special instructions that should be provided to the consignee for opening the package

Ensure that the TI and CSI for each package and the sum of the TIs and CSIs for the shipment are appropriate for the type of shipment.

7.3.1.2.10(f) Package Receipt. The operation procedures will give instructions to the package recipient on the following items:

Ensure that the package is examined for visible damage, status of the tamper-indicating device, surface contamination, and external radiation levels are made

Describe any special actions to be taken if the package is damaged, if the tamper-indicating device is not intact, or if surface contamination or radiation survey levels are too high

Identify any special handling equipment needed

Describe any proposed special controls and precautions for handling and unloading.

7.3.1.2.10(g) Package Unloading. Package unloading will include inspections, tests, and special preparations. As applicable, the procedures used to ensure the safety removal of fission gases, contaminated coolant, and solid contaminants will be discussed. Also, as applicable, any required cool-down procedures will be described, and it will be shown that it does not affect the continued use of the package.

Operating procedures will provide detailed instructions for package unloading. Instructions on the following items shall be included:

A list of any special equipment that may be needed
Preparation of the package for removal from the transport vehicle
Proper removal of the package from the transport vehicle
Package transfer from the transportation vehicle to the unloading site
Describe the appropriate method to open the package
Identify the appropriate method to remove the contents
Ensure that the contents are completely removed
Inspection of the interior of the packaging after contents have been removed
Possible preparation of packaging for short- or long-term empty storage.

7.3.1.2.10(h) Preparation of Empty Packages for Transport. A discussion of inspections, tests, and special preparations of the packaging necessary to ensure safe transport of the empty package will be included. Instructions on the following items will be included:

Verify package is empty

Verify requirements for non-fixed radioactive contamination limits have been met

Verify requirements for fixed-radioactive contamination limits have been met

Properly close packaging

Ensure packaging is delivered, to storage or a carrier, in a condition such that subsequent transport will not reduce the effectiveness of the packaging (e.g., damage to sealing surfaces caused by the freezing of moisture not properly removed.

7.3.1.2.10(i) Inspections and Maintenance. The operating procedure will establish how the maintenance and acceptance requirements are to be implemented.

7.3.1.2.10(j) Records and Reporting Requirements.

7.3.1.2.10(j)(1) Records for Each Shipment. The DOE requires the maintenance of records for each shipment. The operating procedures will identify the applicable DOE and company procedures, and the records they require to be maintained.

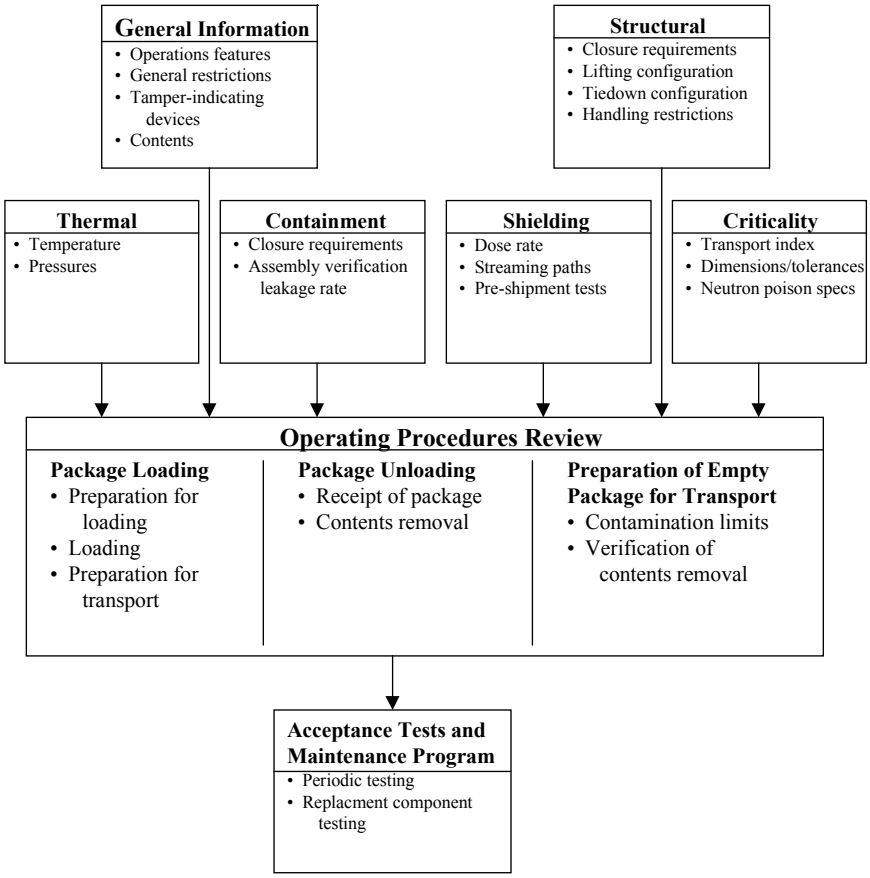
7.3.1.2.10(j)(2) Records of Package History. Historic records will be maintained for the lifetime of the package plus 3 years. Historic records will consist of sufficient QA records to furnish documentary evidence of the quality of packaging components that have safety significance and of services effecting quality. Records to be maintained include results of the following determinations: new package shielding meets design requirements; containment will maintain integrity at 1.5 times the MNOP (where applicable); packaging was fabricated in accordance with the approved design; and results of monitoring, inspections, and auditing of work performance during design, fabrication, assembly, testing, modification, maintenance and repair of the packaging.

7.3.1.2.10(j)(3) Reports. Operating procedures will identify package-specific conditions that require reporting identified in the DOE orders or Hanford Site procedures.

7.3.1.2.10(k) Operation Checklist. Operating procedures will present a checklist by the organization shipping the package. That organization is responsible for ensuring that operating procedures are in place before using the container. The checklist will identify the requirements that must be incorporated into procedures at the time of shipment.

7.3.1.2.10(l) Evaluation Procedures. The operations evaluation of a package is based in part on the description and evaluations presented in other evaluations. In addition, results of the operations evaluation are considered in the evaluation of all other sections. As an aid to the user, an information flow diagram for the operations evaluation is presented in Figure 7-7.

Figure 7-7. Operations Evaluation Flow Diagram.



7.3.1.2.11 Acceptance Tests and Maintenance Program.

This section addresses the contents of the acceptance and maintenance procedures.

The guidance outlines the elements that are to be addressed in the onsite PSSD to demonstrate the acceptance tests and maintenance program required for safe operation of Type B and fissile packages. In addition, the guidance, when applied using a graded approach, is appropriate for any packaging requiring safety documentation:

Structural and pressure tests
Leakage rate tests
Shielding tests
Thermal tests
Other tests.

7.3.1.2.11(a) Acceptance Test Procedures. Test procedures associated with the acceptance of the package for use that are required to be conducted prior to and during the service life of the packaging will be identified. When practicable, national standard procedures will be utilized. In the absence of such codes, the basis and rationale used to formulate the QAP will be described in establishing the requirements. The acceptance tests will include the following:

Visual inspections and measurements
Weld examinations
Component tests
Material tests.

The frequency of the tests will be identified. The requirements should provide flexibility in the schedule to provide for times when the shipping window will extend beyond the due date for the test.

The acceptance test will support the following verifications:

Before first use, fabrication of each packaging must be verified to be in accordance with the approved design. [49 CFR 173.474 and 10 CFR 71.85(c)]

Before first use, each packaging must be inspected for cracks, pinholes, uncontrolled voids, or other defects that could significantly reduce its effectiveness. [49 CFR 173.474 and 10 CFR 71.85(a)]

Before first use, if the MNOP of a package exceeds 35 kPa (5 psig), the containment system of each packaging must be tested at an internal pressure at least 50% higher than MNOP to verify its ability to maintain structural integrity at that pressure. [10 CFR 71.85(b)]

When applicable, before first use, each packaging must be conspicuously and durably marked with its model number, serial number, gross weight, and a package identification number. [10 CFR 71.85(c)]

Additionally, perform any tests deemed appropriate by the approval authority. [10 CFR 71.93(b)]

7.3.1.2.11(a)(1) Acceptance Tests. When the following acceptance tests are specified, present (as a minimum) a description of the test and its acceptance criteria. Standards will be referenced or an alternate basis provided.

7.3.1.2.11(a)(1)(i) Visual Inspections and Measurement. Provide inspections to verify that the packaging has been fabricated and assembled in accordance with the drawings. Dimensions and tolerances specified on the drawings will be confirmed by measurement.

7.3.1.2.11(a)(1)(ii) Weld Examinations. Provide welding examinations to verify fabrication in accordance with the drawings, codes, and standards specified in the design documents. Location, type, and size of the welds will be confirmed by measurement. When appropriate, specifications for weld performance, nondestructive examination, and acceptance will be identified.

7.3.1.2.11(a)(1)(iii) Structural and Pressure Tests. Identify and describe any applicable structural or pressure tests. Such tests will comply with 10 CFR 71.85(b), as well as applicable codes or standards specified in the design documentation.

7.3.1.2.11(a)(1)(iv) Leakage Tests. When applicable, identify that the containment system of the packaging will be subjected to a fabrication leakage test. The sensitivity of these tests must be identified. Those tests specified in ANSI N14.5 should be used when applicable. Require that all closures, including drains and vents, be leak-tested. The acceptable leakage criterion will be consistent with that identified in Section 3.1.2.4, Containment/Confinement Evaluation.

7.3.1.2.11(a)(1)(v) Component and Material Tests. Appropriate tests and acceptance criteria will be specified for components that affect package performance. Examples of such components include seals, gaskets, valves, fluid transport systems, and rupture disks or other pressure-relief devices. Components will be tested to meet the performance specifications shown on the engineering drawing of the package. When tests adversely affect the continued performance of a component, applicable QA procedures will be described to justify that the tested component is equivalent to the component that will be used in the packaging.

Verify that appropriate tests and acceptance criteria are specified for packaging materials. Tests for neutron absorbers (e.g., boron, gadolinia) and insulating materials (e.g., foams, fiberboard) will ensure that minimum specifications for density and isotopic content are achieved. Materials will be tested to meet the performance specifications shown on the engineering drawings.

7.3.1.2.11(a)(1)(vi) Shielding Tests. Appropriate shielding tests will be specified for both neutron and gamma radiation. The tests and acceptance criteria will be sufficient to ensure that no voids or streaming paths exist in the shielding.

7.3.1.2.11(a)(1)(vii) Thermal Tests. Appropriate tests will be specified to demonstrate the heat transfer capability of the packaging. These tests will confirm that the heat transfer performance determined in the evaluation is achieved in the fabrication process.

7.3.1.2.11(b) Maintenance Program. A maintenance program for ensuring continuous safe performance of the packaging will be identified. The packaging must be maintained in unimpaired physical condition except for superficial defects such as marks or dents [49 CFR 173.475 and 10 CFR 71.87(b)]. The program will include periodic testing, inspection, and replacement schedules, as well as criteria for replacement and repair of components and subsystems on a routine or as-needed basis. Frequency of maintenance will be identified. Requirements will provide flexibility in the schedule to provide for times when the shipping window will extend beyond the due date for the maintenance.

7.3.1.2.11(b)(1) Structural and Pressure Tests. If required by the package, structural and pressure tests to be performed and the frequency of performance will be identified. When a test(s) is used, the instrumentation and test sensitivity must be identified. The periodic and maintenance leakage rate tests (when applicable) will be those specified in ANSI N14.5. The acceptable leakage rate criterion will be consistent with that identified in Section 7.3.1.2.4, Containment/Confinement Evaluation. When appropriate, replacement schedules for seals will be identified.

7.3.1.2.11(b)(2) Leak Tests. Leak tests that are to be performed and the frequency of performance will be identified. For most packaging systems, this would include a test of the package before each shipment and an annual test of each packaging. The sensitivity of these tests must be identified. Use of the leakage rate tests specified in ANSI N14.5 is recommended. The acceptable leakage rate criterion will be consistent with that identified in the containment section (7.3.1.2.4). When appropriate, replacement schedules for seals will be identified.

7.3.1.2.11(b)(3) Subsystem Maintenance. The test and replacement schedule to be used for packaging subsystems (e.g., auxiliary cooling systems and neutron shield tanks) whose inadequate performance could impair the total package safety will be described. The schedules established will be justified using verifiable test or manufacturer's data.

7.3.1.2.11(b)(4) Valves, Rupture Disks, and Gasket on the Containment Vessel. The test and replacement schedule for the components on the containment vessel will be specified. The schedules that are established will be justified using verifiable test or manufacturer's data. For most systems, this would include, as a

minimum, a visual inspection before each closure, and an annual gasket and seal replacement.

7.3.1.2.11(b)(5) Shielding. The test and inspection schedules will be described, as well as the corrective action that is to be used to ensure adequate shielding performance. Both gamma and neutron sources will be considered.

7.3.1.2.11(b)(6) Thermal. The tests proposed and the frequency of the tests that will be performed on the total system will be described. It will be shown the proposed total frequency will detect degradation in the thermal performance of the packaging before compromising package safety.

7.3.1.2.11(b)(7) Miscellaneous. Any additional test not previously considered that will be performed periodically on components and subsystems will be described.

7.3.1.2.11(c) Acceptance Criteria.

7.3.1.2.11(c)(1) Visual Inspection. Visual inspections will be performed and the intended purpose for each inspection discussed. The criteria will be clearly stated for acceptance of each inspection, as well as the action that will be taken if noncompliance is encountered.

7.3.1.2.11(c)(2) Structural and Pressure Tests. There will be a description of how the tests are to be performed. The acceptance criteria will be included in the document. The actions that are to be taken when the prescribed criteria are not met will also be included. An estimate of the sensitivity of the tests will be provided.

7.3.1.2.11(c)(3) Leak Tests. A description of the leak tests to be performed will be included in the document. Leak tests will be performed on the containment vessel as well as auxiliary equipment such as shield tanks. The criteria for acceptance and the action to be taken, if the criteria are not met, will be described. The sensitivity of the tests will be estimated, and a basis for the estimate given.

7.3.1.2.11(c)(4) Component Tests. The tests for the components will be discussed in the document. Acceptance criteria will be provided and the action to be taken if the criteria are not met will be discussed.

7.3.1.2.11(c)(4)(i) Valves, Rupture Disks, and Fluid Transport Devices. Valves, rupture disks, and fluid transport devices will be tested under the most severe service conditions for which the package design assumes their acceptable performance. When the tests are presumed to adversely affect the continued performance of a component, the results of the tests on components of the same model and type may be substituted.

7.3.1.2.11(c)(4)(ii) Gaskets. Gaskets will be tested under conditions simulating the most severe service conditions under which the gaskets are to perform. Because these acceptance tests may degrade the performance of the gasket under test or the package into which it is assembled, or both, the tests are not necessarily performed on gaskets or packages to be put into service. The simulation system must ensure adequate representation of those conditions that would prevail if the actual system were used in a test. Gaskets must be procured under a QAP that is adequate to ensure acceptance testing of a given gasket device is equivalent to acceptance testing of all gaskets supplied and identified by that manufacturer as that model gasket.

7.3.1.2.11(c)(4)(iii) Miscellaneous. Any component that is not listed in paragraphs 7.3.1.2.11(c)(4)(i) and 7.3.1.2.11(c)(4)(ii) whose failure would impair the package effectiveness will be tested under the most severe conditions for which the package was designed. Because these acceptance tests may degrade the performance of the component under test or the system into which it is assembled, or both, the tests are not necessarily performed on components or systems to be put into service. The simulation system shall ensure adequate representation of those conditions that would prevail if the actual system were used in this test. Furthermore, components must be procured under a QAP adequate to ensure that acceptance testing of a given component device is equivalent to acceptance testing of all devices supplied and identified by that manufacturer as that model device.

7.3.1.2.11(c)(5) Tests for Shielding Integrity. The tests that are to be performed to establish shielding for both gamma and neutron sources will be discussed. The discussion will include the dimensions of the grid pattern or a description of the scanning procedure that demonstrates the inspection of 100% of the package surface area. The acceptance criteria, as well as the action to be taken if the criteria are not met, will be described.

7.3.1.2.11(c)(6) Thermal Acceptance Tests. The tests to verify that each package performs within some defined variance in accordance with the results of the thermal analyses or tests for NC will be discussed.

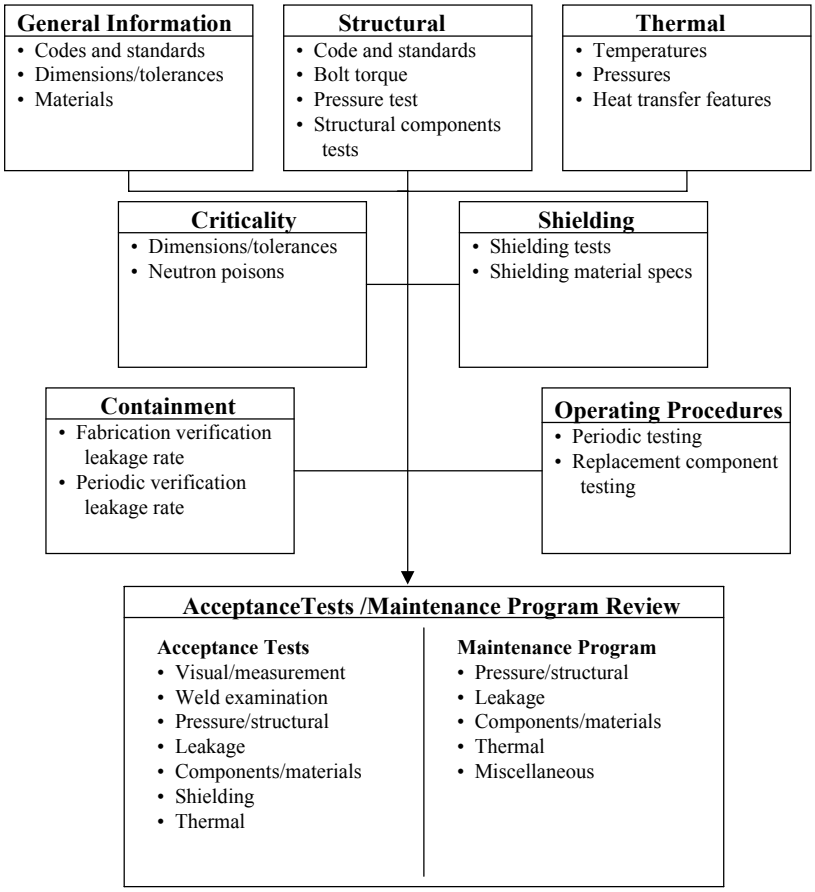
7.3.1.2.11(c)(6)(i) Discussion of Test Setup. The description of the tests will include heat source, instrumentation, and schematic showing thermocouple and heat source locations, as well as the placement of other test equipment. The test sensitivity will be estimated based on instrumentation, test item, and environmental variations.

7.3.1.2.11(c)(6)(ii) Test Procedures. The procedures used in testing and data recording will be discussed. The frequency of data recording during the test will be reported. The criteria used to define the steady-state (thermal equilibrium) condition of the test item will also be discussed.

7.3.1.2.11(c)(6)(iii) Acceptance Criteria. The thermal acceptance criteria and the method employed to compare the acceptance test results with the predicted thermal performance will be discussed. The action to be taken if the thermal acceptance criteria are not met by the packaging unit will also be discussed.

7.3.1.2.11(d) Evaluation Procedures. The acceptance tests and maintenance program evaluation of a package is based in part on the description and evaluations presented in the above sections. In addition, results of the acceptance tests and maintenance program evaluation are considered in the evaluation of all other sections. As an aid to the user, an information flow diagram for the acceptance tests and maintenance program evaluation is presented in Figure 7-8.

Figure 7-8. Acceptance Tests and Maintenance Program Evaluation Flow Diagram.



7.3.2 Risk Based Packagings

When using the alternative onsite risk based packaging requirements, the following risk based evaluation and acceptance criteria must be used. Risk based packages will demonstrate full compliance to Normal Conditions of transport for Type B Packages under 10 CFR 71. Risk based packages based upon a Type A package will also meet Normal Conditions of Transport under 10 CFR 71. , All risk based packages will also be demonstrated to remain sub-critical. At a minimum, three main representative accident scenarios must be addressed: collision, fire, and hydrogen deflagration. Additional accidents specific to the packaging being analyzed shall be considered to ensure that the representative accidents adequately bound the risks for that packaging and payload.

Before conducting the consequence and frequency evaluations, the proposed package must be evaluated against the applicable equivalent package requirements of Section 6.5.2. Applicability shall be based on proposed contents. The evaluation shall be documented in a report and formatted as identified in Appendix E. The PSSD shall document the package's performance according to the requirements in Section 6.5.3.2. If the package does not meet all of these

requirements, a discussion of the performance must be provided. The consequence and failure frequency evaluations shall be developed in accordance with the methodologies provided in Sections 7.3.2.1 and 7.3.2.2. The consequence and failure frequency information provided shall be detailed enough to support the risk based approval decision.

SARAH (HNF-8739) and RADIDOSE are approved for use in nuclear safety evaluations at Hanford. SARAH and RADIDOSE include the use of 95-percent average sector meteorology (χ/Q's) and ICRP 68/71 DCFs. The contractor shall use the applicable values from SARAH and RADIDOSE for determining the accident parameters for analysis of risk based shipments in the Hanford areas described in this TSD. The accident locations shall be based on the accidents occurring at the most conservative facilities in each site area on the shipment route.

Use of the SARAH and RADIDOSE χ/Q' values is acceptable for the evaluation of consequences described in Appendix G of this TSD. The DRs, ARFs, and RFs from SARAH and RADIDOSE corresponding to the TSD-prescribed accidents may also be used as long as they are conservatively selected.

Typical dose consequences accepted by RL for risk based packages shown in Appendix G, Tables 2a and 2b. The tables were developed using SARAH/RADIDOSE methodology to determine shipment inventory limits based on maintaining dose consequences to the MOI at the values consistent with the risk bin guidance in SARAH and those previously approved in the TSD SER. This methodology meets the expectations stated in DOE-STD-3009-94, Appendix A, the TSD SER, the TSD, and 10 CFR 830. The values contained in Appendix G, Tables 2a and 2b represent typical RL-approved risks for onsite transportation activities.

7.3.2.1 Evaluation Requirements and Acceptance Criteria for Risk based Packages

This section outlines the elements that are to be addressed for an onsite PSSD to demonstrate acceptable radiological and toxicological safety, and/or acceptable risk based on the requirements identified in Section 6.5.3.2. It also defines the acceptable analysis to be conducted to demonstrate the packaging provides an equivalent degree of safety and acceptable level of risk.

Appendix G, Justification and Basis for Shipment of Risk based Packages, contains the technical arguments or justification to validate the equivalence of the packaging performance. It also presents typical accident scenario data to be applied when conducting an analysis.

7.3.2.1.1 Consequence Analysis Methodology.

This section covers the calculation of package-specific releases and resultant dose consequences. See Appendix G for additional discussion on analysis bases for risk based packages. Package-specific releases from the specified representative accidents are calculated for the MOI and co-located worker to determine the consequences and

associated risks. Appendix G, Tables 2a and 2b document typical accepted risks for transportation-specific accident scenarios.

To promote consistency between consequence analyses for different packages, an approved methodology for calculating the dose consequences from transportation accidents is provided.

The consequence analysis determines the radiological consequence, or dose, to the maximally exposed onsite and offsite receptors from a radioactive material release during an accident. Note that the maximally exposed co-located worker (receptor) is defined as a person within the Hanford Site boundary 100 m (328 ft) from the accident. As a minimum, the consequence analysis shall quantitatively evaluate collision, fire, and hydrogen deflagration accidents. The initiators of these accidents shall be no more severe than the accident test conditions for certified Type B packages described in Section 6.5.3.2.1. And, in accordance with Appendix A of DOE-STD-3009, the analyses shall provide a realistic evaluation of the postulated conditions that could be encountered onsite. Although puncture, crush, and immersion tests are also described in the regulations, the collision event is normally more severe than the puncture and crush events, and immersion is not a credible accident scenario on the Hanford Site.

The consequence analysis considers the credible pathways through which the onsite and offsite receptors may be exposed to radiation. In the case where one pathway dominates the dose, the evaluation of other pathways may be less rigorous or qualitative. All receptors may be exposed to radioactive material by inhaling particulate matter while being submersed in a particulate aerosol carried downwind. Direct external dose from unshielded photons, beta particles, and neutrons is normally negligible at distances of 100 m (328 ft) or greater.

Exposure from consuming contaminated food or drinking contaminated water is not considered, because state and federal emergency response procedures (DOE-0223, *Emergency Plan Implementing Procedure*; WSDOA 1994, *Fixed Nuclear Facility Emergency Response Procedure*; WSDOH 1993, "Response Procedures for Radiation Emergencies;" EPA 1992, *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*) are in place to prevent ingestion of contaminated food and water in the event of an accident. The primary determinant of exposure from the ingestion pathway is the effectiveness of public health measures (i.e., interdiction) rather than the severity of the accident itself.

The material that leaks from the damaged package shall account for the physical and chemical form of the waste material during the AC using appropriate airborne release fractions and respirable fractions. The consequence analysis may include the mitigating effect of the damaged package after the AC using damage ratios or leak path factors, provided that a structural analysis supports the mitigating effect. If these factors are used, then both the mitigated and the unmitigated dose consequences shall be reported.

In addition to the onsite receptor, immediate workers in the vicinity of the accident (i.e., less than 100 m [328 ft]) may be exposed to radiation. The immediate worker for transportation cannot be defined in the same sense as for facilities. This is because the location of a release of radioactive material during transportation may potentially occur at any point along the transportation route between the originating and receiving facilities. The shipment may pass by several facilities along the route, and each shipment may pass by different facilities depending on the particular originating and receiving facilities. In addition, the shipment may pass by other vehicles along the route. In the event of an accident, it is foreseeable that people in other vehicles may stop to try to assist the driver involved in the accident, unknowingly being exposed to the released radioactive material. Furthermore, calculations of inhalation dose are subject to widely varying uncertainties. Therefore, because the immediate worker is not easily defined, consequence evaluations to workers in the immediate vicinity of an accident (i.e., less than 100 m [328 ft]), are addressed qualitatively.

The offsite receptor is the maximally exposed member of the public at the Hanford Site boundary for an exposure duration of not less than 2 hours. All dose consequences are to be calculated using the RL-approved SARAH and RADIDOSE methodologies.

7.3.2.1.2. Hydrogen Generation Analysis Methodology.

Mitigation of the consequences from a hydrogen deflagration in risk-based packages shall be provided by verifying per the methodology in Appendix G, or equivalent, that void volume hydrogen concentrations remain below the risk based values shown in Appendix G, Table 3 during the expected shipping window.

7.3.2.2 Frequency Analysis Methodology

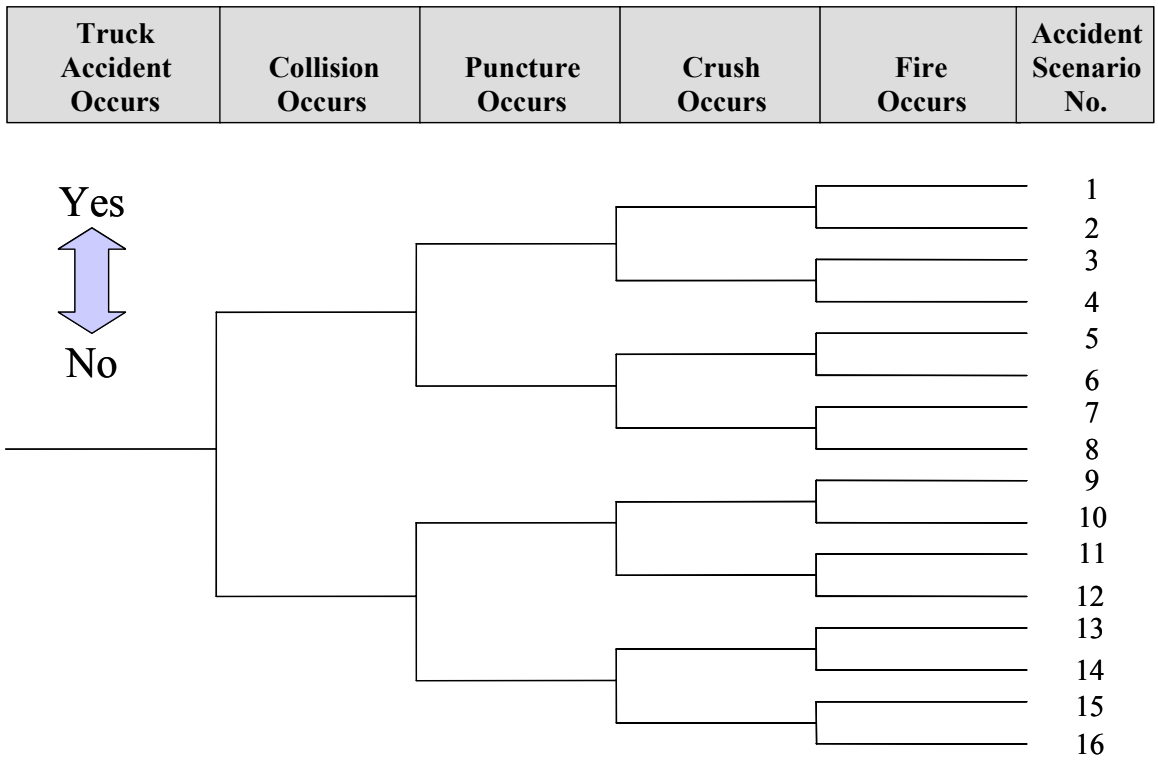
The accident frequencies must be commensurate with the severities of the accident scenarios to provide a valid evaluation. This section describes the approach and provides data to be used to evaluate the frequencies of transportation accidents on the Hanford Site.

7.3.2.2.1 Accident Frequency Analysis Approach.

The overall approach to determining Hanford Site accident frequencies is to start with the assumption that an accident has occurred based on the initiating event frequency as discussed in this section. This includes all accidents, ranging from minor “fender benders” to high-speed collisions and fires. The hazards analysis in Appendix G highlighted the accident scenarios that must be evaluated quantitatively and reduced the number of accident scenarios that need to be evaluated. However, it only eliminated those that were less than credible and those that are prevented through engineering and administrative controls (i.e., less than $1x10^{-7}$/yr), the remaining accident scenarios represent the bulk of the risk of transporting radioactive materials on the Hanford Site. As with the consequence evaluations, the accident frequencies will be utilized to determine each accident scenario risk classification bin.

An event tree approach is used to establish the overall framework for calculating the frequencies of truck accidents that could lead to a release of radioactive material on the Hanford Site (Figure 7-9). An event tree starts with an initiating event (in this case, the initiating event is a truck transportation accident) and follows with a series of ACs that describe the mechanical (collision) and thermal (fire) environments that could potentially be generated in an accident. Potential accident environments are both unmitigated and mitigated collision, followed by fire, and a single container hydrogen deflagration. Note that immersion, the final HAC defined in 10 CFR 71, is not applicable to the Hanford Site (see Appendix G).

Figure 7-9. "Unpruned" Event Tree Model of Potential Transportation Accident Conditions.



The fifth event represents fire conditions that may occur in accidents. All five events are aligned in chronological order at the top of the event tree shown in Figure 7-9. The event tree diagram was then constructed by first drawing a branch to represent the occurrence of any accident, then drawing a second set of branches to represent the impact event, and so on. The top branch of the impact event represents the occurrence of impact (i.e., collision or overturn) conditions and the bottom branch represents non-collision accidents. Similarly, for subsequent events, the top branches represent the occurrence of the specific condition and the bottom branch represents its absence from the particular scenario. Probabilistic information is then inserted on each branch to quantify the event tree. The probabilistic information may be in the form of a point value or a distribution. The probability of the top branch is 1 minus the probability of the bottom branch.

The following general equation is used to calculate the frequencies of the various accident scenarios depicted in Figure 7-9:

$$F_j = RNDP_j$$

where:

F_j = The frequency of accident scenario "j"
R = Accident rate (accidents/vehicle-km)
N = Number of shipments/yr
D = One-way shipping distance (km)
P_j = Conditional probability of Accident Scenario "j" given an accident has occurred.

The different scenarios in Figure 7-9 can be modeled by substituting different expressions for P_j, as follows:

P_j = P_i for collision-only accident scenarios
P_j = $P_{p/i}$ for collision scenarios that also lead to puncture conditions
P_j = $P_{c/i}$ for collision scenarios that also lead to crush conditions
P_j = $P_{f/i}$ for collision scenarios that also involve fires
P_j = $P_{f/p}$ for collision/puncture scenarios that also involve fires
P_j = $P_{f/c}$ for collision/crush scenarios that also involve fires
P_j = P_f for accident scenarios that involve fire-only conditions (no collision).

In other words, the calculational approach involves estimating the frequency of all accidents (product of the accident rate, shipping distance, and annual number of shipments) and then multiplying this product by a series of fractions that represent the probabilities of encountering conditions that could compromise the integrity of each package's containment system. The rest of this chapter describes the derivation process for the accident rate (parameter "R") and conditional probabilities (values for P_j) used in the calculations. The remaining parameters, including N and D, are obtained by consulting with potential users of the package.

7.3.2.2.1.1 Truck Accident Rate (R). Several studies have been conducted that determined highway accident rates for transportation risk assessment. Table 7-5 presents a side-by-side display of the accident rate information provided in the reviewed documents. Although the bases for the accident rates differ from one study to the other and should not be compared directly, the more recent values are within the range from about $2x10^{-7}$ to $4x10^{-7}$ accidents per vehicle-km (i.e., from 2 to 4 accidents/10 million km traveled). This illustrates that all of the values in this range would be acceptable for developing accident frequency estimates and none would result in a serious under- or over-estimate of Hanford Site accident frequencies.

Table 7-5. Summary of Truck Accident Rates from Previous Studies.

Source	Time period covered	Rate (accidents per vehicle-km)[a]	Comment
SLA-74-0001	1966 - 70	$2.5x10^{-6}$	National average data for trucks and delivery vans
NUREG/CR-4829	1968 - 81	$4.0x10^{-6}$	National average data; American Petroleum Institute data for heavy trucks
ANL/ESD/TM-68	1986 - 88	$2.6x10^{-7}$	Washington State primary highways; heavy trucks
		$3.94x10^{-7}$	National average primary highways; heavy trucks
ANL/ESD/TM-150	1994 - 96	$1.75x10^{-7}$	Washington State primary highways; heavy trucks
		$3.66x10^{-7}$	National average primary highways; heavy trucks
WHC-SD-TP-RPT-021	1990 - 95	$2.0x10^{-7}$	Hanford Site rate for trucks, vans, and pickups combined
NUREG/CR-6672	1984, 1986 - 88	$2.2x10^{-7}$	Nation-wide data, rural areas; adjusted Bureau of Motor Carrier Safety data

[a]Because of different bases that were used to derive the accident rates, such as the definition of an accident, the values are not directly comparable. See the source studies for additional information on the bases for the derived accident rates.

Sources:

ANL/ESD/TM-68, *Longitudinal Review of State-Level Accident Statistics for Carriers of Interstate Freight*, Argonne National Laboratory, Argonne, Illinois.

ANL/ESD/TM-150, *State-Level Accident Rates of Surface Freight Transportation: A Reexamination*, Argonne National Laboratory, Argonne, Illinois.

NUREG/CR-4829, *Shipping Container Response to Severe Highway and Railway Accident Conditions*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-6672, *Reexamination of Spent Fuel Shipment Risk Estimates*, Sandia National Laboratories, Albuquerque, New Mexico.

SLA-74-0001, *Severities of Transportation Accidents Volume I--Summary*, Change 1, Sandia National Laboratories, Albuquerque, New Mexico.

WHC-SD-TP-RPT-021, *Hanford Site Truck Accident Rate,* Westinghouse Hanford Company, Richland, Washington.

The most recent evaluation of truck accident rates is the basis for this document. Note that highway shipments on the Hanford Site may be conducted using a number of different truck types, including semi-tractor/trailer combination rigs, flatbed trucks, and vans. For this analysis, a single accident rate is used to represent the accident rates of all types of highway vehicles. The available data did not support separating the overall highway accident rate into separate rates for specific types of vehicles (e.g., heavy-combination trucks, delivery vans).

The overall truck accident rate (parameter "R" in equation 1) used in the risk evaluation is represented by the nation-wide average accident rates for heavy trucks developed by NUREG/CR-6672 (Figure 3.10a). The rate was developed using Bureau of Motor Carrier Safety data that has been adjusted to isolate accidents that occurred in cities and non-city regions. The database used to develop the highway accident rates was large, which increases the confidence in the estimates. The rural (non-city) accident rate is used for Hanford Site evaluations because of its generally rural nature. The accident rate given by NUREG/CR-6672 for rural highways is $2.2x10^{-7}$ accidents per vehicle-km

($3.5x10^{-7}$ accidents/vehicle-mile), which is the approximate 50% confidence interval (i.e., there is a 50% likelihood that the actual accident rate is $2.2x10^{-7}$/km or less). This represents the rate of all accidents, regardless of severity, ranging from minor fender-benders to severe collisions and fires. The annual frequency of all accidents for a given packaging system is the product of the highway accident rate, number of shipments per year, and the shipping distance. Note that only the one-way shipping distance is used in the Hanford Site accident frequency calculations because the package is loaded only when traveling in one direction; i.e., the package is empty for the return trip.

7.3.2.2.1.2 Collision Probability (P_i). Collision conditions generated in an accident are a function of many variables, including impact velocity, orientation, and impact surface characteristics. NUREG/CR-6672 and NUREG/CR-4829 constructed impact velocity distributions that considered the impact orientation (i.e., corner, end, or side impact) and the characteristics of various real surfaces (e.g., hard rock, soil, concrete, roadbed). The distributions were constructed to develop factors to adjust the overall accident rate to reflect real ACs and to determine the fractions of accidents that exceed specified impact velocities. This type of data is needed to calculate Hanford Site accident frequencies.

According to NUREG/CR-6672, the probability of a collision or overturn, given an accident occurs, is 0.7412. The probability of a non-collision accident is (1 – 0.7412) or 0.2588, given an accident occurs. The impact velocity distributions constructed by NUREG/CR-6672 and NUREG/CR-4829 were constructed assuming that a collision/overturn accident occurs. Thus, the following distribution is used to determine the fraction of collision and overturn accidents that result in impact velocities of a specified value. For this methodology, the specified impact velocity would be the impact failure threshold determined via structural analysis.

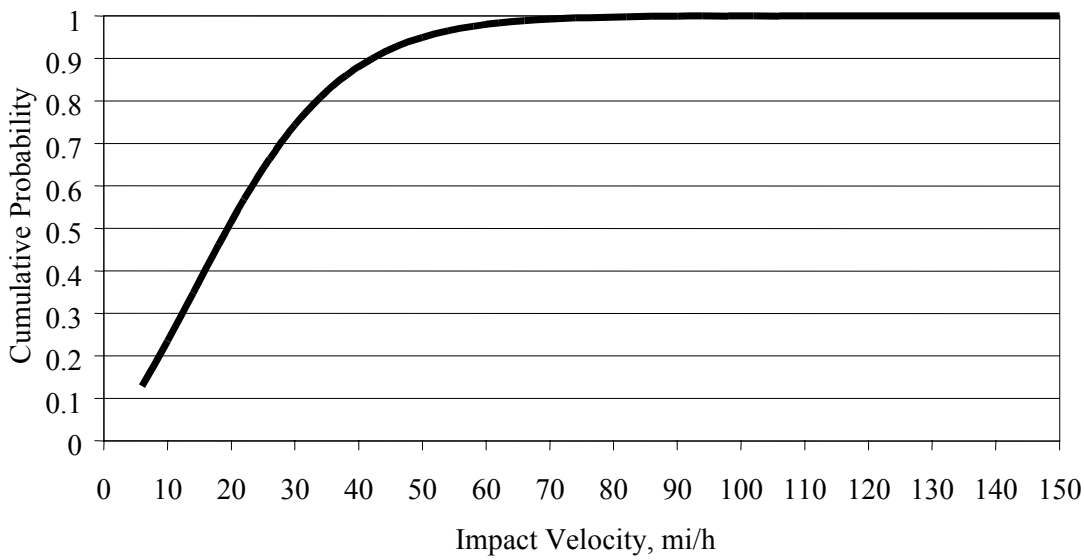
To construct the distributions, NUREG/CR-6672 assumed that the impacts at any angle are equally probable. They used data from Geographic Information System (GIS) interrogation of the digitized U.S. Department of Agriculture maps to characterize the wayside characteristics adjacent to three representative truck shipping routes. They then conducted Monte Carlo analyses to develop the cumulative distributions that are used here to assign the conditional probabilities of experiencing varying levels of impact severity. The distributions used for Hanford Site evaluations are shown in Table 7-6. The cumulative distribution is also illustrated in Figure 7-11 to assist in interpolation between the impact velocities listed in Table 7-6.

Table 7-6. Cumulative Truck Accident Velocity Distribution.

Initial Truck Velocity Adjusted for Braking							
Velocity (mi/h)	**Cumulative Probability**	**Velocity (mi/h)**	**Cumulative Probability**	**Velocity (mi/h)**	**Cumulative Probability**	**Velocity (mi/h)**	**Cumulative Probability**
0.0	0.0	30.0	0.74353	62.0	0.98383	94.0	0.99979
2.0	0.03834[(a)]	34.0	0.80877	66.0	0.98908	98.0	0.99990
6.0	0.12916	38.0	0.86020	70.0	0.99261	102.0	0.99995
10.0	0.23508	42.0	0.89961	74.0	0.99503	106.0	0.99998
14.0	0.34886	46.0	0.92881	78.0	0.99670	110.0	0.99999
18.0	0.46237	50.0	0.95009	82.0	0.99825	150.0	1.0
22.0	0.56877	54.0	0.96547	86.0	0.99910		
26.0	0.66345	58.0	0.97634	90.0	0.99956		

Source: NUREG/CR-6672.
[(a)] Probability that the accident or impact velocity is less than or equal to the listed velocity. For example, about 0.038 (3.8%) of all accidents have an impact velocity of 3 km/h (2 mi/h) or less.

Figure 7-11. Plot of Cumulative Distribution of Impact Velocities.



The velocity distribution shown in Table 7-6 is for accidents that occur on level ground. This is representative of the Hanford Site because there are no bridges of concern for a truck to fall from and strike the ground below the bridge. There are also no significant embankments for the truck and packaging system to fall from and strike an object or surface below. The distribution credits a reduction in velocity due to braking. The distribution also incorporates the probability of striking surfaces of various characteristics, such as hard rock, soft rock, soil, and the roadbed. The data used by NUREG/CR-6672 to characterize the impact surface was developed from U.S. Department of Agriculture digitized maps using GIS interrogation techniques. This corrected some potential non-conservatisms in the NUREG/CR-4829 study. The GIS techniques were applied to four illustrative routes, including one cross-country route between Florida and Washington State. These data were accounted for in the NUREG/CR-6672 analysis.

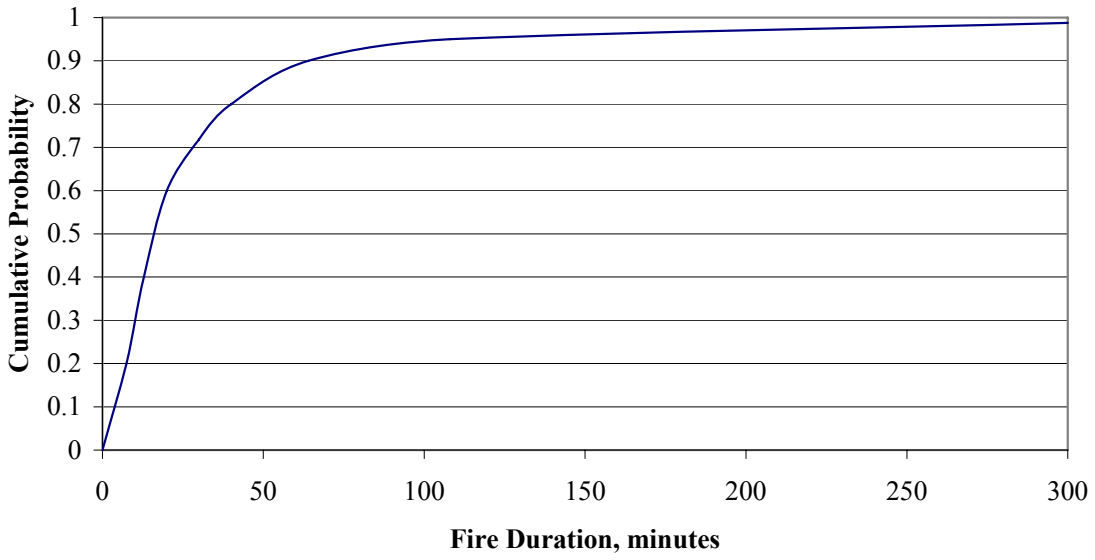
7.3.2.2.1.3 Fire. The effects of fires are a function of the temperature and duration of the fire, the fire orientation with respect to the package (i.e., fire and container are co-located versus offset from each other), and the thermal properties of the package (e.g., thermal resistance of the seals, emissivity of the container surfaces). NUREG/CR-6672, NUREG/CR-4829, and SAND 93-2580, *A Statistical Description of the Types and Severities of Accidents Involving Tractor Semi-Trailers*, have examined accident reports and modeled fire effects to characterize the probabilities of various fire environments. Typically, these studies generated a number of probabilistic distributions to generate the approximate probabilities of fires of varying severities. These distributions are based on nation-wide truck transport and are assumed to be applicable to the Hanford Site in general. However, certain distributions are not applicable, such as the probabilities of fires occurring after truck/train grade-crossing accidents (rail transport is no longer used on the Hanford Site).

This section describes the information needed to estimate the conditional probabilities of generating various fire scenarios. As with the previous distributions, the first distributions require the ACs to be isolated from the packaging integrity evaluations conducted in the studies listed above.

There are two types of fire scenarios modeled in Figure 7-14. One is a fire that occurs in conjunction with or following a mechanical impact event, such as a collision or overturn. The other is a fire that occurs in non-collision accidents. The former scenarios are intended to model the cumulative damage from mechanical and thermal ACs while the latter models thermal-only ACs (i.e., no mechanical damage sustained prior to fire initiation). The conditional probabilities of these scenarios are developed in the following subsections.

A fire frequency per accident of 1.6 percent is recommended for use on the Hanford Site per SLA-74-0001, *Severities of Transportation Accidents Volume III—Motor Carriers*.

Figure 7-14. Cumulative Probability Distribution of Fire Duration for Accidents Involving Mechanical Damage (i.e., collisions, overturns).



7.3.2.2.1.6 Conditional Probability of Fire Given Mechanical Accident. In SAND 93-2580, cumulative distributions of fire durations were developed based on reviews of accident reports, curve-fitting techniques, and Monte Carlo analyses. A cumulative distribution of fire duration was developed that will be used to select the conditional probability of encountering such conditions on the Hanford Site. Note that the distributions are based on nation-wide accident data. Little can be done to adjust these distributions to more-closely reflect Hanford Site road conditions, as the fire severity probabilities are mostly dependent on the type of vehicle struck (e.g., truck tanker, passenger car, etc.) rather than road wayside conditions. The following assumptions are implied in the use of this distribution:

The fire temperature reached is assumed to be the regulatory hypothetical fire test temperature (800 °C [1,472 °F]). No credit is taken for the probability that the fire temperature is lower than that value. For perspective, SAND 93-2580 concluded that essentially all fires have average fire temperatures greater than 650 °C (1,202 °F) and that only one fire in two reaches an average temperature of 1,000 °C (1,832 °F).

- It is assumed that the fire is engulfing. For perspective, SAND 93-2580 determined that no more than one fire in two is engulfing.

The distribution includes the data on fires involving collisions with trains. For perspective, SAND 93-2580 determined that collisions with trains are the most likely scenarios to result in an engulfing fire condition (or fires with diameters

greater than 7.6 m [25 ft]). Collisions with trucks, cars, and fixed or non-fixed objects were determined to have an 80% probability of being less than 7.6 m (25 ft) diameter. In other words, inclusion of train-accident initiated fires lead to a higher probability of being engulfing than would be calculated for the Hanford Site where rail shipping is no longer conducted.

These assumptions and the perspectives describe key conservatisms that demonstrate the bounding nature of this methodology and data.

7.3.2.2.1.7 Conditional Probability of Fire-only Accident. The cumulative distribution used to select the conditional probabilities of fire-only accident scenarios is shown in Figure 7-15. This figure was developed using NUREG/CR-6672 data that represents the cumulative probability of fires lasting less than or equal to some duration for non-collision accidents. The numerical values used to construct the distribution are shown in Table 7-7.

Figure 7-15. Cumulative Probability Distribution of Fire Duration for Non-collision Accidents.

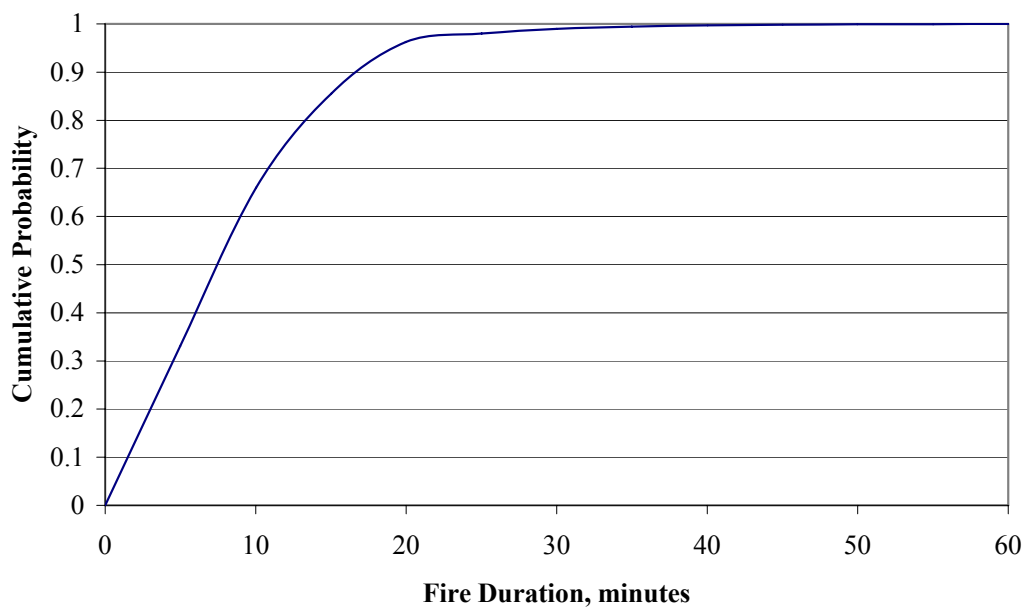


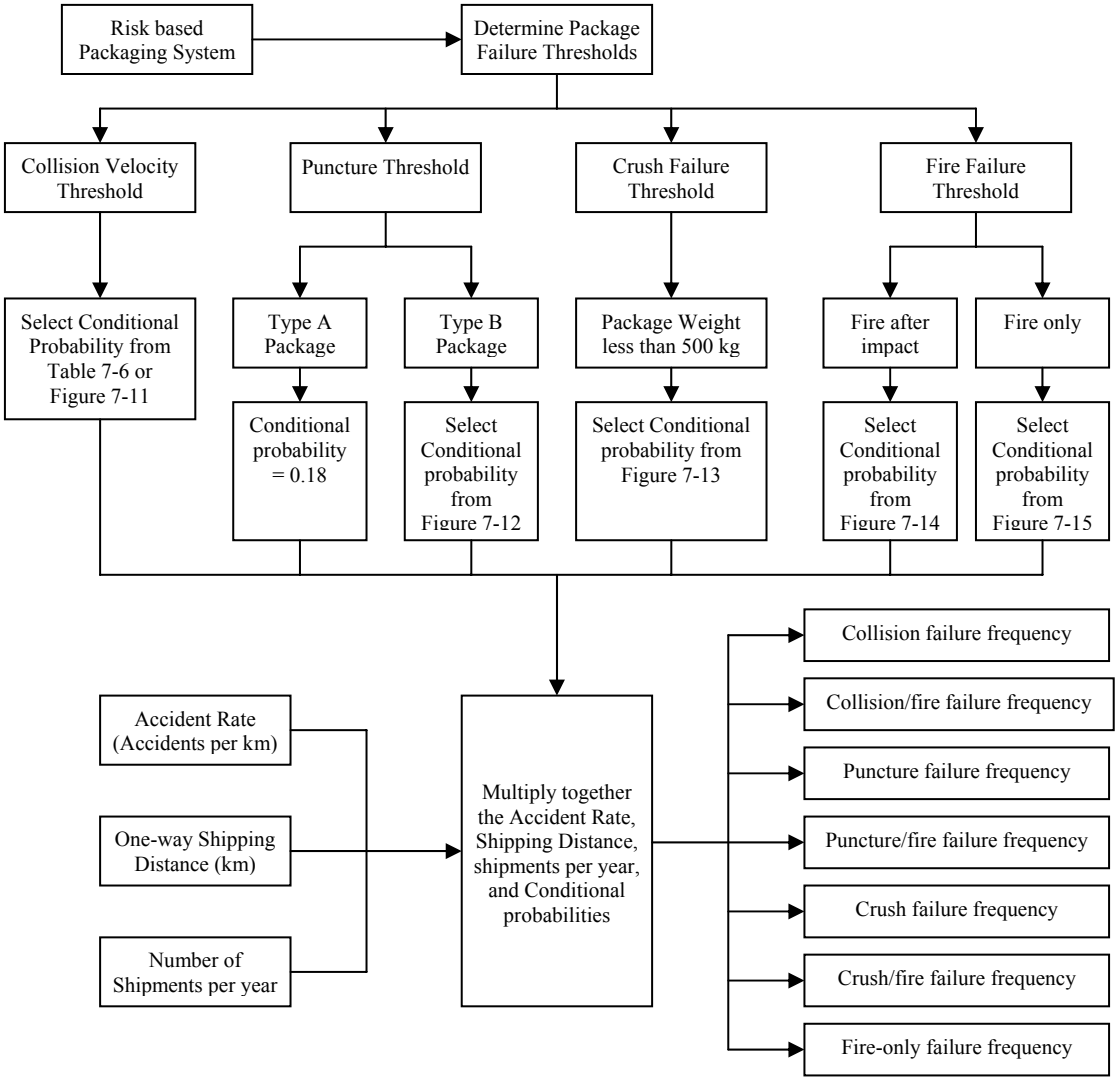
Table 7-7. Cumulative Fire Duration Probability Given Collision or Overturn.

Duration, minutes	Cumulative Probability	Duration, minutes	Cumulative Probability	Duration, minutes	Cumulative Probability	Duration, minutes	Cumulative Probability
0	0	20	0.9625	40	0.9970	60	0.9998
5	0.3311	25	0.9801	45	0.9985	65	0.99991
10	0.6596	30	0.9897	50	0.9992	70	0.99996
15	0.8551	35	0.9944	55	0.9996	75	~1

7.3.2.2.2 Hanford Site Accident Frequencies.

Figure 7-16 shows the overall calculation process for determining the frequencies of severe accidents that could result in package failures. Up to five accident scenario frequencies are calculated for Type A packages and five for Type B packages (note that a different set of data is used to calculate the probabilities of puncture for Type A packages than for Type B). The frequencies of severe accidents on the Hanford Site are calculated by multiplying together the accident rate, number of shipments per year of the particular cargo to be transported, one-way shipping distance, and the conditional probabilities of the various ACs described above. An example evaluation is provided in Appendix G.

Figure 7-16. Accident Frequency Calculation Process.



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CHAPTER 8.0. ROUTINE TRANSFERS

This chapter describes the processes and procedures used to make routine onsite shipments. All packagings prepared and shipped as routine must be authorized and fully comply with the provisions of the TSD. Basic procedures and processes for handling onsite shipments of hazardous materials and wastes are included in this chapter. Contractors provide more detailed facility/project operation procedures at the facilities where T&P activities occur.

8.1 COMMON HAZARDOUS MATERIALS AND WASTES SHIPPED ONSITE

All government-owned hazardous materials and wastes regulated by the DOT when shipped in commerce must be packaged and transported onsite in accordance with the provisions of this TSD regardless of the material or waste type or waste category. Generally, all onsite shipments made in accordance with this TSD are considered routine. Approximately 500 to 700 routine onsite shipments are made each month across the Hanford Site.

Nonroutine shipments are those that fall outside the provisions of the TSD or are shipments that meet the criteria of an "emergency move." Procedures for handling nonroutine shipments and emergency movements are further addressed in Chapter 9.0, Nonroutine Transfers.

The Hanford Site is a large industrial site with many chemical and nuclear processing facilities, laboratories, and waste management treatment, storage, and disposal sites. As a result, hundreds of different chemicals and chemical products are brought to the Hanford Site each year to support various projects and their missions. Materials commonly shipped onsite between facilities include the following:

- Flammable, nonflammable, and toxic compressed gases
- Corrosive liquids and solids
- Flammable liquids and solids
- Reactive metals, oxidizers, and explosives.

These materials and their resultant wastes represent all the DOT hazard classes (Class 1 through Class 9), and federal and state waste categories (EPA hazardous wastes, Washington Department of Ecology dangerous wastes, and extremely hazardous wastes.)

Additionally, radioactive materials and wastes are generated, used, and transported across the Hanford Site. Radioactive materials commonly shipped onsite include the following:

- Uranium and plutonium metals and oxides
- Sealed radiation, irradiation, and industrial test sources
- Process and environmental samples
- All categories of radioactive wastes
- Mixed waste.

Hanford Site facilities generate, package, and ship waste onsite to waste management treatment, storage, and disposal facilities. These radioactive wastes consist of the following categories:

Spent Nuclear Fuel - The majority of this material was generated at the nuclear production reactors along the Columbia River. Most of this fuel has been extracted from the fuel storage basins, placed into specially designed canisters and casks, and transported to the Canister Storage Building (CSB) located in 200 East Area. Currently, as SNF is found during decontamination and demolition (D&D) at other Hanford facilities, it is transported to the 100 K West basin for processing and shipment to storage. The onsite cask used for this transfer is called the multi-canister overpack cask. The fuel-filled canisters will remain at the CSB until they can be transferred to a licensed spent nuclear fuel repository.

High-Level Waste - The majority of the Hanford Site high-level waste (HLW) is stored in underground storage tanks located in the 200 East and 200 West areas. It is expected this waste will be extracted from the tanks and processed into vitrified glass, which, in turn will be placed into specially designed canisters for long-term storage and disposal. The low-activity waste generated from this process will be placed in a burial trench located in the 200 East Area. The HLW will be placed into special canisters and casks and transferred to the CSB in the 200 East Area and to similar buildings for long-term storage. The HLW will remain in storage until it can be transferred to a licensed HLW repository. Casks for the movement of the low-activity waste and HLW are currently being designed.

Transuranic Waste - This waste can be either remote-handled or contact-handled waste. It is generally confined to a small number of facilities that processed or handled transuranic (TRU) radionuclides, such as plutonium and americium, in support of defense program activities conducted at the Hanford Site. Much of this waste is located at the Hanford Site Plutonium Finishing Plant, CWC, and at the Waste Receiving and Processing facility. Generally, this waste is placed into authorized metal drums and metal box-based packaging systems and shipped onsite. Eventually, much of this waste will be prepared and shipped to the Waste Isolation Pilot Plant located near Carlsbad, New Mexico.

Low-Level Waste - This waste is generated at Hanford Site facilities where radioactive materials are processed or handled. This waste is usually a secondary waste stream generated because of other work or waste generated from a specific cleanup project. At the Hanford Site, this waste is usually made up of trash, building rubble, soil, laboratory supplies, and personal protective equipment potentially contaminated with mixed fission products or activation products. This waste is generally packaged in metal drums and metal boxes for contact-handled waste or specially designed casks or other container systems for remote-handled wastes. The wastes are transported onsite from the point of origin to the appropriate disposal facility or burial trench.

Mixed Waste or Radioactive Mixed Waste - This waste is generally radioactive low-level waste that is also cross contaminated with other hazardous constituents regulated under EPA or state rules. These wastes are generated throughout the Hanford Site and must be treated, stored, and disposed under special waste management rules. Generally, these wastes are packaged in metal drums or metal box containers or specially designed high-integrity containers. They are transported onsite to designated mixed waste facilities located in the 200 West Area.

8.2 COMMON PACKAGINGS USED

At the Hanford Site, the policy and expectation is that all hazardous materials and hazardous wastes (except onsite radioactive materials and wastes, or otherwise as stated in Sections 8.3.1.2 and 8.3.1.4) must be packaged and transported onsite and offsite in full compliance with DOT regulations. Onsite radioactive material and waste shipments must either meet DOT regulations or provide an equivalent degree of safety as defined and demonstrated in this TSD.

Most hazardous materials and wastes are packaged in nonbulk packagings authorized in accordance with the DOT regulations under 49 CFR 173, Sections 173.201, 173.202, and 173.203 for liquid hazardous materials meeting packing groups I, II, and II, and Sections 173.211, 173.212, and 173.213 for solid hazardous materials meeting packing groups I, II, and III. Commonly used containers or packagings are identified below:

- *Class 1 Explosives* – see 49 CFR 173 Subpart C for details

- *Class 2 Division 2.1, 2.2, and 2.3* – Cylinders meeting DOT Specification 3A, 3AA, 3AX, 4B and 39 as common examples

- *Class 3 Flammable Liquids* – DOT Specification UN1A1 or UN1A2 single packagings, or authorized combination packagings

- *Class 4 Flammable Solids* – DOT Specification UN1A1 or UN1A2 single packagings, or authorized combination packagings

- *Class 5 Oxidizers* – DOT Specification UN1A1 or UN1A2 single packagings, or authorized combination packagings

- *Class 6 Poisonous Materials* – DOT Specification UN1A1 or UN1A2 single packaging, or authorized combination packagings

- *Class 7 Radioactive* – Excepted packagings, industrial packagings IP-1, IP-2, IP-3, DOT Specification 7A Type A packagings, and NRC or DOT Certified Type B packages, or in onsite packaging systems authorized under the provision of this TSD. See Appendix A for a list of currently authorized onsite packaging systems

- *Class 8 Corrosives* – DOT Specification UN1A1 or UN1A2 single packagings, or authorized combination packagings

- *Class 9 Misc. Hazardous Materials* – Excepted packagings, and DOT Specification UN1A1 or UN1A2, or authorized combination packagings.

Some hazardous materials and wastes, including those that are radioactive, are transported onsite in bulk packagings. These include large wooden and metal boxes meeting appropriate specifications, and DOT Specification MC 312 and MC 412 cargo tanks. Table 8-1 provides a list of currently used cargo tank equipment.

Table 8-1. Current Cargo Tank-Trailer Fleet.

Tanker Type	Identification Number	Material of Construction	Capacity L (gal)
Polar[a] Tank Trailer, DOT MC 312	64-03858	316 Stainless Steel	19,000 (5,000)
Polar Tank Trailer, DOT MC 312	64-03859	316 Stainless Steel	19,000 (5,000)
Superior[b] Tank Trailer, DOT MC 412	64-04268	304 Stainless Steel	3,800 (1,000)
Polar Tank Trailer, DOT MC 312	64-04275	316 Stainless Steel	19,000 (5,000)
Walker[c] Tank Trailer, DOT MC 312	64-04294	316 Stainless Steel	19,000 (5,000)
Beall[d] Tank Trailer, DOT MC 412	64-05385	316 Stainless Steel	30,400 (8,000)
Beall Tank Trailer, DOT MC 412	64-05386	316 Stainless Steel	30,400 (8,000)
CHG Tanker			

[a]Polar is a trademark of Polar Tank Trailer, Inc., Holdingford, Minnesota.
[b]Superior is a trademark of Superior Steel Products, Inc., Caldwell, Idaho.
[c]Walker is a trademark of Walker Stainless Steel Equipment Company, Inc., New Lisbon, Wisconsin.
[d]Beall is a trademark of Beall Corp., Portland, Oregon.

The MC 312 cargo tanks were fabricated to the MC 312 DOT Specification per 49 CFR 178.340 and 178.343 (1989 standards). The MC 412 units were fabricated to the MC 412 DOT Specifications per 49 CFR 178.345 and 178.348 (current standards). Each cargo tank is ASME certified, and has a CoC that states the cargo tank was designed, constructed, and tested in accordance with DOT Motor Vehicle Cargo Tank Specifications for cargo tanks used for the transportation of liquids classified as hazardous material.

Special Packaging Authorizations (SPAs) contained in Appendix I identify typical packagings authorized for onsite shipment of radioactive material payloads under specific conditions and controls described in individual SPA documentation.

8.3 ONSITE HAZARDOUS AND RADIOACTIVE MATERIAL SHIPMENTS - PROCESS AND PROCEDURES

The previous two sections identified the commonly shipped hazardous materials and wastes, and the common packagings used to ship them. The following sections identify the procedures that are to be followed when conducting onsite shipments of hazardous materials.

8.3.1 Requirements

Onsite shipments of hazardous materials and wastes including radioactive materials and wastes must be executed in accordance with this TSD and in accordance with contractor implementing procedures.

RL, ORP, PNSO, and site prime contractors that conduct onsite hazardous material T&P activities must prepare and implement procedures that incorporate the following general and specific activities when applicable.

8.3.1.1 General Requirements for All Shipments

8.3.1.1.1 Contractor Program, Project, and Facility Procedures.

Hazardous material shipments must be performed in accordance with applicable operating procedures that provide for nuclear safety, environmental protection, QA, security, radiological exposure and contamination control, and T&P requirements, as well as applicable federal, state, and contractor requirements. Examples include the following:

DOE orders
49 CFR, "Transportation"
10 CFR 71 "Packaging and Transportation of Radioactive Materials"
10 CFR 830 "Nuclear Safety"
This TSD
PSSD or OTRS
CoC
10 CFR 835, "Occupational Radiation Protection."

All PSSD or OTRS requirements from applicable onsite package documents, CoCs, and/or applicable federal regulations governing the use of each package must be verified and incorporated into applicable program, project, facility operating, or work package procedures. Compliance with these procedural requirements is mandatory.

The safety assessments conducted for T&P activities are conducted for completed packages. The point where the safety responsibility transfers between a facility and the T&P activity is identified in Table 8-2.

Table 8-2. Transportation to Facility Safety Responsibility Interfaces.

Shipping Facility	Receiving Facility	TSD Interface Boundaries
Facility has safety or authorization basis document that defines facility boundary within which all activities including T&P activities are addressed.	Facility has safety or authorization basis document that defines facility boundary within which all activities including T&P activities are addressed.	Transfer of responsibility occurs at shipping facility safety or authorization basis boundary and at the receiving facility safety or authorization basis boundary.
Facility has not defined a boundary in a safety or authorization basis document within which T&P activities are addressed.	Facility has safety or authorization basis document that defines facility boundary within which all activities including T&P activities are addressed.	Transfer of responsibility occurs at shipping facility loading dock/area and at the receiving facility safety or authorization basis boundary.
Facility has not defined a boundary in a safety or authorization basis document within which T&P activities are addressed.	Facility has not defined a boundary in a safety or authorization basis document within which T&P activities are addressed.	Transfer of responsibility occurs at shipping facility loading dock/area and at the receiving facility loading/area dock.

All interface requirements resulting from transport of hazardous materials must be incorporated into operating procedures. Packing and unpacking of a package is conducted under the facility safety or authorization basis documentation, consistent with transportation safety basis requirements for the package. Procedures for those tasks, however, must incorporate steps that result in the completed package meeting all applicable T&P requirements. Packages prepared in full compliance with DOT requirements may be stored in compliance with DOT storage requirements if permitted by the facility safety or authorization basis documentation. All onsite packages must be stored in compliance with the facility safety or authorization basis documentation. All onsite packages must be loaded on the transport vehicle in compliance with both the facility safety or authorization basis documentation and the PSSD. Most PSSDs do not evaluate the hazards associated with packing or loading activities.

New or revised procedures for activities conducted at an interface must be subjected to the USQ_T process.

8.3.1.1.2 Packaging Authorization.

All hazardous material and waste (except radioactive material and waste, or otherwise as allowed in Sections 8.3.1.2 and 8.3.1.4) shipped onsite shall be packaged and shipped in accordance with DOT hazardous material regulations as set forth in 49 CFR 171 through 185, and conform to the requirements of this TSD.

Radioactive materials and wastes shipped onsite shall be packaged and shipped in accordance with DOT Hazardous Material Regulations as set forth in 49 CFR 171 through 185 or may be shipped under a DOE-approved alternative providing an equivalent degree of safety as specified in this TSD.

8.3.1.1.2.1 Approval of Packaging Systems.

DOE Order 460.1B requires DOE Operations or Field Offices to review and approve onsite Transportation Safety Documents. This TSD describes the methodology and compliance processes to meet equivalent safety measures relative to deviations from 49 CFR 173. This TSD defines three categories of packaging: (1) DOT-compliant packaging, (2) equivalent packaging, and (3) risk based packaging. Each of these categories of packaging is approved as described below.

8.3.1.1.2.1.(a) Compliant Packaging Systems.

8.3.1.1.2.1.(a).(1) NRC-Certified Packaging. If the contractor or DOE is registered as a user and the contractor possesses a copy of the latest NRC CoC and the packaging's SARP (or operation and maintenance chapters or manual), the contractor may use a NRC-certified packaging.

8.3.1.1.2.1.(a)(2) DOT Specification Containers. Packaging designs that have been published in 49 CFR 173 as specification packagings may be used as DOT compliant until October 2008 provided that all provisions of the DOT specification and applicable QA requirements are met and provided that the use of the packaging is not prohibited by DOE Order 460.1B.

8.3.1.1.2.1.(a)(3) IAEA Certificate of Competent Authority. DOE contractors may use any international certification to which they or DOE are registered as a user provided all requirements of the certification, special provisions, and other applicable regulations are met.

8.3.1.1.2.1.(a)(4) U.S. Department of Defense (DOD)-Certified Packaging. If the contractor or DOE is registered as a user and the contractor possesses a copy of the latest DOD CoC and the packaging's SARP (or operation and maintenance chapters or manual), the contractor may use a DOD-certified packaging.

8.3.1.1.2.1.(a)(5) DOE-Certified Packaging. DOE contractors may use a DOE-certified packaging provided the contractor possesses a copy of the latest DOE CoC and the packaging's SARP (or operation and maintenance chapters or manual).

8.3.1.1.2.1(b) Equivalent Packaging Systems. Equivalent packaging is packaging that can be shown conclusively to provide performance equivalent to packaging meeting DOT requirements for onsite shipment. Equivalent packaging is to be used with control and communication requirements equivalent to DOT or defined in the TSD. A PSSD is to be prepared that demonstrates the TSD requirements are met. The PSSD will provide evidence that the package meets equivalent standards. The initial PSSD will be approved by RL. Subsequent modifications to the PSSD will be performed using the RL-approved USQ_T process.

8.3.1.1.2.1.(c) Risk Based Packaging Systems. Risk based packaging is onsite packaging that cannot be demonstrated to function equivalently to DOT packaging. A PSSD will be prepared that establishes a performance envelope for the packaging and specific control and communication requirements developed that ensure the transport system operates safely within the performance envelope. To establish the performance envelope of the packaging, evaluation of the requirements established in Chapter 6.0 will be conducted in accordance with the methodology established in Chapter 7.0. The initial PSSD will be approved by RL. Subsequent modifications to the PSSD will be performed using the RL-approved USQ_T process (Appendix C).

8.3.1.1.3 Personnel Delegation and Training.

All personnel involved with preparing hazardous material for transport including operators, drivers, waste handlers, and managers are considered hazmat employees and must be trained in accordance with 49 CFR 172.704, "Training requirements." See Chapter 10, Personnel Training and Qualification, for details.

Contractor operating organizations making shipments must establish a process for authorizing and delegating shipper responsibility.

The authorizing signature on a shipping document shall be that of an individual who is on the contractors' delegated (authorized) shippers list.

Drivers of vehicles hauling hazardous material onsite must have a current and appropriate driver's license (e.g., commercial driver's license [CDL] when required), medical card, and if transporting greater than highway route controlled quantity, proof of training in their possession while on duty.

USQ_T evaluators must be appropriately trained in accordance with 49 CFR 172.704 and the requirements of the contractor's USQ_T process (see Appendix C).

8.3.1.1.4 Operational Controls.

Authorized shippers should use a shipment checklist when preparing hazardous material and waste shipments, radioactive material and waste shipments, and mixed waste shipments.

Transport of government-owned hazardous material by Hanford Site contractors shall be performed using a commercial carrier or approved government vehicle properly equipped to transport hazardous material with a trained and qualified driver. Transport of nongovernment-owned hazardous materials must meet the same requirements as when transported offsite.

Only properly maintained and regulatory-compliant motor vehicles may be used for the transportation of hazardous material.

The shipment of hazardous materials in privately owned vehicles is prohibited.

The contractor shall define acceptable conditions for weather, road conditions, and other natural phenomena. At a minimum, the following will be included in safety assessments and operating procedures for onsite transport. If the ambient air temperature is 4 ^{o}C (40 ^{o}F) or less (as determined at the Hanford Weather Station just prior to shipment), personnel shall drive the shipping route to ensure there is no appreciable ice or snow on the road immediately prior to shipment. If it is determined that adequate traction exists, the shipment may be made. If visibility is less than 200 m (0.125 mi), the shipment shall not be made.

A copy of the current Hazardous Material - Certificates of Registration must be provided in the cab of each vehicle that may require placards for the transport of hazardous material (49 CFR 107, Subpart G).

8.3.1.1.5 Documentation and Records.

Source documentation used for physical, chemical, and radiological characterization of material and waste must be maintained as described in the contractor's records management system. Source documentation may include laboratory analysis, Material Safety Data Sheets, contents inventory sheets, waste designations, radiological characterization data, radiological calculation data, survey reports, radioactive material area certifications, Solid Waste Information Tracking System (SWITS) reports, and/or Land Disposal Restriction Certifications/Notifications.

An auditable record of the inspection, maintenance, and certification for a packaging that documents the package is ready for use must be maintained at the packager's facility. This includes a copy of the current PSSD (e.g., onsite SARP, OTRS, SEP, test and evaluation report, CoC, or O&M instructions) and should include applicable package testing documentation and package closure instructions.

The shipper must be able to document that each package's content meets the authorized payload limits as applicable in 49 CFR, the CoC issued by the NRC or DOE, or the onsite package documentation.

Records generated because of transporting hazardous material must be maintained. This includes a file of supporting documentation used as a basis for making the shipment (e.g., current CoC, PSSD). All appropriate internal procedures must reflect the requirements of these documents prior to making the initial shipment. Records should be retained for the same period as defined for the equivalent offsite shipment.

8.3.1.1.6 Safeguards and Security.

Shipments of accountable nuclear materials must have contractor and DOE Safeguard's approval prior to shipment.

Shipments of Category I and II SNM must be scheduled in advance to ensure availability of equipment, security, and properly cleared drivers.

When road closures are required by the PSSD or by safeguards and security requirements, these closures shall be coordinated and scheduled through the transportation service provider lead or designee.

8.3.1.1.7 Nuclear and Radiological Safety.

All commercial vehicles operated by non-Hanford Site contractors will be free released back into commerce using DOT limits. Contractors using their own vehicles will also be released using DOT limits. All other onsite shipments using government vehicles will be free released per limits specified in 10 CFR 835.

Dose rates and contamination limits for onsite shipments must comply with, as applicable, 49 CFR 173; 10 CFR 835, Appendix D; or under limits authorized by this TSD within the specific PSSD (e.g., onsite SARP, OTRS or SEP).

8.3.1.1.8 Planning and Communications.

U.S. Department of Energy-Headquarters (DOE-HQ) Security approval is required for certain radioactive material shipments. In order to obtain this approval, a request is submitted by the contractor to the RL Traffic Manager at least two weeks prior to the shipment. The RL Traffic Manager will notify the contractor when DOE-HQ approval is received.

Each shipper of fissile radioactive material, Type B quantity of radioactive material, or gas poisonous by inhalation must provide the receiving organization with an estimated time of arrival and notification of shipment release. If a shipment of fissile radioactive material, Type B quantity radioactive material, or gas poisonous by inhalation is not received at its intended destination near the expected estimated time of arrival, the receiving organization must contact the originator to determine reason for delay and to determine if corrective actions are necessary.

A one-day advance notice of shipment to involved organizations is recommended. The notice is to allow time for adequate regulatory review and coordination for onsite shipments. Special shipments (e.g., waste shipments, road closure, or escorted shipments) may require longer lead times.

Emergency response information must be provided in the cab of the vehicle. This includes the appropriate emergency response guide page from the *North American Emergency Response Guidebook*, the shipping papers, or a current copy of the guidebook. Shipping papers must provide an emergency contact telephone number.

Contractor management must be notified of all transportation-related incidents as soon as practical. Formal reporting of all incidents must be completed in accordance with the Hanford Site incident and occurrence reporting system requirements.

8.3.1.1.9 Checklists.

The contractor should develop a shipment checklist. The checklists should include applicable requirements from DOE orders, DOT regulations, and onsite shipment requirements adequate to ensure that material is characterized, described, packaged, marked, labeled, and can be transported in accordance with applicable requirements. A checklist should be completed prior to each shipment not covered by an *Onsite Routine Radioactive Shipment Record* (ORRSR). An example of the typical checklists can be found in Appendix H, Example Checklists.

8.3.1.2 Radioactive Material Shipments – General Provisions

8.3.1.2.1 Fissile Material and SNM.

The shipment of fissile material requires certain controls in addition to those needed for nonfissile radioactive material. Fissile material requires controls for criticality safety and accountability and because DOT-designated fissile material is also SNM of national strategic importance, additional controls for security and safeguards are mandatory. Fissile material as defined per 49 CFR 173.403 identifies the following radionuclides and isotopes: ^{239}Pu, ^{241}Pu, and ^{233}U, ^{235}U, or combinations of these radionuclides.

<u>Fissile-Excepted Material</u> - Fissile material is classified as either fissile or fissile-excepted material. Fissile-excepted material is exempted from criticality safety packaging requirements. These shipments must be in accordance with both shipping and receiving facility fissionable material limits and restrictions. Fissile material exceptions given in 49 CFR 173.453, “Fissile materials—exceptions,” may be used for onsite shipments.

Shippers must evaluate fissile material packages and shipments per limitations specified in the following:

- 10 CFR 71.18, “General License: Fissile material limited quantity per package,” through 10 CFR 71.24, “General License: Fissile material, limited moderator, controlled shipment”

- 10 CFR 71.35, “Package evaluation”

- 49 CFR 173.457, "Transportation of fissile material, controlled shipments—specific requirements"

- 49 CFR 173.459, "Mixing of fissile material packages."

This requires the shipper to evaluate activity and packaging per these section limitations.

Fissile Material - All onsite shipments of fissile material not packaged in offsite packages shall be packaged in packages authorized by the TSD and reviewed and approved by the contractor approval authority. Appropriate ES&H and QA organizations shall review onsite packages for criticality safety concerns. Onsite package design when coupled with other considerations shall provide criticality safety protection equivalent to protection provided by approved offsite packages.

Onsite shipments shall be made in accordance with both shipping and receiving facility criticality safety specifications or facility fissile material status and the package fissile contents limitations based on the PSSD. The PSSD shall be available for use within the loading and unloading areas or any place where packages containing fissionable material are stored.

Accountable Material - Accountable material is nuclear material so designated by the Secretary of Energy and currently includes depleted uranium, enriched uranium, ^{241}Am, ^{243}Am, curium, berkelium, californium, $^{238\text{-}242}$Pu, ^{6}Li, ^{233}U, normal uranium, ^{237}Np, deuterium, tritium, and thorium. The requirements of the contractor's nuclear material accountability plan describe accountable material as any material that contains 0.5 times or more of the reporting unit of one or more of the above listed materials, elements, or isotopes. In more general terms, some of this material is also referred to as the following:

- Nuclear material
- SNM
- Source material.

Accountable nuclear material must be controlled and accounted for as directed by DOE Order 474.1A, *Control and Accountability of Nuclear Materials*. Material shipments and transfers must be documented and controlled in conformity with this order.

Approvals for Accountable Radioactive Material - Certain onsite movements of accountable radioactive material require Safeguard's concurrence and RL approval. Nonreportable radioactive material shipments and some small amounts of accountable radioactive material may be covered by a blanket approval obtained at the beginning of each fiscal year; approvals for larger amounts of accountable material are generated on a case-by-case basis. (RLID 473.1)

The shipment originator shall initiate application for Safeguard's concurrence and RL approval of the shipment. (RLID 473.1)

Categorization and Physical Protection for SNM Shipments - The degree of security imposed on SNM shipments is determined by the category amounts of SNM. DOE Order 474.1A defines the minimum requirements for safeguarding SNM by categories while in transit.

The contractor must manage all Category I shipments and their documentation as classified. Some Category II shipments may also be classified based on the criteria established in DOE Order 474.1A.

8.3.1.2.2. Radioactive Mixed Waste.

Radioactive mixed waste is radioactive waste contaminated with waste that is hazardous/dangerous as defined in 40 CFR 261 and/or WAC 173-303. The radioactive component of mixed waste is regulated under the *Atomic Energy Act of 1954*. The nonradioactive hazardous component of mixed waste is regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA). To the extent that RCRA is not inconsistent with the *Atomic Energy Act of 1954*, mixed waste must be handled in accordance with the requirements of both federal laws (except as noted below).

Note: Normally scheduled routine, radioactive mixed waste shipped solely within the 300 Area (other than those radioactive mixed wastes requiring placarding per 49 CFR 172.504, Table 1) may be packaged and transported in compliance with contractor approved procedures; those radioactive mixed wastes where placarding is required per Table 1 shall be packaged (including marking and labeling) in accordance with DOT hazardous material regulations when shipped solely within the 300 Area.

8.3.1.2.3 Shipment of Packages on Public Access Roadways.

All radioactive material transported over onsite roadways that are open to the public (DOT definition of "in-commerce") must be in compliance with DOT regulations. For a shipment that does not meet these regulations, transporting on the Hanford Site may be done during off-peak hours with the roads closed and/or crossings manned by Benton County Sheriff or Hanford Patrol to prevent public access to the shipment.

This provision, allowed by DOT, removes the “in-commerce” clause by physically eliminating unrestricted public access by the use of gates and/or guards. This process has been reviewed and approved by the DOT and DOE. For these shipments, packages approved only for onsite use by PSSD (e.g., SARP, SEP) are authorized. In addition to the road closure requirements, the applicable PSSD may require other safety constraints such as speed restrictions and/or escorts for the shipment.

Each contractor shall implement a 'Road Closure' procedure prior to performing a shipment requiring restricting public access. The procedure shall direct how Hanford Site areas and roadways to which the public has access are to be closed so that onsite shipments can be conducted. The procedure shall ensure, as a minimum, the following requirements:

- Public access will be restricted for a hazardous materials shipment
- Authorization is required before shipment
- Roads and areas to be closed
- Escort requirements
- Roads are barricaded to exclude the public
- Movement of the shipment into controlled areas and how roads will be controlled
- No traffic on the roads or in the area before shipment
- Emergency vehicle access during a road or area closure
- 'Safe secure trailer' shipment has access during a road closure
- Road closure occurs during off-peak hours.

8.3.1.2.4 Radiological Vehicle Control Program.

Radiological controlled vehicles, formerly referred to as "regulated vehicles," do not qualify as radioactive material shipments by DOT definition and, therefore, are not documented on an onsite *Radioactive Shipment Record* (RSR). Movement and management of these vehicles onsite are covered under an approved program. This program identifies responsibilities and requirements for managing all radiological controlled vehicles including survey requirements and identification of the vehicles as per 10 CFR 835.603, "Radiological areas and radioactive material areas," paragraph (g), which requires the placement of a decal bearing a trefoil symbol and the words "Caution Radioactive Material" posted on the front, back, and both sides of the vehicle.

8.3.1.2.5 Radioactive Instruments and Articles (Radiological Sources).

Radioactive material that meets the definition as described in 49 CFR 173.424, "Excepted packages for radioactive instruments and articles," (i.e., radiological sources) shall be packaged/transported by or under the direction of authorized personnel. In order to use the provisions of 49 CFR 173.424, items (a) through (h) have to be satisfied. This includes the packaging requirements referenced in 49 CFR 173.410, "General design requirements," and notice requirements in 49 CFR 173.422, "Additional requirements for excepted packages containing Class 7 (Radioactive) materials," which requires information on the outside of the packaging. The ORRSR may be used in place of normal package documentation to control onsite movement of these sources.

8.3.1.2.6 Inspection and Maintenance Completion Time Frames.

Table 8-3 provides acceptable completion time frames for periodic inspection and maintenance activities required by PSSDs. These time frames apply when completion of maintenance activities required by the PSSD cannot be completed within the required inspection and maintenance cycles. This situation can occur if a shipment is delayed after loading, precluding any maintenance activities. If maintenance activities will be due during a planned use of the vehicle or packaging, the maintenance activity should be completed prior to use. A package may not be loaded outside of its maintenance timeframe. For example if a package's annual leak test is due February 15, 200X, and the leak test is not completed by that date, it may not be loaded until the satisfactory completion of the leak test. The leak test is considered to be completed *in periodicity* as long as it is completed within the 48 to 56 week window under this section of the TSD.

Table 8-3. Inspection and Maintenance Completion Time Frames.

Package-specific safety document required maintenance time frame	Approved completion windows
Monthly	3 to 5 weeks
Quarterly	10 to 14 weeks
Annually	48 to 56 weeks

8.3.1.3 Onsite Routine Radioactive Shipment Record

Because of their frequency and uniformity of contents and packaging, some onsite radioactive material shipments are considered routine and the contractor may authorize movement and documentation by using a special shipping paper known as an Onsite Routine Radioactive Materials Shipment Record (ORRSR).

The ORRSR must provide preprinted shipment requirements and limitations. The preprinted requirements and limitations specified must be adhered to when making a shipment using the ORRSR. Violations or misuse must result in withdrawal of the ORRSR by the contractor.

Requirements, limitations, and supporting documentation specified on the ORRSR shall be reviewed and approved by the following organizations:

- Operations management (management of organization requesting ORRSR)
- Requesting facility's radiological engineering safety
- The transportation service provider lead or designee.

The ORRSR may allow qualified personnel as well as authorized radioactive material shippers to certify that the shipment meets all the requirements as set forth on the ORRSR. The transportation lead or designee shall certify the packaging system meets applicable requirements for onsite shipment.

8.3.1.4 Onsite Nonradioactive Hazardous Material/Hazardous Waste Shipments

The contractor shall ensure the onsite nonradioactive hazardous materials/hazardous waste shipments are made in compliance with applicable DOT requirements (except as noted below). The contractor is responsible to obtain a DOE approval or waiver from RL for any requirement that cannot be met in accordance with the provisions of this TSD.

Note: Normally scheduled routine, hazardous materials shipped solely within the 300 Area (other than those hazardous materials requiring placarding per 49 CFR 172.504, Table 1) may be packaged and transported in compliance with contractor approved procedures; those hazardous materials where placarding is required per Table 1 shall be packaged (including marking and labeling) in accordance with DOT hazardous material regulations when shipped solely within the 300 Area.

Procedures for onsite shipment of nonradioactive material/waste must include directions on how to accomplish the following tasks:

1. Obtain source documentation for proposed package contents.

2. Determine if the material to be transported meets the definition of a hazardous material as defined in 49 CFR 171.8, "Definitions and abbreviations."

3. Determine how the material to be shipped is defined by chemical, technical, or generic name.
   a. Determine or define hazardous properties.
   b. Determine quantity of material to be shipped (by weight, volume, or otherwise, as appropriate).

4. If material to be shipped is currently packaged, determine if packaging is in unimpaired condition and meets DOT regulations for the material contained.

5. If material is a waste, determine if it is a federally regulated hazardous waste (40 CFR 261 and WAC 173-303-070) or a state-only dangerous waste regulated only by WAC 173-303-070 in accordance with WAC 173-303.

6. Consult the HMT in 49 CFR 172.101 "Subpart B-purpose and use of hazardous materials table."
   a. Determine if material contains a RQ of a hazardous substance under 49 CFR 172.101, Appendix 1, "Hazardous substances other than radionuclides."
   b. Determine hazard class and/or division (Column 3 of HMT).

c. Establish proper shipping name (Column 2 of HMT or WAC 173-303-180(7) for state-only dangerous waste).
d. Determine identification number (Column 4 of HMT).
e. Determine packing group (Column 5 of HMT).
f. Determine labeling requirements that apply to the shipment (Column 6 of HMT).
g. Determine special provisions applicable to the shipment (Column 7 of HMT).

Note: 49 CFR 173, contains specific requirements for packaging hazardous material or waste identified in the HMT. These requirements should be closely examined because they specify types of packaging, loading requirements and restrictions, internal packaging, and markings specific to the commodity being shipped.

7. If material is unpackaged, or requires repackaging, select and obtain a container based on the following considerations:
   a. The applicable determinations of Steps 1 through 5 above.
   b. Size, shape, weight, and volume of material to be shipped.
   c. Destination, mode of transport, and consignee's ability to handle receipt of the shipment (air carriers may have different requirements for size and weight limits for sample shipments).
   d. Availability of shipping containers.

8. Complete a packaging, marking, labeling, and loading instructions checklist if used.

9. Inspect the package to make sure it is in unimpaired physical condition. Verify that the package meets specifications of Column 8 in the HMT. If the package is a DOT performance-oriented package, verify the manufacturer's notification is available. If it is not available, obtain the notification.

10. Fill and close the package following the manufacturer's notification if applicable.

11. Inspect marking and labeling on containers and correct deficiencies as necessary.

12. If shipment is to be made from a radiation control area, obtain a radiation survey to determine radiation and contamination information and to ensure the exterior surfaces are free of contamination.

13. When required, contact the receiving facility and arrange for receipt of the load.
    a. Make all shipment pre-notifications to the receiving facility.
    b. Notify the consignee (receiver) of the dates of the shipment, the expected date of arrival, and any special loading and unloading instructions.

14. Coordinate the shipment with transportation and waste handling organizations.

15. Determine the appropriate shipping paper to be used: *Hazardous Material Shipment Record* (HMSR), *Uniform Hazardous Waste Manifest* (UHWM).

16. When a HMSR is the shipping paper used, complete Form 54-3000-596 or equivalent, i.e., shipment record generated in SWITS database.

17. When a UHWM is the shipping paper used, complete the form or equivalent, i.e., shipment record generated in SWITS database. The completed manifest, and other pertinent shipping papers or instructions, must accompany the shipment. Distribution of the UHWM can be found on the back of the form.

Note: If an outdated UHWM is being used, EPA has authorized the continued use of the forms. The Federal Register has published this authorization allowing preparers of the UHWM to line out void expiration dates and write in the new extension date along with the preparer's initials in the upper right corner.

8.3.1.5 Onsite Radioactive Material/Waste Shipments

Procedures for the onsite shipment of radioactive material/waste must include directions on how to accomplish the following tasks:

1. Determining if the material to be shipped is radioactive material to be regulated by DOT or this TSD. Refer to 49 CFR 173.403, "Radioactive material."
   a. Determine the radionuclides present (e.g., ^{239}Pu, ^{233}U, ^{137}Cs).
   b. Determine the total activity in terms of becquerels (Bq).
   c. When fissile radionuclides are present (49 CFR 173.403, "Definitions"), determine the grams of fissile material for criticality control.
   d. Determine if material qualifies as a Hazardous Substance RQ. (See 49 CFR 171.8, "Definitions and abbreviations," and 49 CFR 172.101, Appendix A, Tables 1 and 2, 'Other than radionuclides' and 'Radionuclides.')
   e. Determine if material will be shipped as 'normal form' or 'special form' (49 CFR 173.403).
   f. If normal form, determine the physical form (e.g., solid, liquid, gas) and the chemical form (e.g., nitrate, oxide, elemental) of the radioactive material.
   g. Determine if other hazardous material is present or if other hazardous characteristics are exhibited (e.g., corrosive, flammable liquid, oxidizing material).
   h. If the material is a waste, determine if it is a federally regulated hazardous waste (40 CFR 261 and WAC 173-303-070) or a state-only dangerous waste regulated only by WAC 173-303-070 in accordance with WAC 173-303.
   i. Identify appropriate A_1 or A_2 values for radionuclides present.

      - Determine A_1 values for radionuclides in special form (49 CFR 173.433, "Requirements for determining A_1 and A_2 values for radionuclides and for the listing of radionuclides on shipper papers and labels," and 49 CFR 173.435, "Table of A_1 and A_2 values for radionuclides.").

      - Determine A_2 values for radionuclides in normal form (49 CFR 173.433 and 49 CFR 173.435).

j. Determine the quantity category based on the radionuclides present, their A_1 or A_2 values as appropriate, and the total activity in Bq (TBq is also acceptable) in each package (e.g., cask, box, drum). See the following sections of 49 CFR for the quantities listed:

- LSA I, II, or III radioactive material, or SCO I or II (49 CFR 173.403). Materials classified as either LSA or SCO require a formal evaluation of the material to insure that it qualified as either LSA or SCO. This formal evaluation will be conducted in accordance with the methodology in NRC NUREG-1608, "Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects. The formal evaluation will be included with the shipment records.

- Excepted Package, 49 CFR 173.403 and 49 CFR 173.421 through 173.426.

- Type A Quantity, 49 CFR 173.431, "Activity limits for Type A and Type B packages," paragraph (a).

- Type B Quantity, 49 CFR 173.431, paragraph (b).

- Highway Route Controlled Quantity, 49 CFR 173.403.

Note: (If a LSA or SCO shipment contains fissile radionuclides, they must meet the requirements for fissile-excepted per 49 CFR 173.453.)

2. Determine the proper shipping name, hazard class, and the United Nations/North American Hazardous Material Identification number. (49 CFR 172.101, HMT, Columns 2, 3 and 4 or WAC 173-303-180(7) for state-only dangerous waste)

3. Determine the packaging, marking, and labeling requirements.

4. A listing of commonly used packages for shipping radioactive material onsite can be found in Appendix A, Package-Specific Safety Documentation.

   a. Select a packaging according to either 49 CFR or this TSD based on the following considerations:

   - Preference to use DOT/DOE/NRC compliant package, or if unavailable, an onsite package approved under this TSD

   - Quantity, type, form, and classification of material to be packaged

   - Need for shielding and/or cooling

- Size, shape, and weight of material to be shipped; if other hazards present, compatibility with those hazards
- Destination, mode of transport, and consignee's ability to receive the shipment
- Dose rate and contamination considerations
- Availability of shipping packages
- The additional requirements of HNF-EP-0063, HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*, Rev. 1 or other on-site receiving facilities..

b. Determine marking and labeling requirements for each package in compliance with 49 CFR or the PSSD, where applicable. Because of high dose rates, the requirement to mark and/or label may be waived according to the applicable PSSD (e.g., SARP or SEP).

5. Determine all special considerations such as suggested routings, mode of transport, special vehicle requirements, safeguards and security considerations, destination, requested delivery dates, and any other pertinent information concerning the shipment.

6. Arrange for a radiological survey of the package(s) to determine that dose rate limits and removable contamination limits are not exceeded.

Note: Certain packaging systems are exempt from onsite limits and are instead controlled by limits specified in the approved PSSD.

7. Determine the category and the security requirement if the material is SNM (see DOE Order 474.1A). Obtain Safeguard's review if necessary.

8. Determine the shipping paper to be used.

9. Determine if any requirements found in Section 8.3.1.2, Radioactive Material Shipments - General Provisions, apply to the material.

10. Identify package, loading, and closure instructions.

11. Ensure the appropriate emergency response phone number is documented on the shipment record (e.g., RSR, Hazardous Waste Manifest).

12. Schedule onsite transportation from the originating facility to receiving facility. Schedule transportation equipment suitable for the shipment. Schedule radiological control technician (RCT) support or road closure support if required.

13. Arrange for a RCT to perform a removable contamination and deep dose radiation survey of the vehicle and vehicle cab for release per applicable limits and swipe requirements.

14. Ensure the vehicle is appropriate for the load and free of defects that could affect the safe transport of the material. Verify that a copy of the current Hazardous Material Certificate of Registration is in the cab of each vehicle that may require placards for the transport of hazardous material or is a commercial motor vehicle with a gross vehicle weight rating of 4,356 kg (10,000 lb).

15. Verify a copy of the Safety Permit required in 49 CFR 385.415(a)(1) is in the vehicle when transporting materials requiring a Safety Permit (49 CFR 385.403)

16. Ensure preventative maintenance or equivalent inspections are current and required safety equipment is on the transport vehicle.

17. Ensure required emergency equipment is on the transport vehicle: Warning devices for stopped vehicles such as bi-directional reflective triangles or flares, spare fuses (if equipped) and charged fire extinguisher rated 10 BC or more.

18. Ensure the RCT has verified the radiation level in the cab is within acceptable limits (e.g., less than 0.02 mSv/hr). Note: this level can be exceeded if the driver has appropriate dosimetery and is in a federally regulated radiation protection program (49 CFR 173.441(b)(4).

19. Ensure supervision of the loading and securing of packages into or onto the transport vehicle to ensure compliance with applicable loading and tiedown requirements as specified in 49 CFR 393, "Subpart I-Protection Against Shifting or Falling Cargo;" 49 CFR 177.834(a), "General requirements;" or procedures found in the PSSD (e.g., SARP or CoC). Ensure riggers or truck drivers are aware of any tiedown requirements that may be listed in associated CoCs, PSSD, work procedures.

20. Ensure the carrier has received instructions pertaining to any administrative controls specified in the PSSD for transport of the package(s).

21. Advise the receiver of the estimated time of arrival and request confirmation of delivery on inter-area shipments exceeding Type A quantities.

Note: Depending on the quantities shipped, some SNM shipments shall require classified notifications. Information and quantity limits can be found in DOE Order 474.1A and should be consulted prior to all SNM shipment.

22. When applicable, make the following notifications when performing SNM shipments:

- Notify the on-duty Hanford Fire Department battalion chief of the starting time, estimated duration of the shipment, route to be followed, and destination to expedite assistance, if needed. Examples are road closure, and "no fire" provision.

- Notify Hanford Patrol of the departure time, route, destination, and estimated time of arrival. Request escort service as required.

23. Ensure completion of the applicable shipment checklist.

24. Resolve all questions concerning any special services required while the package is being transported to the consignee's facility (e.g., cooling water in case of delay enroute, control of personnel because of a radiation dose, escort by Hanford Patrol or Benton County Sheriff for traffic control).

25. Ensure the original shipping paper(s) are provided to the driver making the shipment.

26 Ensure the proper placard is identified for the material to be transported.

27. Ensure the transport vehicle is placarded “Radioactive,” when required, and as appropriate for other hazardous material being transported in accordance with DOT regulations or as required when utilizing PSSD (e.g., SARPs, SEPs). Ensure placarding is documented on shipping paper in appropriate box.

28. A copy of the shipping document shall be maintained as a record.

8.3.1.6 Special Packaging Zone (SPZ).

An SPZ is a TSD-designated onsite area composed of multiple facilities connected by a road or roads that are access restricted to authorized onsite users. The facilities may be collocated or in close proximity to each other. The SPZ will include both the designated facilities and roads. Shipments between facilities within the SPZ are subject to modified marking, labeling, placarding, and manifest requirements listed below. With the exception of placarding and manifest requirements, waste shipments between facilities within the SPZ will meet other TSD requirements. All shipments within the SPZ will be shipped in approved packages in accordance with package requirements. SPZ requirements do not supercede facility placarding and manifest requirements. Use of the SPZ designation for shipments is voluntary. When using the SPZ option for shipments, the shipper shall comply with the TSD except as clarified below.

Manifesting: The use of a separate shipping manifest is optional where there is an existing documented hazardous material inventory document available; e.g., ORRSR, Traveler, or equivalent. An inventory of hazardous material being shipped is still required; a separate shipping manifest is not required.

Notifications: The shipper is required to notify potential emergency response responders along the shipping route of the shipment, contents, and schedule.

Road Access Restrictions: The shipper is responsible for limiting access to the shipment route during the shipment to eliminate nonessential traffic for the duration of the shipment. Methods for limiting access can include road closures or moving road closures.

It is the responsibility of the shipper to coordinate shipments to minimize impact on other operations.

Table 8-4 shows the SPZs, facilities, and boundaries.

Table 8-4. Special Packaging Zones.

SPZ	Name	Facilities	Boundaries
1	100/200 Restricted Area	All onsite facilities and roadways north of the Wye Barricade and inside (east) of the Yakima and Rattlesnake Barricades	See Map 1.
2	Reserved		
3	Reserved		
4	Reserved		
5	300 Area	300 Area facilities and PNNL North Richland facility	See Map 5.
6	400 Area	FFTF and related facilities	See Map 6.

CVDF = Cold Vacuum Drying Facility
CWC = Central Waste Complex
FFTF = Fast Flux Test Facility
ERDF = Environmental Restoration Disposal Facility
LLBG = low-level burial grounds
ORP = Office of River Protection
PFP = Plutonium Finishing Plant
PNNL = Pacific Northwest National Laboratory
WRAP = Waste Receiving and Packaging

8.4 REFERENCES

10 CFR 71, "Packaging and Transportation of Radioactive Material," *Code of Federal Regulations,* as amended.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations,* as amended.

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations,* as amended.

49 CFR 107, "Hazardous Materials Program Procedures," *Code of Federal Regulations*, as amended.

49 CFR 171, "General Information, Regulations, and Definitions," *Code of Federal Regulations*, as amended.

49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements," *Code of Federal Regulations,* as amended.

49 CFR 173, "Shippers--General Requirements for Shipments and Packagings," *Code of Federal Regulations,* as amended.

49 CFR 177, "Carriage by Public Highway," *Code of Federal Regulations,* as amended.

49 CFR 178, "Specifications for Packagings," *Code of Federal Regulations,* as amended.

49 CFR 393, "Parts and Accessories Necessary for Safe Operation," *Code of Federal Regulations,* as amended.

49 CFR Subchapter C, "Hazardous Materials Regulations," *Code of Federal Regulations*, as amended.

DOE Order 474.1A, *Control and Accountability of Nuclear Materials*, U.S. Department of Energy, Washington, D.C.

DOT, *North American Emergency Response Guidebook*, U.S. Department of Transportation, Research and Special Programs Administration, Office of Hazardous Materials Initiatives and Training.

DOE Order 460.1B, *Packaging and Transportation Safety*, U.S. Department of Energy, Washington, D.C.

HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*, Fluor Hanford, Richland, Washington.

HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*, Fluor Hanford, Richland, Washington.

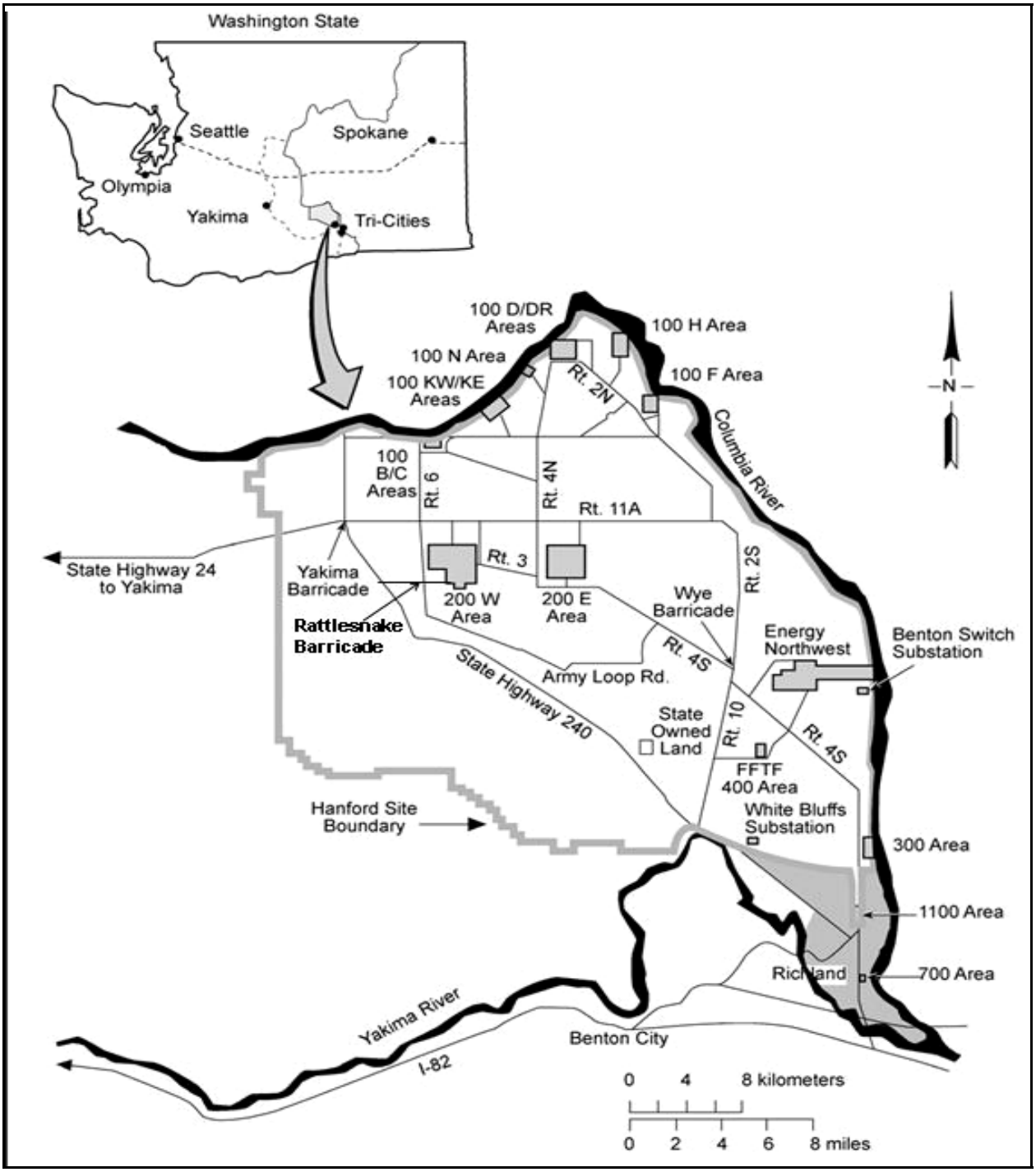
NUREG-1608, "Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects, Nuclear Regulatory Commission, Washington, D. C.

RLID 473.1, *Protection of Safeguards and Security Interests*, Implementing Directive, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Washington State Department of Ecology, Olympia, Washington.

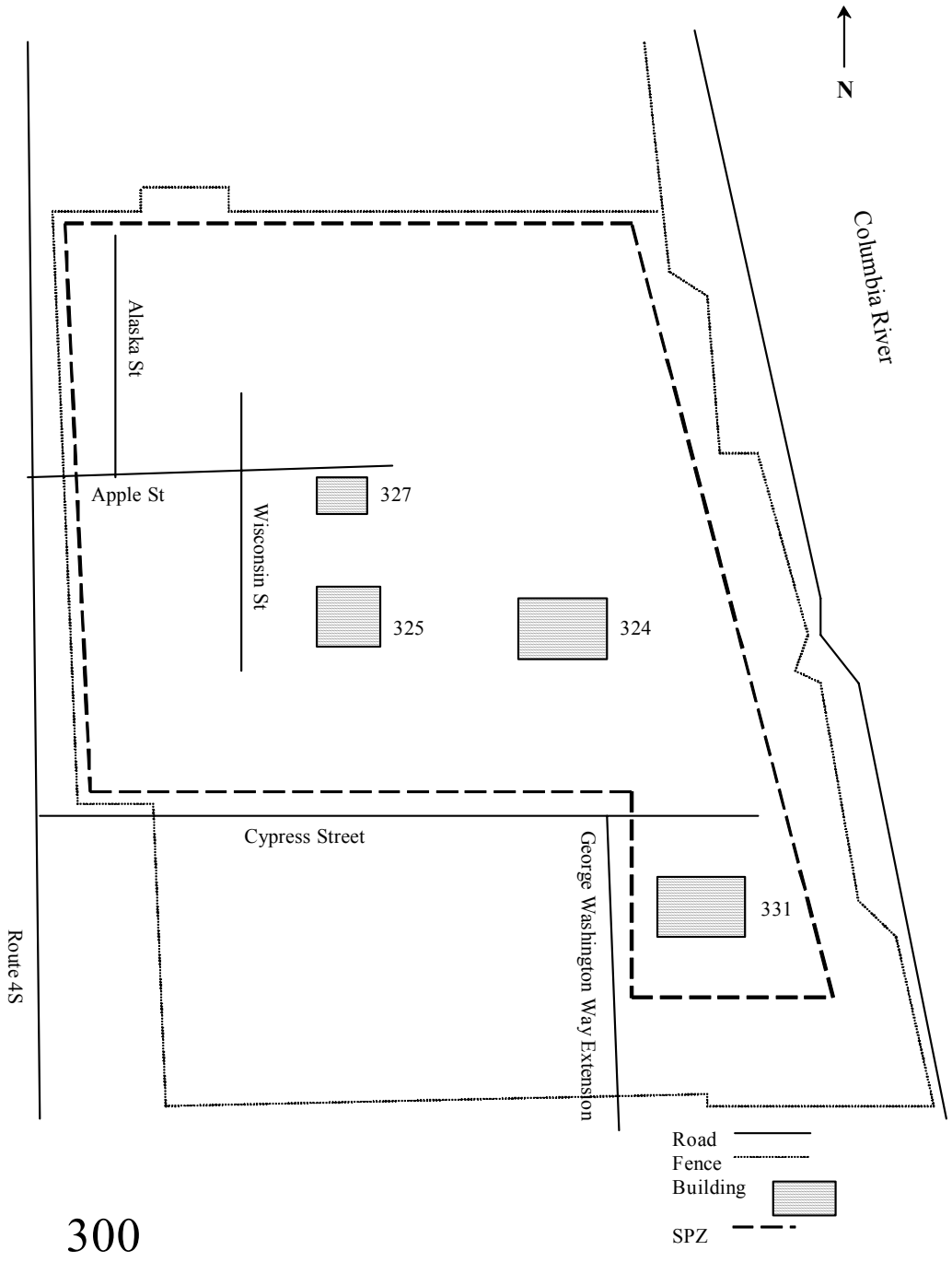
MAPS

Map 1. North of Wye Barricade Special Packaging Zone.

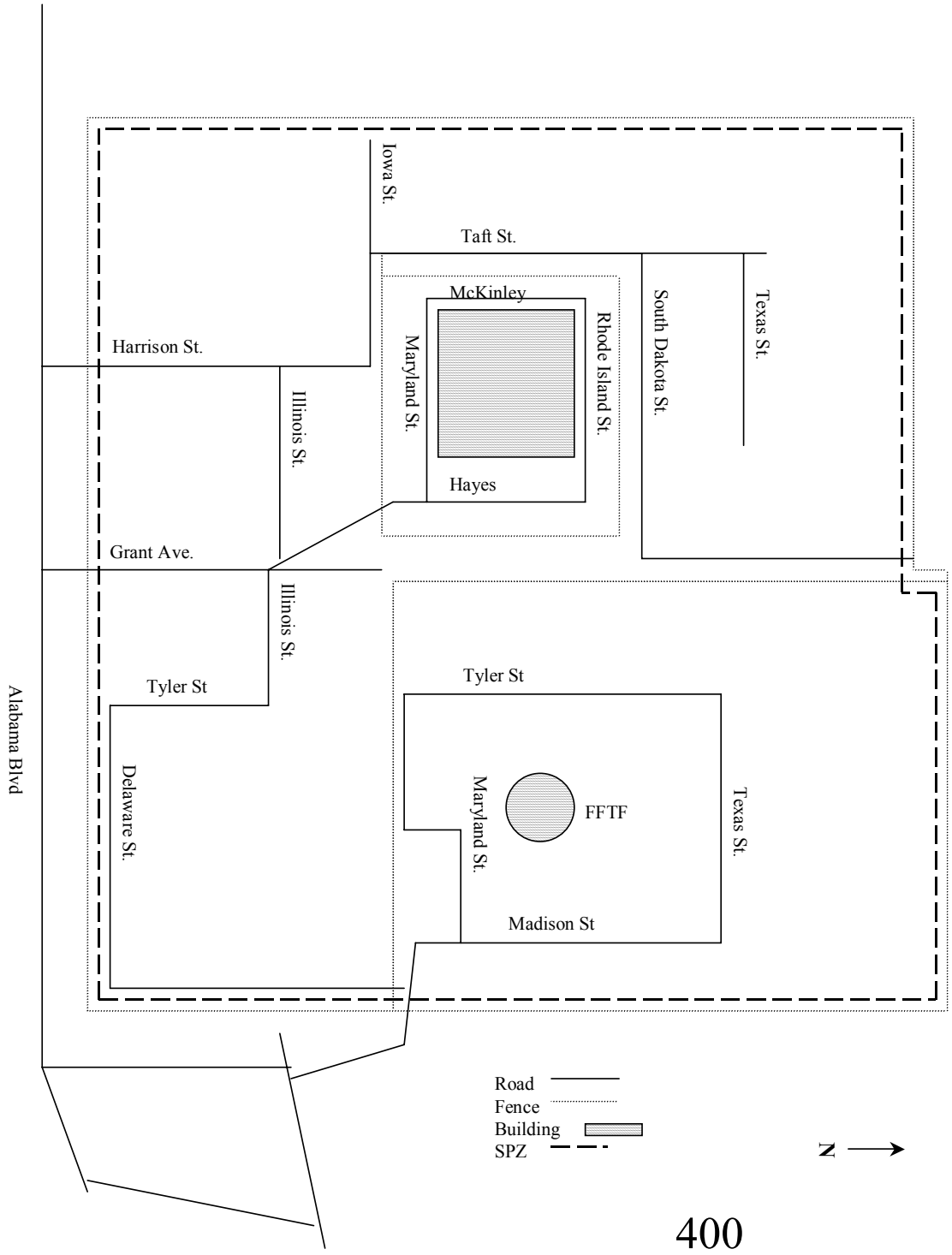


Map 2. Reserved
Map 3. Reserved
Map 4. Reserved

Map 5. 300 Area Special Packaging Zone.



Map 6. 400 Area Special Packaging Zone.



CHAPTER 9.0 NONROUTINE TRANSFERS

This chapter describes the processes and procedures for dealing with nonroutine transfers. Nonroutine transfer are sub-divided inbto two categories; 1. Exemption Requests, and 2. Emergency Transfers. Conditions and circumstances for exemption requests or emergency transfers are defined, as well as applicable procedures and the approval process.

9.1 EXEMPTION REQUESTS AND EMERGENCY SHIPMENT PROCEDURES

This chapter identifies how nonroutine and emergency shipments (transfers) are handled under the onsite hazardous materials T&P safety program. Nonroutine onsite shipments (transfers) and emergency transfers are unusual and unpredictable events that may occur onsite. A nonroutine shipment or transfer may be necessary to facilitate the movement of a piece of equipment that cannot be easily cleaned or dismantled. For example, a test loop contaminated with sodium. Offsite, a request for an exemption would be submitted to DOT by way of DOE. Onsite, DOE must grant the exemption to the onsite requirement. In an emergency, to mitigate a spill or release event, and/or provide immediate protection to workers, the public, or to the environment as a result of an accident or incident, immediate action may be required. For example, a cargo tank could be transported onsite and a road obstruction or collision causes damage to the containment boundary allowing a small spill to begin. The Incident Commander for emergency responders and site management may decide to trans-load the liquid contents to another cargo tank to mitigate the event, minimize the clean up needed, and facilitate recovery operations. Emergency procedures will define such events and protocols to be used in making such a decision.

9.1.1 Exemption Requests

Nonroutine onsite shipments (transfers) are handled by submitting a One Time Request for Shipment (OTRS) to the cognizant Hanford DOE Field Offic Manager. OTRSs are exemption requests and are risk based following the risk methodology in this TSD. As an exemption, they are not subject to the USQ_T program. Any changes to an OTRS will be submitted to the cognizant Hanford DOE Field Office Manager for approval. Compliance of shipments to an OTRS is accomplished through the use of an evaluation form.

The OTRS will be issued for a one-time shipment or for a transportation campaign covering a period of time not to exceed five years. Each OTRS is assigned a unique number and that number will not change throughout the life of that particular OTRS. Appendix E provides additional detail on the format and content of an OTRS.

9.1.2 Emergency Shipments

The need for an emergency shipment will be determined in accordance with DOE/RL-94-02, *Hanford Emergency Management Plan* (HEMP). The Emergency Duty Officer shall have the responsibility for event classification and activation of the Hanford Emergency Response Organization as appropriate. Shipments (transfers) are handled in accordance with the site emergency preparedness plan. Additional information about the HEMP is presented in Chapter 12, Incident Reporting and Emergency Response.

9.2 REFERENCES

49 CFR 107, "Hazardous Materials Program Procedures," *Code of Federal Regulations*, as amended.

DOE/RL-94-02, *Hanford Emergency Management Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

CHAPTER 10.0 - PERSONNEL TRAINING AND QUALIFICATION

This chapter describes the qualification and training requirements for Hanford Site contractor hazmat personnel, authorized shippers, drivers, and USQ_T evaluators. Individual facilities and organizations, to which personnel may be assigned, may establish additional qualifications and required training based on specific job task analysis, job classification, or individual training plan.

10.1 REQUIREMENTS

Each Hanford Site contractor must have a personnel training and qualification program that emulates the requirements identified in 49 CFR 172, Subpart H, "Training."

10.1.1 Training Program Requirements

All hazmat employees involved in T&P activities must be trained and tested to the training requirements identified in 49 CFR 172, Subpart H. Training requirements include the following:

- General awareness/familiarization training designed to enable the employee to recognize and identify hazardous materials consistent with the hazard communication requirements in 49 CFR 172 and this TSD.

- Function-specific training specifically applicable to the functions the employee performs. This includes modal-specific training requirements as described in 49 CFR 174 through 177.

- Safety training concerning the following:
  - Emergency response information
  - Measures to protect the employee from the hazardous materials to which they may be exposed
  - Methods and procedures for avoiding accidents.

Drivers or other persons operating commercial motor vehicles as defined in the Federal Motor Carrier Safety Regulations (FMCSR) must be trained and tested in accordance with 49 CFR 177.816, "Driver training."

A new hazmat employee, or a hazmat employee changing job functions, must complete initial training within 90 days after employment or a change in job function. The employee may perform those functions prior to the completion of required training -- provided the employee performs those functions under the direct supervision of a properly trained and knowledgeable hazmat employee.

DOT and this onsite emulation require this training and certification to occur every 3 years [49 CFR 172.704(c)(2)]). Each hazmat employer is responsible for ensuring hazmat employees are aware of any regulatory changes that may affect their specific functions in the onsite T&P program.

Each Hanford Site contractor's training program must identify and qualify the following personnel through adequate training and testing:

- All hazmat employees (e.g., operators, technicians, warehousemen, drivers, managers, supervisors) who in the course of their employment affect transportation safety as defined by the DOT must be trained in accordance with 49 CFR 172.704. This training must include general awareness, function specific safety training, and also driver training when the employee operates a motor vehicle used to transport hazardous materials, substances, and wastes.

- Designated shippers, authorized shippers, or shipping agents acting on behalf of the contractor or RL and ORP must receive advanced hazmat training to address characterization and classification of material for shipment, selection and use of packagings, hazard communications, regulatory compliance, operational procedures, and transport protocols. Training must be given commensurate with the employee's responsibilities and authority to execute shipments.

- Drivers or other persons operating commercial motor vehicles as defined in the FMCSR must possess a CDL and must be trained and tested in accordance with 49 CFR 177.816. Drivers must also receive training on contractor or project procedures and protocols.

USQ_T evaluators must be trained and tested in the USQ_T process and its application with the TSD as described in Appendix C.

10.1.2 Employer Certification

Each Hanford Site contractor must have a formal process in place to certify that each hazmat employee has been trained and tested as required in 49 CFR 172.704(d)(5) and this TSD.

10.1.3 Shipper Authorization

Each Hanford Site contractor must have a formal process in place to authorize employees as designated shippers, authorized shippers, or shipping agents acting on behalf of the contractor and/or RL, ORP. This process must include the following:

- Identification of qualifications and training
- Management delegation of signature authority.

Each contractor must maintain an Authorized Shippers List, which is updated regularly.

Only persons holding delegated shipper authority may be authorized to sign shipping documents on behalf of the contractor and/or DOE.

Each Hanford Site contractor authorizing shippers may, in addition to DOT training requirements, identify other federal, state, and local requirements necessary to maintain "authorized shipper" status.

10.1.4 USQ_T Evaluator Authorization

Each Hanford Site contractor that has a USQ_T process must have a process for designating and qualifying USQ_T evaluators. See Appendix C for training and qualification requirements for USQ_T evaluators.

10.2 DOCUMENTATION AND RECORDS REQUIREMENTS

Documentation and records requirements for onsite hazmat employees are to be in accordance with the requirements identified in 49 CFR, Subpart H and Chapter 11.0, Documentation and Record Keeping.

10.3 REFERENCES

49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements," *Code of Federal Regulations,* as amended.

49 CFR 174, "Carriage by Rail," *Code of Federal Regulations,* as amended.

49 CFR 175, "Carriage by Aircraft," *Code of Federal Regulations,* as amended.

49 CFR 176, "Carriage by Vessel," *Code of Federal Regulations,* as amended.

49 CFR 177, "Carriage by Public Highway," *Code of Federal Regulations*, as amended.

CHAPTER 11.0 DOCUMENTATION AND RECORD KEEPING

This chapter identifies documentation and records requirements for different package categories. It also identifies or references processes and procedures for managing this documentation throughout the Hanford Site.

11.1 DOCUMENTATION REQUIREMENTS

Record requirements include retention of items such as packaging documentation, training records, vehicle maintenance and inspection records, and documentation associated with the onsite transfer of hazardous material.

Records shall be legible throughout the retention period and copies shall be reproducible and legible. Measures shall be taken to preserve records in such a manner as to preclude deterioration of the records.

11.2 PACKAGING DOCUMENTATION

Packaging documentation for onsite transportation of hazardous materials shipments (transfers) must be in full compliance with applicable DOT regulations or the onsite emulation of the applicable regulations.

Packagings that fully meet a DOT specification or DOT/NRC performance standard (i.e., UN1A2, MC 412, DOT-7A Type A) when used onsite must meet all the documentation requirements for that DOT specification or performance standard as required in 49 CFR 171 through 179.

Packagings that do not meet a DOT specification or DOT performance standard when used onsite must be approved by RL. The documentation must meet the onsite implementation of the DOT documentation requirements, those identified in this TSD, and those identified in the PSSD.

11.2.1 Excepted Packaging Documents

Excepted packagings, frequently referred as "strong tight packagings," have no formal documentation requirements associated with the procurement or use of any individual package. The shipper must use his or her professional judgment to determine if the packaging and package as offered for transportation meets 49 CFR 173.24, "General requirements for packagings and packages;" 173.24a, "Additional general requirements for nonbulk packagings and packages;" and 173.24b, "Additional general requirements for bulk packagings;" as appropriate. For radioactive materials, excepted packagings must also meet 49 CFR 173.410, "General design requirements." In addition to determining if the package meets the requirements, consider also the needs of the offeror and receiver, including their need for stacking.

11.2.2 Industrial Packaging Documents

For industrial packagings except IP-1 as required by 49 CFR 173.411, "Industrial packagings," the shipper must maintain on file for at least 1 year after the latest shipment complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with the applicable packaging specification (i.e., IP-2, IP-3).

11.2.3 Type A Packaging Documents

For 7A Type A packagings as required by 49 CFR 173.415, "Authorized Type A packages," the shipper must maintain on file for at least 1 year after the latest shipment complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with the applicable packaging specification.

11.2.4 Type B And Fissile Packaging Documents

For packagings used onsite for the shipment of Type B and/or fissile materials and wastes, the contractor must have a NRC or DOE-approved SARP, develop and maintain an onsite PSSD, or possess an approved OTRS covering the payload.

Onsite PSSDs are generally developed and approved for multi-purpose, multi-use, or multi-user packagings. See Section 7.3.1.2 for application content details.

11.3 PAYLOAD CLASSIFICATION RECORDS

Materials classified as either LSA or SCO require a formal evaluation of the material to insure that it qualified as either LSA or SCO. This formal evaluation will be conducted in accordance with the NRC NUREG-1608, "Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects." The formal evaluation will be included with other transportation safety documents and retained with other shipping records.

11.4 TRAINING AND QUALIFICATION RECORDS

Each Hanford Site contractor offering transportation, or transports hazardous material on roads to which the public has unrestricted access, must meet the requirements defined in 49 CFR 107, Subpart G, "Registration of Persons Who Offer or Transport Hazardous Materials." For onsite shipments (transfers), an onsite emulation of this regulation has been implemented.

Each organization shall maintain training records in accordance with 49 CFR 172.704 (d) for all personnel who have a direct effect on transportation safety.

11.4.1 Hazmat Employees

Each Hanford Site contractor with a hazmat employee involved in onsite T&P activities must meet the documentation and record keeping requirements defined in 49 CFR 172, Subpart H, "Training."

11.4.2 Drivers

Each Hanford Site contractor driver used to transport hazardous materials onsite must meet the documentation and record keeping requirements defined in 49 CFR 177.816, "Driver training;" 49 CFR 383, Subpart J, "Commercial Driver's License Document;" and 49 CFR 391, "Qualifications of Drivers."

Each Hanford Site contractor shall also maintain an accident register and accident report for drivers, in accordance with 49 CFR 390.15, for a period of 1 year after an accident occurs.

11.4.3 USQ_T Evaluators

Each Hanford Site contractor with an USQ_T process must meet the documentation and record requirements identified in 10 CFR 830 for the USQ process.

11.5 VEHICLE MAINTENANCE AND INSPECTION RECORDS

Each Hanford Site contractor motor carrier that uses motor vehicles onsite to ship hazardous materials must meet the requirements defined in 49 CFR 396, "Inspection, Repair, and Maintenance," for motor vehicles.

11.6 SHIPPING PAPERS

The requirements for documentation and record keeping shall be established from U.S.C., Title 49 CFR -- Transportation, Subtitle III -- General and Intermodal Programs, Chapter 51 -- "Transportation of Hazardous Material," Section 5110, Shipping papers and disclosure.

Shipment documentation shall be retained and filed as lifetime records, including documentation accompanying use of SPAs, OTRSs, and PSSDs. For onsite shipments of non-radioactive hazardous materials, the HMSR, which is filled out by the shipper, may serve as the only documentation to accompany the shipment onsite.

11.7 REFERENCES

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*, as amended.

49 CFR 107, "Hazardous Materials Program Procedures," *Code of Federal Regulations*, as amended.

49 CFR 171, "General Information, Regulations, and Definitions," *Code of Federal Regulations*, as amended.

49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements," *Code of Federal Regulations,* as amended.

49 CFR 173, "Shippers--General Requirements for Shipments and Packagings," *Code of Federal Regulations*, as amended.

49 CFR 174, "Carriage by Rail," *Code of Federal Regulations,* as amended.

49 CFR 175, "Carriage by Aircraft," *Code of Federal Regulations,* as amended.

49 CFR 176, "Carriage by Vessel," *Code of Federal Regulations,* as amended.

49 CFR 177, "Carriage by Public Highway," *Code of Federal Regulations*, as amended.

49 CFR 178, "Specifications for Packagings," *Code of Federal Regulations,* as amended.

49 CFR 179, "Specifications for Tank Cars," *Code of Federal Regulations,* as amended.

49 CFR 383, "Commercial Driver's License Standards; Requirements and Penalties," *Code of Federal Regulations,* as amended.

49 CFR 390, "Federal Motor Carrier Safety Regulations; General," *Code of Federal Regulations,* as amended.

49 CFR 391, "Qualifications of Drivers," *Code of Federal Regulations,* as amended.

49 CFR 396, "Inspection, Repair, And Maintenance," *Code of Federal Regulations,* as amended.

NUREG-1608, "Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects, Nuclear Regulatory Commission, Washington, D. C.

CHAPTER12.0 INCIDENT REPORTING AND EMERGENCY RESPONSE

This chapter describes requirements for incident reporting, emergency response, and references Hanford Site-specific policies, manuals, and procedures for emergency management. It also addresses emergency planning, drills and exercises, and Hanford Site response capabilities.

12.1 REPORTING REQUIREMENTS

Actions taken to implement incident reporting and emergency response requirements associated with onsite T&P activities are identified in the HEMP (DOE/RL-94-02). This TSD requires compliance with the requirements identified in DOE/RL-94-02 by RL and ORP and their primary contractors and subcontractors. DOE maintains policies, programs, and procedures (DOE-0223) to implement the HEMP, including onsite T&P activities.

12.2 HANFORD SITE EMERGENCY MANAGEMENT PROGRAM BASIS

The comprehensive Hanford Site emergency management program is based on and commensurate with the hazards and consequences associated with facilities and activities on the Hanford Site (i.e., developed consistent with a graded approach), offsite facilities that may impact the Hanford Site, and onsite and offsite DOE transportation emergency preparedness activities involving radiological and nonradiological hazardous materials.

12.3 HANFORD TRANSPORTATION EMERGENCY PREPAREDNESS PROGRAM

The Hanford Transportation Emergency Preparedness Program provides the framework for response to onsite and offsite transportation incidents involving radiological and nonradiological hazardous material. For transportation planning purposes, shipments transported on roadways and in areas of the Hanford Site where public access is restricted are exempt from the DOT regulations found in 49 CFR. Shipments transported on roadways and in areas where the public is granted unrestricted access are considered "in commerce" and shall be regulated under the DOT regulations found in 49 CFR. When public access control is extended to areas within the Hanford Site boundary, to which the public had previously been granted unrestricted access (e.g., road closure), shipments may be made under onsite control. Onsite controls may be used on roadways and in areas for as long as the public access restriction remains in force.

For transportation incidents that occur on the Hanford Site, including shipments of nongovernment material being moved in full compliance with DOT/NRC requirements, the Incident Command System is used to mitigate the situation. Upon notification of the event, the Hanford Fire Department assumes incident command responsibilities. The Emergency Duty Officer has the responsibility for event classification and activation of the Hanford Emergency Response Organization as appropriate.

12.4 HEMP SUMMARY

The Hanford Emergency Management Plan (HEMP) (DOE/RL-94-02) details the Hanford Site emergency organization, authorities, and responsibilities for response to and mitigation of emergency events involving facilities and activities on the Hanford Site including transportation. These events include the full spectrum of operational emergencies, natural phenomena, transportation events, and safeguard and security emergencies. The HEMP also describes the authorities, responsibilities, and agreements for response to offsite and near-site facility emergencies that have the potential for detrimentally affecting the health of personnel and safety of operations at the Hanford Site.

DOE maintains procedures necessary to implement the emergency management program described in the HEMP. The procedures contain detailed information and specific instructions, including response actions, associated precautions and prerequisites, and identification of responsible individuals needed to perform the appropriate action during a drill, exercise, or actual emergency.

For the Hanford Site, these procedures include, but are not be limited to, the following:

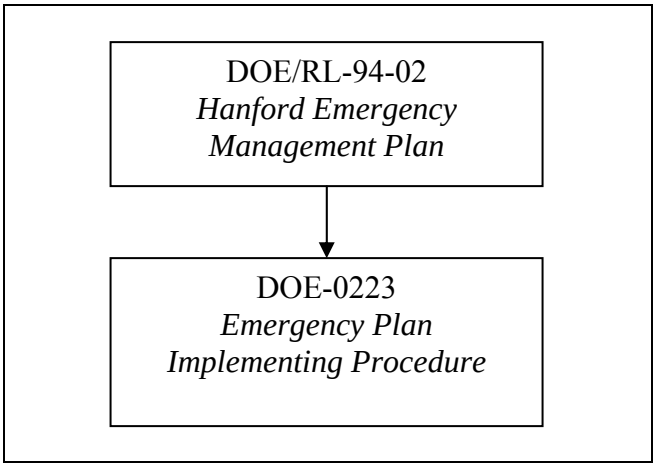
- The operation of the Hanford Incident Command System and responsibilities of the Incident Command Organization
- The responsibilities for the DOE Hanford Emergency Operations Center, which includes the Policy Team, Site Management Team, and the Joint Information Center
- Recognition, categorization/classification, and notification of emergencies and other incidents
- Protective action recommendations
- Response to nonradiological hazardous substance spills or releases during transportation incidents occurring onsite, which are not covered by unit-specific contingency plans or building emergency plans
- Response to polychlorinated biphenyl spills or releases in accordance with 40 CFR 761, “Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions”
- Termination, reentry, and recovery for DOE order emergencies and events that meet RCRA contingency plan implementation criteria
- Response to incidents involving onsite and offsite shipments of DOE-owned radiological and nonradiological hazardous materials.

In addition to the program for response to and mitigation of emergencies, the HEMP also provides direction on the activities necessary to ensure emergency preparedness on the Hanford Site such as training, drills, exercises, and assessments. The authority and responsibility for interfaces with offsite organizations responsible for protecting the public and the environment, including those agencies that may provide or request support in the event of an emergency, is also delineated.

The DOE responsibility to provide, upon request, radiological advice and assistance to other federal, tribal, state, or local governments under the Radiological Assistance Program is defined in DOE/RL-92-49, *U.S. Department of Energy Radiological Assistance Program Response Plan Region 8*.

Figure 12-1 provides the hierarchy for emergency preparedness documentation for transportation.

Figure 12-1. Transportation Emergency Preparedness Documentation Hierarchy.



12.5 REFERENCES

40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*, as amended.

49 CFR, "Transportation," *Code of Federal Regulations*, as amended.

DOE-0223, *Emergency Plan Implementing Procedure*, U.S. Department of Energy, Richland Field Office, Richland, Washington.

DOE Order 151.1B, *Comprehensive Emergency Management*, U.S. Department of Energy, Washington, D.C.

DOE/RL-92-49, *U.S. Department of Energy Radiological Assistance Program Response Plan Region 8*, U.S. Department of Energy, Richland, Operations Office, Richland, Washington.

DOE/RL-94-02, *Hanford Emergency Management Plan*, U.S. Department of Energy, Richland, Operations Office, Richland, Washington.

CHAPTER13.0 - TRANSPORT VEHICLE OPERATIONS

This chapter describes the requirements for motor vehicle inspection and maintenance programs for T&P activities on the Hanford Site. References to specific requirements and procedures are provided for use by each contractor or subcontractor conducting transportation operations within Hanford Site boundaries.

13.1 ONSITE TRANSPORTATION PROGRAM REQUIREMENTS

For transportation, equivalent safety is achieved by compliance with DOT requirements or by emulating the DOT regulations associated with hazardous materials transportation.

Modes of transportation used for the onsite shipment of hazardous materials regulated by the DOT for hazardous materials shipped in commerce are covered by the requirements of this TSD. DOT requirements cover shipments by rail, air, water, motor vehicle, and pipeline.

13.1.1 General

Each Hanford Site contractor that transports onsite hazardous material shipments must do so in a safe and regulatory compliant manner. Compliance with the DOT regulations for shipment by rail, air, water, and motor vehicle or the onsite emulation of them is required. Contractors must conduct transport operations in accordance with this TSD, which imposes regulatory requirements, best industry practices, and other site procedures deemed necessary by the DOE to achieve equivalent safety and be in accordance with applicable federal and state regulations.

13.1.2 Modal Application

13.1.2.1 Rail

Onsite rail shipments of hazardous materials are currently performed on a case-bycase basis. Each rail shipment must be made in full compliance with applicable DOT regulations or DOE-approved emulation of the applicable regulations.

13.1.2.2 Air

No onsite air transportation is currently performed. If onsite air transportation is started, shipments must be made in full compliance with applicable DOT regulations or RL and ORP-approved emulation of the applicable regulations.

13.1.2.3 Water

All onsite transportation by water (carriage by vessel) is performed in areas open to the public. All onsite shipment by water must be in full compliance with the applicable DOT regulations.

13.1.2.4 Motor Vehicle

Onsite transportation of hazardous materials shipments by motor vehicle must be made in full compliance with applicable DOT regulations or the onsite emulation of the applicable regulations. When the emulation of DOT requirements is used, RL will implement those actions identified for the DOT within the DOT regulations. RL, ORP, and their contractors will implement those actions identified for the user of the DOT regulations.

Compliance with applicable DOT regulations or equivalent standards must be met for the operation, inspection and maintenance of vehicles, and/or the selection, qualification and training of management, drivers, inspection personnel, and maintenance staff.

13.1.2.5 Pipeline

This TSD does not include onsite transportation of hazardous materials by pipeline. The safety of onsite transportation of hazardous materials by pipeline is covered in a facility SAR or other DOE-approved safety or authorization basis documents.

13.1.3 Transport Vehicle Operation

RL, ORP, and their contractors performing transportation operations, fleet operations, or vehicle maintenance for onsite transportation of hazardous material must implement programs, polices, and procedures necessary to meet the provisions of this TSD. Program requirements must address the following key elements as applicable to the specific onsite transportation operation:

- Transportation workplace drug testing program
- Controlled substance and alcohol use and testing
- Driver licensing standards
- Compliance with FMCSRs or approved alternatives
- Qualification of drivers
- Driving of Commercial Motor Vehicles as defined by DOT
- Equipment necessary for safe operation
- Hours of service for drivers
- Inspection, repair, and maintenance
- Transportation of hazardous materials, driving, and parking rules

- Employee safety and health standards
- Training.

13.1.4 Motor Vehicle

The following is a list of transportation program requirements that must be considered in each Hanford Site contractor's transportation program. All transport vehicle operations involving the onsite transfer of hazardous materials, substances, and wastes must comply with the FMCSR found in 49 CFR 40, "Procedures for Transportation Workplace Drug Testing Programs," Sections 325, 355 through 399; DOT Hazardous Material Regulations in 49 CFR 177; or must be performed under a RL-approved program meeting the intent of these regulations, which provides an equivalent degree of safety for site personnel, the public, and the environment. All variances from the FMCSR must be documented in the contractor's transportation operations manual, polices, and/or procedures, and must be approved by RL.

Programs performed under this TSD must include all applicable items from the following listing:

- Vehicles used to transport hazardous materials, substances, and wastes onsite must be in accordance with FMCSR specifications and standards when procured and placed into service, and must be inspected and maintained in accordance with these requirements.

- Management personnel, vehicle drivers, inspection personnel, and maintenance staff must be trained and qualified in accordance with the FMCSR and the DOT Hazardous Material Regulations when applicable.

- All vehicle maintenance must be performed and meet applicable DOT and Government Services Administration (GSA) requirements and schedules for the type of vehicle and type of service for which it is used.

- Periodic inspections must be performed on motor vehicles in accordance with DOT regulations at intervals not to exceed 12 months.

- Cargo tank trailers controlled by Hanford Site contractors must be inspected, tested, and maintained in accordance with applicable DOT regulations or exemptions.

- Preventative maintenance schedules must be maintained for each type of vehicle. The type of motor vehicle determines the frequency and level of maintenance. Maintenance must be provided in accordance with the GSA vehicle maintenance schedules.

13.1.5 Operator Duties

The following list provides the transportation program requirements associated with operator duties identified as key to accomplishing the required level of safety in Hanford Site contractor transportation programs. Programs performed under this TSD must include all applicable items from the following listing:

- Drivers must inspect all commercial motor vehicles in accordance with DOT pre-trip and post-trip requirements.

- Drivers hauling placarded loads must have a current and properly endorsed CDL and meet all driver qualifications including participation in a drug and alcohol testing program meeting applicable federal standards.

- Drivers must report all vehicle accidents or incidents, driving violations, fines, or penalties immediately to their respective contractor management.

- Drivers must comply with all FMCSR or approved alternatives including driver hours of service, driving and parking rules, pre-trip and post-trip inspections, maintenance of shipping documents and emergency response guides, and other safety equipment and tiedown/load securement requirements.

13.2 INSPECTION AND MAINTENANCE PROGRAM REQUIREMENTS

Each Hanford Site contractor must have programs, policies, and procedures in place to ensure all transport vehicles used for the onsite transport of hazardous materials, substances, and wastes undergo daily and periodic inspections and maintenance in accordance with DOT and FMCSR regulations and in accordance with applicable GSA schedules. Variance from these federal standards must be documented and approved by RL.

A list of the inspection and maintenance program requirements, which must be considered in the Hanford Site contractor's transportation programs, is provided below. Programs performed under this TSD must include all applicable items from the following:

- Assignment of responsibilities for inspection and maintenance activities
- Identify number and type of vehicles and other transport equipment available for service and identify equipment load ratings
- Identify type of maintenance service to which each vehicle is assigned
- Identify GSA inspection and maintenance schedules applicable to each vehicle or vehicle type
- Identify location of all inspection and maintenance records
- Specify frequency of audits, findings, and corrective actions.

13.3 ONSITE DRIVER QUALIFICATION AND TRAINING

RL and ORP contractors operating vehicles for onsite transport of hazardous materials, substances, and wastes must have programs, polices, and procedures in place ensuring all drivers operating the vehicles are properly trained and qualified in accordance with FMCSR and DOT Hazardous Materials Regulations. Variance from these federal standards must be documented and approved by RL.

A list of driver requirements identified as key to accomplishing the required level of safety in Hanford Site contractor transportation programs is provided below. Programs performed under this TSD must include all applicable items from the following:

- Assignment of responsibilities
- Basic driver qualification (consider age, health, driving experience)
- Drug and alcohol testing
- Licensing and endorsements
- Initial and recurrent training
- Driver personal and work driving record
- Maintenance of driver records.

13.4 REFERENCES

49 CFR 40, "Procedures for Transportation Workplace Drug Testing Programs," *Code of Federal Regulations*, as amended

49 CFR 177, "Carriage by Public Highway," *Code of Federal Regulations,* as amended.

APPENDIX A

APPROVED PACKAGE SPECIFIC SAFETY DOCUMENTS LIST

APPENDIX A - APPROVED PACKAGE SPECIFIC SAFETY DOCUMENTS LIST

The following tables contain listings of authorized onsite Package Specific Safety Documents (PSSD). The term Safety Analysis Reports for Packaging (SARP) applies only to offsite packages and will not be applied to onsite packaging safety documents. The legacy term Safety Evaluation for Packaging (SEP) likewise will not be used.

Table 1, contains a listing of DOT Compliant SARPs. These packages either have an existing Certificate of Compliance (CoC) from a competent Package Licensing Authority, or are authorized for use on the Hanford Site under a previous CoC. In many cases, the active CoC has de-scoped existing payloads, not for safety related reasons, but because the original Licensee did not want to pay to maintain payloads that were no longer considered necessary. DOE has evaluated the CoC and decided to incorporate the earlier CoC to provide additional package flexibility to the user. Since packages with DOT Compliant SARPs and CoCs may have an active CoC, physical changes are not authorized to the package without prior DOE permission.

Table 2 contains a listing of Hanford Site (Onsite) Equivalent PSSDs, packages that are fully compliant to the TSD and are authorized for unlimited use on the Hanford site. These packages have been evaluated to meet the equivalent packaging standards identified in Chapter6.0, Site-Specific Standards, Procedures, and Instructions, of the TSD. Table 2A contains a listing of Hanford Site (Onsite) Equivalent packages that are not fully compliant to the TSD that may be used with the stated restrictions.

Table 3 contains a listing of Hanford (Onsite) risk based packages. These packages do not meet the equivalent packaging standards identified in Chapter6.0, Site-Specific Standards, Procedures, and Instructions, of the TSD. Table 3A contains a listing of Hanford Site (Onsite) risk based packages that are not fully compliant to the TSD that may be used with the stated restrictions.

Table 4 contains a listing of Hanford (Onsite) Exempted packages. These packages have been exempted from meeting TSD requirements, and have been authorized for use by a Hanford Site Field Officer Manager.

Documents approved as required by this TSD may be added to this listing. Requests for changes to TSD Appendix A Tables shall be submitted to the company contracted to maintain the TSD.

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
NRC					
USA/0361/B(U)F-85	8		Model No. PAT-1		
USA/4888/B( )	12		Model No. SENTINEL-25A, LCG-25A; SENTINEL-25B, LCG-25B; SENTINEL-25C, LCG-25C; SENTINEL-25C3, -25D, -25E, and -25F		
USA/4986/AF	40		Model No. RA-3		
USA/5059/AF	13		NFS Uranyl Nitrate Tank Trailer		
USA/5086/B(U)F	12		Model No. UNC-2600		
USA/5607/B( )F	12		Model No. T-2		
USA/5796/B(U)	15		Model Nos. 181375 and 181361		
USA/5797/B(U)F	15		Model No. Inner High Flux Isotope Reactor (HFIR) Unirradiated Fuel Element Shipping Container, and outer HFIR Unirradiated Fuel Element Shipping Container		
USA/5805/B( )	23		Model No. CNS 3-55		
USA/5830/B( )	9		Model No. SNAP-21		
USA/5862/B( )	8		Model No. SENTINEL-100F		
USA/5926/B( )F	18		Model No. GE-100		
USA/5939/B( )F	32		Model No. 1500		
USA/5957/B( )F	27		Model No. BMI-1		
USA/5979/B( )	11		Model No. 5979		
USA/6058/B( )F	14		Model No. B-3		
USA/6078/AF	30		Model Nos. 927A1 and 927C1		
USA/6206/AF	29		Model No. Model B		
USA/6294/AF	26		Model No. UNC-2901		
USA/6346/B( )F	29		Model No. FSV-1		
USA/6347/AF	10		FSV-3		
USA/6357/AF	8		Model No. NNFD-10		
USA/6400/B( )F	27		Model No. 6400		
USA/6553/AF	19		Model No. PADUCAH TIGER		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/6574/B( )	29		Model No. 3-82B		
USA/6581/AF	33		Model No. 51032-1		
USA/6613/B(U)	10		Model No. 702		
USA/6642/B( )	7		Model No. 4.5-TON CF		
USA/6786/B( )F	8		Model Nos. URIPS-8A and URIPS-8B		
USA/9001/B( )F	39		Model No. IF-300		
USA/9010/B( )F	40		Model No. NLI-1/2		
USA/9015/B( )F	20		Model Nos. TN-8 and TN-8L		
USA/9016/B( )F	12		Model No. TN-9		
USA/9023/B( )F	9		Model No. NLI-10/24		
USA/9027/B(U)-85	17		Model Nos. 741-OP		
USA/9030/B( )	9		Model Nos. MW-3000 and SENTINEL-8		
USA/9034/AF	12		Model No. TRIGA-I		
USA/9036/B(U)-85	10		Model No. C-1		
USA/9037/AF	12		Model No. TRIGA-II		
USA/9056/B(U)	12		Model No. SPEC 2-T		
USA/9067/B( )F	7		Model No. BCL-3		
USA/9081/B( )	14		Model No. CNS 1-13C		
USA/9098/B( )	10		Model Nos. CI-20WC-2 and CI-20WC-2A		
USA/9099/B(U)F-85	10		Model No. ATR		
USA/9102/B( )	10		Model No. NPI-20WC-6		
USA/9132/B(M)F	14		Model No. T-3		
USA/9148/B(U)	7		Model No. 770		
USA/9150/B(U)-85	6		Model No. PAT-2		
USA/9152/B( )F	14		Model No. CNS 1-13C II		
USA/9157/B(U)-85	11		Model No. IR-100		
USA/9165/B(U)	5		Model No. 855		
USA/9168/B(U)	15		Model No. CNS 8-120B		
USA/9184/B(U)	6		Model No. PAS-1		
USA/9185/B(U)-85	6		Model No. OP-100		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/9187/B(U)	6		Model No. 865		
USA/9196/AF-85	21		Model No. UX-30		
USA/9200/B(M)F	11		Model No. 125-B		
USA/9203/AF	13		Model No. DHTF		
USA/9204/B(U)-85	10		Model No. CNS 10-160B		
USA/9206/B(U)F	15		Model No. TN-REG		
USA/9212/B(M)F-85	3		RH-TRU 72-B		
USA/9215/B(U)	7		Model No. NPI-20WC-6 MkII		
USA/9216/B( )F	9		Model No. CNS 1-13G		
USA/9218/B(U)F-85	17		Model No. TRUPACT-II		
USA/9225/B(U)F-85	39		Model No. NAC-LWT		
USA/9226/B(U)F-85	1		Model No. GA-4		
USA/9228/B(U)F-85	21		Model No. 2000		
USA/9233/B(U)	7		Model No. TN-RAM		
USA/9234/B(U)F	15		Nuclear Containers Model NCI-21PF-1		
USA/9235/B(U)F	8		Model No. NAC-STC		
USA/9239/AF	12		Model Nos. MCC-3, MCC-4, and MCC-5		
USA/9246/AF	3		Model No. ST		
USA/9248/AF	18		Model Nos. SP-1, SP-2, and SP-3		
USA/9250/B(U)F-85	9		Model No. Babcock and Wilcox Model No. NNFD 5X22		
USA/9251/AF	12		Model No. BW-2901		
USA/9252/AF	5		Model No. 51032-2		
USA/9253/B(U)F	10		Model No. TN-FSV		
USA/9255/B(U)F-85	9		Model No. NUHOMS MP187 Multi-Purpose Cask		
USA/9258/B(U)-85	2		MDS Nordian Model No. F-294		
USA/9261/B(U)F-85	3		Model No. HI-STAR 100 System		
USA/9263/B(U)-85	4		Model No. SPEC-150		
USA/9269/B(U)-85	3		Model No. 650L		
USA/9272/AF-85	6		Model No. CE-B1		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/9274/AF	7		Model No. ABB-2901		
USA/9277/B(U)F	1		Model No. FSV-1 UNIT 3		
USA/9279/B(U)F-85	2		HalfPACT Waste Shipping Container		
USA/9280/AF-85	2		Model No. UBE-1		
USA/9281/AF-85	3		Model No. UBE-2		
USA/9282/B(U)-85	1		Model No. SPEC-300		
USA/9283/B(U)-85	1		Model No. OPL-660 and OP-660.		
USA/9284/B(U)F-85	4		ESP-30X Protective Shipping Package for 30-Inch UF6 Cylinders		
USA/9285/AF-85	2		Model No. SRP-1		
USA/9287/B(U)-85	1		Model No. Sterigenics Eagle		
USA/9288/B(U)F-85	6		Model No. CHT-OP-TU		
USA/9289/B(U)F-85	3		Model No. WE-1		
USA/9293/B(U)-85	1		Model No. TN-68 Transport Package		
USA/9294/AF-85	3		Model No. NPC		
USA/9295/B(U)F-96	0		MFFP		
USA/9296/B(U)-85	3		Model No. 880 Series Packages		
USA/9297/AF-96	0		Traveller SRD and Traveller XL		
USA/9301/AF-85	1		MODEL No. TNF-XI		
USA/9309/B(U)H-96	2		MODEL No, RAJ-II		
USA/9310/B(U)-96	2		F-431 TRANSPORT PACKAGE		
USA/9511/B(U)	3		Model No. Beneficial Uses Shipping System Cask (BUSS) R-1		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
DOE					
USA/5320-3/B( )F (DOE)	21		PU Oxide and AM Oxide Shipping Cask		
USA/5467/AF-85 (DOE)	22		Model: Steel Banded Wooden Shipping Containers, Models G-4214, G-4255, G-4273 and G-4292		
USA/9099/B(U)F (DOE)	15		ATR Fuel Element Shipping Container		
USA/9132/B(M)F (DOE)	11		T-3 CASK		
USA/9225/B(U)-85 (DOE)	2		Model No. NAC-LWT		
USA/9511/B(U) (DOE)	7		BUSS Model R-1		
USA/9516/B(U)F-85 (DOE)	9		Model No. Mound 1KW		
USA/9904/B(U)F-85 (DOE)	8		Model No. RTG Package		
USA/9932/B(U) (DOE)	9		Model No. UC-609		
USA/9975/B(M)F-85 (DOE)	12		Model N0. 9975		
DOT					
USA/0018/S	7		SR-CF-100 Series Neutron Source Manufactured by either the Savannah River Laboratory (SRL) or Oak Ridge National Laboratory (ORNL)		
USA/0036/S	7		NRD Model A-001		
USA/0043/S	10		Monsanto Research Corporation Model 2720		
USA/0065/S	7		Model SR CF-1000 Series Neutron Source Manufactured by either the Savannah River Laboratory or ORNL		
USA/0066/S	6		3M Model 4F6H		
USA/0071/S	6		3M Model 4D6L Capsules Manufactured Prior to August 3, 1989.		
USA/0074/S	6		3M Model 4F6P		
USA/0077/S	6		3M Model 4F6S. "Use Only" for service life of capsule		
USA/0080/S	4		Monsanto Research Corporation Capsule Identified by MRC Drawing No. SK19502A0 (A Prototype of Model No.		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
			24132)		
USA/0087/S	5		Dresser Atlas Model No. DA-5.		
USA/0088/S	6		Dresser Atlas Model No. DA-20		
USA/0095/S	8		Source Production and Equipment Co. Series B, G, R and T Model Sources		
USA/0112/S	6		Schlumberger Model NSR-GB		
USA/0113/S	9		Model Nos. NSR-F, NSR-D and NSR-R		
USA/0114/S	6		Gulf Nuclear, Inc. Model No. AMBE 71-1		
USA/0115/S	9		Gulf Nuclear, Inc. Model VL-1		
USA/0116/S	4		Halliburton Services Model X-602-04-101 Neutron Source		
USA/0124/B(U)-96	16		MDS Nordion International Inc. F-245 Shipping Container, Serial Nos. 1 to 5 and 7 to 26		
USA/0125/B(U)-96	14		Nordion International Inc. Model No. F-327/F-247 Serial Nos. 1 to 10 Inclusive, 12 to 41 Inclusive		
USA/0135/S	8		Model Nos. NSR-M and NSR-L.		
USA/0141/S	10		General Electric Company Neutron Source Model GEN-CF-1X or 2765-AAOO		
USA/0149/S	5		Gulf Nuclear Model AMBE 71-2A Source Capsules Manufactured Prior to March 8, 1988		
USA/0154/S	8		Amersham Corporation Model Nos. 60001, 60004, 60006, 60017, 60018, 60020, 60021 and 68310		
USA/0159/S	5		E.I. Du Pont/Nen Model NER-478C		
USA/0161/S	2		New England Nuclear Model NER-550		
USA/0165/S	6		AEA TECHNOLOGY QSA, INC. MODEL NOS. A424-2 through A424-19 (excluding A424-6 and A424-9) and A453-1 through A453-10 (excluding A453-3 and A453-4).		
USA/0174/S	5		Gulf Nuclear, Inc. Model CS-2		
USA/0179/S	8		AEA TECHNOLOGY QSA, INC Series 900 Iridium Capsule.		
USA/0192/S	5		Isomedix Model ISO-1000 Manufactured prior to June 30, 1998		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/0208/B(U)F-85	7		Model No. JRC-80Y-20T		
USA/0214/B(U)	13		MDS Nordion Inc. Model F-168-X, Shipping Flask Nos. 22-X, 23-X, 24-X, 25-X, 26-X, and 41-X		
USA/0221/S	7		IPL Line Source		
USA/0242/S	5		Monsanto Research Corporation Model 24154-C		
USA/0245/S	9		AB ELEKTA Model 43047 and AB ELEKTA Model 43685 Source Capsule		
USA/0257/S	6		AEA TECHNOLOGY QSA, INC Model 849		
USA/0263/S	3		Monsanto Research Corp. Model No. 24195		
USA/0283/S	4		3M Model 3FIG Capsules Manufactured Prior To August 3, 1989		
USA/0292/S	6		Neutron Product, Inc. Model Nos. NPTT Series, NPI-XX-XXXXW, and NPI-XX-XXXX		
USA/0297/S	4		Industrial Nuclear Company Model A Source Capsule		
USA/0331/S	6		Gammatron Model AN-HP Source Capsule		
USA/0335/S	6		AEA TECHNOLOGY QSA, INC 875 Series Source Capsule Assemblies		
USA/0336/S	8		IPL Model XFB-3		
USA/0337/B(U)-85	10		Croft Associates Model 2773A		
USA/0348/B(U)	9		MDS Nordion Inc. Model F-231, Serial Numbers 7, 8, 9, 11 to 24 inclusively		
USA/0350/S	4		IPL Model 343		
USA/0351/S	4		IPL Model N-252		
USA/0352/S	4		IPL Model No. 295		
USA/0353/S	4		IPL Model No. 193		
USA/0354/S	4		IPL No. 274-1		
USA/0356/S	8		IPL Model Nos. 225, 416, A3000, A3015, A3023, A3024, A3030		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/0357/S	7		IPL Model Nos. A3214 and A3203 Source Capsules		
USA/0361/B(U)F-85	4		PAT-1, Plutonium Air Transportable Package		
USA/0363/S	4		Amercham Corporation Capsule Code X38/4		
USA/0366/S	4		Gammatron Model GT-GHP		
USA/0367/S	5		Frontier Technology Corporation Model 10 Series and Model 100 Series		
USA/0376/S	3		Specification SS-2050		
USA/0377/S	4		TECH/OPS RPD, Inc. or Amersham Corporation Models 60011, 60012, 60013		
USA/0381/B(U)F-85	5		Transport Container No. GNS 11		
USA/0382/B(U)-85	8		Croft Model No. 2835A		
USA/0383/S	2		Coratomic Type X Source for Cardiac Pacemaker		
USA/0392/S	5		Amersham Corporation Series 875 Capsule		
USA/0393/S	2		CIS-US, Inc. Model 791		
USA/0394/S	2		Amersham Corporation Model No. 922		
USA/0401/B/(U)F-85	5		Model No. JMS-87Y-18.5T		
USA/0404/B(U)-85	5		Gammacell 40 MK2 Irradiator		
USA/0406/AF-85	9		21PF-1 Overpacks as Specified in Japanese Certificate of Approval of Package Design No. J/27/AF-85, Rev. 2 and in Japanese Certificate of Approval for Packaging No. J/27/AF-85, Rev. 2		
USA/0407/B(U)	5		U.K. Design No. 3100A		
USA/0408/B(U)-85	6		U.K. Design No. 3300A		
USA/0411/AF	7		Model Nos. 5A, 5B, 8A, 12A, 12B, 30A, 30B, 48A, 48F, 48G 48H, 48X, 48HX and 48Y		
USA/0412/AF-85	8		Model No. BU-D		
USA/0419/S	2		3M Model 4P6E		
USA/0420/S	2		3M Model 4P6M		
USA/0427/S	3		CIS-US, Inc. Models 772 and 774 Source Capsules		
USA/0442/AF-85	11		NT-IX		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/0444/B(U)	5		MDS Nordion Inc. Model F-271 Transport Package, Serial Nos. 1 to 10		
USA/0452/B(U)F-85	7		JRF-90Y-950K		
USA/0459/B(U)-85	4		Model No. Theratronics International F147 (85) Transfer Case, Serial Numbers 61 and Higher		
USA/0461/B(U)-85	5		MDS Nordion Inc., F-168 (1985) Transport Package, Serial Number 53 to 76 inclusive; 83 and up		
USA/0462/S	3		IPL Models 3021 and 3027		
USA/0463/S	1		J. L. Sheperd & Associates Model 7810-109-BP		
USA/0464/S	1		J.L Shepherd & Associates Model 5810-190		
USA/0468/B(U)-85	3		MDS Nordion Inc. Model F-168-X (1985), Shipping Flask Nos. 77-X, 78-X, 79-X, 80-X, 81-X, and 82-X		
USA/0469/B(U)-85	4		MDS Nordion Inc. Gammacell 1000 and 3000, (Shipping Models) Serial Numbers 42 and up		
USA/0474/B(U)-85	1		JAERI Model No. TPL-92Y-45K		
USA/0475/B(U)	2		Nordion International, Inc. Gammacell 1000 Irradiator (Shipping Model in the 20WC-5 Overpack) and Nordion International, Inc. Gammacell 3000 Irradiator (Shipping Model in the 20WC-5 Overpack)		
USA/0477/B(U)-85	3		Nordion Gammacell 1000 and 3000, (Shipping Models in the 20WC-5 Overpack) Serial Nos. 42 and up		
USA/0480/AF	2		AECL Model: Maple 4 Enriched Fuel Bundle Shipping Package, Serial Nos. 1 to 7		
USA/0485/B(U)F	1		AECL Model 4H Enriched Fuel Bundle Shipping Package, Serial Nos. 1 through 8		
USA/0490/AF-85	4		J/37/AF-85, Rev.3		
USA/0494/S	1		Omnitron International, Inc. Source Wire Model Nos. SL-777 and SL-777V		
USA/0495/AF-85	2		RAJ-II		
USA/0497/S	1		Amersham Model X.444		
USA/0498/S	1		IPL Model HEG-1		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/0500/S	1		Amersham Model X.1065		
USA/0501/S	1		Amersham Model X.44		
USA/0502/S	2		Amersham Model X.54 and X.540		
USA/0508/S	1		IPL Model A3906		
USA/0509/B(U)-85	3		MDS Nordion Models F-127, F-127-X and RAI/F-127 Transport Packages, Serial Nos. 59 and Up		
USA/0513/S	1		Amersham Model X.560		
USA/0514/S	0		AN-HP		
USA/0515/S	1		IPL Model GFS-3 Source Capsule		
USA/0516/S	1		IPL Model Nos. A3224-01, A3224-02, A3224-03, A3224-11, A3224-12, A3224-13 and A3807 Source Capsules		
USA/0517/S	1		IPL Model Nos. A3224-04, A3224-14, A3901-1 and A3901-2 Source Capsules		
USA/0518/S	1		IPL Model A3908 Source Capsule		
USA/0523/S	0		JL Sheppard 78100484-1		
USA/0526/S	0		JL Sheppard 7810-0109-R		
USA/0530/S	0		JLS&A 8810-AMBE-154		
USA/0531/S	0		Model DSK 2384		
USA/0532/B(U)-85	2		Ganuk Model GA-01 Transport Container		
USA/0539/S	0		AMBE MJ-1L and AMBE MJ-1S		
USA/0540/S	0		J. L. Shepherd Model No. 7810-9		
USA/0541/S	0		J.L. Sheperd Model 7810-8		
USA/0543/S	0		Sperry Sun Source Plug Assembly No. 009100		
USA/0544/S	0		CIS-US Model 789		
USA/0545/B(U)	1		U.K. Design No. 3605C		
USA/0551/B(U)F-85	3		GNS-16 Spent Fuel Cask		
USA/0552/B(U)F-85	0		AEA Technology Neutron Source Container		
USA/0553/B(U)-85	0		AECL-CRL Irradiated Material Transport Package		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/0554/B(U)-85	3		Theratronics Int. LTD. Radiotheraphy Heads: Theratron 780C (T780C), S/N 274 & up; Theratron 780E (T780E), S/N 601 & UP; Theratron 1000E (T1000E), S/N 44 & up; Phoenix, S/N 145 & up; Theratron Elite 80, S/N 1 & up; & Theratron Elite 100, S/N 1 & up		
USA/0556/B(U)-85	2		KATY		
USA/0558/B(U)F-85	0		Model No. JMS-87Y-18.5T		
USA/0559/S	0		Model Nos. 6810G - Types I, II, III, IV, V and VI		
USA/0560/S	0		JLS & A 7810-150		
USA/0562/B(U)-85	5		ZA/CNS1005/B(U)-85		
USA/0563/AF-85	2		BNFL Model 3516 Uranium Transport Package		
USA/0566/S	0		Source Production and Equipment Co. Model Nos. G and T (Spec. Drawing 19B002, Rev. 1)		
USA/0567/AF-85	1		Model Nos. DOT Specification 21PF-1 and 21PF-1B Protective Overpacks		
USA/0569/B(M)-85	0		Model No. NR-10		
USA/0570/S	1		CNS0010-192 Brachytherapy Source		
USA/0571/S	0		Varian Model VS-2000		
USA/0573/B(U)F-85	0		TN 7-2 Irradiated Fuel Assembly Cask		
USA/0575/H(U)-96	0		2000 Med Package		
USA/0577/B(U)F-85	0		COG-OP-30B Overpack		
USA/0578/B(U)-85	0		MDS Nordion Inc. Model F-231 (1985) and Model F-231 MK 2 Transport Packages, Serial Nos. 11 and higher		
USA/0587/B(U)-85	0		Gammacell 40 MK3 Irradiator, Serial No. 11 and Subsequent		
USA/0590/B (U)-85	0		U.K. Design No. 3605A		
USA/0592/B(U)-85	0		U.K. Design No. 3605B		
USA/0593/B(U)-85	0		U.K. Design No. 3605C		
USA/0594/B(U)-85	0		U.K. Design No. 3605M		
USA/0597/S	0		Model X.2050 Series source capsules		
USA/4986/AF	28		Model No. RA-3		
USA/5467/AF-85	1		SBWSC (Steel Banded Wooden Shipping Container)		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/5796/B(U)	12		Model Nos. 181375 and 181361		
USA/5979/B( )	7		Alpha Omega Services, Inc. Model No. 5979		
USA/6050/B(U)	12		MDS Nordian Inc. Model F-144 Shipping Container, Serial Nos. 1, 5, and 9, and Model F-144-AC, Serial No. 3		
USA/6078/AF	1		Model Nos. 927A1 and 927C1		
USA/6125/B(U)	12		Nordion Gammacell 220 Irradiator, Serial Nos. 1 to 256 Inclusive		
USA/6162/B(U)	16		Nordion International Inc. F-127 J-Rod Shipping Container, Serial Nos. 50, 52, and 54		
USA/6214/B(U)	16		Nordion International Inc. F-112 Shipping Containers, Serial Nos. 10, 11, 20, 29,31, 33, 34, 36, 37, 40, 42, 43, 61,62, 64, 65, 68. Nordion International Inc. F-113, Shipping Containers, Serial Nos. 1, 4-10, 13, 15-18, 20, 22, 59, 60, 61, 63-66, 68, 69, 72-74, 76-78, 105-110		
USA/6217/B(U)	15		MDS Nordion Inc. Model F-143 Transfer Case, Serial Nos. 20, 50, 53, 54, 59, 62, and 64; or Model F-158 Transfer Case, Serial Nos. 3, 4, 5, 6, 8, 9, 10 and 14		
USA/6306/B(U)	14		Nordion International Inc. F-168 Shipping Flask Nos. 20, 21, 28, 31, 32, 33, 36, 38, 39, 42 to 52		
USA/6355/B(U)	12		Theratronice International F-147 Transfer Case Serial Numbers 1 to 60		
USA/6400/B( )F	1		Model No. 6400 (Super Tiger)		
USA/6581/AF-85	25		Siemens Power Corporation Model No. 51032-1		
USA/6613/B(U)	8		Amersham Model No. 702		
USA/6717/B(U)	13		Amersham Corporation Model 6717-B		
USA/6788/B(U)F-85	5		Croft Associates Model 2799E		
USA/9019/AF	26		General Electric Company Model BU-7		
USA/9027/B(U)-85	14		Model No. 741-OP		
USA/9032/B(U)-85	6		Amersham Model 650		
USA/9034/AF-85	12		Model No. TRIGA-1		
USA/9035/B(U)-85	10		Model No. 680-OP		
USA/9036/B(U)-85	12		Model Spec. C-1		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/9037/AF-85	12		Model No. TRIGA-2		
USA/9039/B(U)	11		AEA Technology Model No. 715		
USA/9056/B(U)-85	11		Source Production & Equipment Company, Inc. Model Spec 2-T		
USA/9107/B(U)-85	6		Model No. 771 Shipping Container		
USA/9148/B(U)	4		Model 770 Packaging		
USA/9150/B(U)-85	5		Model No. PAT-2		
USA/9157/B(U)	5		Model No. IR-100		
USA/9165/B(U)	5		Model No. 855		
USA/9185/B(U)-85	5		Model No. OP-100		
USA/9187/B(U)	5		Amersham Model No. 865		
USA/9196/AF-85	21		Model No. UX-30		
USA/9204/B(U)-85	1		CNS 10-160B		
USA/9215/B(U)	5		Model No. NPI-20WC-6 MkII		
USA/9217/AF	11		American Nuclear Fuels Corporation Model ANF-250		
USA/9225/B(U)F-85	23		Model No. NAC-LWT		
USA/9228/B(U)F-85	11		General Electric Model 2000		
USA/9234/B(U)F	11		Nuclear Containers Model NCI-21PF-1		
USA/9239/AF	12		Model Nos. MCC-3, MCC-4, and MCC-5 Packagings		
USA/9245/B(U)-85	5		Model No. 420		
USA/9248/AF	16		Framatome ANP Richland Division, Inc. Model Nos. SP-1, SP-2 and SP-3		
USA/9250/B(U)F-85	4		BWX Technologies Inc, Model No. NNFD 5X22		
USA/9258/B(U)-85	0		MDS Nordian Model No. F-294		
USA/9263/B(U)-85	5		Model No. Spec-150		
USA/9269/B(U)-85	3		AEA Technology/QSA Inc. Model 650L		
USA/9272/AF-85	0		CE-B1		
USA/9274/AF	3		AAB-2901		
USA/9282/B(U)-85	0		SPEC-300		

Table 1. DOT Compliant Packages with Approved CoC.

Document Number	Current Revision	Clearance Date	Title	Configuration Manager	Package Custodian
USA/9283/B(U)-85	0		AEA Technology Model Nos. OPL-660 and OP-660		
USA/9284/B(U)F-85	0		ESP-30X Protective Shipping Package		
USA/9285/AF-85	1		SRP-1		
USA/9288/AF-85	2		ECO-PAK OP Uranium Oxide Transport Unit (OP-TU)		
USA/9292/AF-85	1		PATRIOT		
USA/9294/AF-85	1		Global Nuclear Fuel Model No. NPC		
USA/9296/B(U)-85	0		AEA Technology 880 Series Packages		
USA/9516/B(U)F-85	2		Mound 1KW		

Table 2, Hanford Site (Onsite) Equivalent PSSDs

Document Number	Revision/ Date	Title	Configuration Manager/ Custodian	Restrictions
SNF-10823	1 10/19/03	Sludge Transport System (STS)	FH T&P FH T&P	

Table 2A, Non TSD Compliant Hanford Site (Onsite) Equivalent PSSDs

Document Number	Revision/ Date	Title	Configuration Manager/ Custodian	Restrictions
BHI-01476	0 05/08/01	PAS-1 Cask Onsite SARP for 105F/H Fuel Storage Basin Spend Nuclear Fuel	WCH WCH	
HNF-4763	0-A 03/07/01	Steel Waste Package	WCH WCH	
HNF-SD-TP-SARP-001	2-C 09/25/00	Sample Pig Transport System	CHG CHG	
HNF-SD-TP-SARP-017	3-B 05/28/02	Multicanister Overpack (MCO) Cask	FH T&P FH T&P	
HNF-SD-TP-SARP-020	0 03/26/97	T-3 Cask	FH T&P FH T&P	
HNF-SD-TP-SARP-023	0-D 09/29/99	Doorstop Sample Carrier System	CHG CHG	
HNF-SD-RE-SARP-054	3-B 07/01/97	21-PF-1 Overpack/EBR-II Spent Fuel Cask	WCH WCH	
WHC-SD-TP-SARP-010	0 01/30/96	Interim Storage Cask	FH T&P FH T&P	
WHC-SD-WM-SARP-001	1-G 08/25/00	Lead-Lined Drum 21 PF-1 Packaging System	WCH WCH	

Table 3, Hanford Site (Onsite) Risk Based PSSDs

Document Number	Document Number	Document Number	Document Number	Document Number

Table 3A, Hanford Site (Onsite) Non TSD Compliant Risk Based PSSDs

Document Number	Revision/ Date	Title	Configuration Manager/ Custodian	Restrictions
HNF-2209	0-A 06/05/01	Steel Drum	FH T&P FH T&P	
HNF-2760	1 09/18/02	Ion Exchange Modules	FH T&P FH T&P	
HNF-3341	0 09/29/98	Decontaminated Equipment Self Container	FH T&P FH T&P	
HNF-3786	0 09/23/99	ATG Nuclear Services 382-B Cask	FH T&P FH T&P	
HNF-6326 PNNL MINI SARP	0 09/30/02	Shielded Waste Cask	PNNL PNNL	
HNF-6807	1-D 12/23/2004	Pipe Overpack Container	FH T&P FH T&P	
HNF-7538	0-A 05/31/01	Finished Fuel Assembly	FH T&P FH T&P	
HNF-SD-TP-SARP-004	2 06/14/2005	Standard Waste Box (SWB)	FH T&P FH T&P	05-SED-0123
HNF-SD-TP-SARP-013	0-A 11/07/00	Long-Length Contaminated Equipment Transport System	CHG CHG	
HNF-SD-TP-SARP-027	0-A 03/19/98	WESF Ion Exchange Module	FH T&P FH T&P	
WHC-SD-TP-SARP-002	1-F 02/03/00	Onsite Transfer Cask	CHG CHG	
WHC-SD-TP-SARP-006	0-A 10/06/95	85-Gallon Retrieval Drum	FH T&P FH T&P	
WHC-SD-TP-SARP-009	0-A 07/22/98	LR56/H Cask System	CHG CHG	
WHC-SD-TP-SEP-022	1 10/10/95	Neutron source Holder Assembly	CHG CHG	

Table 4, Hanford Site (Onsite) Exempted Packages

Document Number	Revision/ Date	Title	Configuration Manager/ Custodian	Restrictions
BHI-01609	0 04/03/02	618-4 Burial Ground Depleted Uranium Drums OTRS	WCH WCH	
BHI-01732	0 09/28/04	LSA-II Material in Roll-Off Containers OTRS	WCH WCH	
FH-0401515	0 08/16/04	Unvented Drums and Drums Containing Greater than 5% Hydrogen Concentrations OTRS	FH T&P FH T&P	
FH-0502993	0 10/27/2005	K West Fuel Racks	FH T&P FH T&P	
HNF-14247	0 02/13/03	200 Area Building Demolition Debris OTRS	FH T&P FH T&P	
HNF-19949	0 04/28/04	Two RTGs from CWC to the MW Burial Trench OTRS	FH T&P FH T&P	
HNF-20022	0 06/28/04	Unirradiated FFTF Sodium Bonded Fuel Pins in the T-3 Cask onsite from PFP to FFTF OTRS	FH T&P FH T&P	
HNF-20961	0 09/30/2005	Unvented Kerr-McGee Drums and Drums Containing Greater than 5% Hydrogen Concentrations OTRS	FH T&P FH T&P	
HNF-22145	1 09/30/2005	Transport of Degraded or Suspect Packagings Onsite within an Overpack Container Meeting U.S. DOT IP-1 Performance Requirements OTRS	FH T&P FH T&P	
HNF-23874	0 10/31/2005	Shipment of 4 ISCs from FFTF to 200 Area ISA	FH T&P FH T&P	
HNF-25044	0 06/01/05	327 Facility Ion Exchange Columns in Type A Boxes OTRS	WCH WCH	
HNF-25684	0 08/04/2005	PFP Glove Box OTRS	FH T&P FH T&P	

AECL = Atomic Energy of Canada, Ltd., Ontario
ATG = Applied Technology Group
BHI = Bechtel Hanford Inc.,
BNFL = British Nuclear Fuels
BUSS = Beneficial Uses Shipping system Cask
CHG = CH2M Hill Group
CNS = Chem-Nuclear System
DOE-RL = U.S. Department of Energy, Richland Operations Office
FH = Fluor Hanford
GNS = Gesellschaft fur Nuklear-Service mbH
HFIR = High Flux Isotope Reactor
HNF = Hanford Nuclear Facility (document identifier)
IPL = Isotope Products Laboratories
LSA = low specific activity
NRF = Neutron Radiography Facility
ORNL = Oak Ridge National Laboratory
SARP = Safety analysis report for packaging
SERF = Special Environmental Radiometallurgy Facility
T&P = transportation and packaging
TRIGA = Test Reactor and Isotope Production General Atomics
WESF = Waste Encapsulation and Storage Facility
WHC = Westinghouse Hanford Company (document identifier)

APPENDIX B

JUSTIFICATION AND BASIS FOR EQUIVALENCY TO DOT REGULATIONS FOR TYPE B AND FISSILE PACKAGES TRANSPORTED ON THE HANFORD SITE

HANFORD SITEWIDE TRANSPORTATION SAFETY DOCUMENT

LIST OF TERMS

AC	accident condition
ASME	American Society of Mechanical Engineers
BPVC	Boiler and Pressure Vessel Code
CFR	*Code of Federal Regulations*
CSB	Canister Storage Building
CWC	Central Waste Complex
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
HAC	hypothetical accident condition
FEA	Finite Element Analysis
IAEA	International Atomic Energy Agency
MCNP	Monte Carlo (computer code for) neutron photon (transport)
NC	normal condition
NCT	normal conditions of transport
NRC	U.S. Nuclear Regulatory Commission
NUREG	U.S. Nuclear Regulatory Commission Regulation
RL	Richland Operations Office
SED	strain energy density
TSL	triaxial strain limit

APPENDIX B - JUSTIFICATION AND BASIS FOR EQUIVALENCY TO DOT REGULATIONS FOR TYPE BAND FISSILE PACKAGES TRANSPORTED ON THE HANFORD SITE

B.1 INTRODUCTION AND OBJECTIVE

The objective of this Appendix is to demonstrate equivalency to regulations specified in 10 *Code of Federal Regulations* (CFR) 71, "Packaging and Transportation of Radioactive Material," of the acceptable performance criteria for design, construction, and evaluation of Type B packages for use on the Hanford Site. The proposed Hanford Site acceptable performance criteria are based on U.S. Nuclear Regulatory Commission (NRC) staff guidelines established in Regulatory Guide 7.6, *Design Criteria for Structural Analysis of Shipping Cask Containment Vessels*, to demonstrate acceptable performance of spent fuel and Category I package design under performance tests specified in 10 CFR 71.71, "Normal conditions of transport," and 10 CFR 71.73, "Hypothetical accident conditions." These acceptable performance criteria, adopted by the U.S. Department of Energy (DOE) – Richland Operations Office (RL), Office of River Protection (ORP) and Pacific Northwest Site Office (PNSO), provide a degree of safety equivalent to that provided by 10 CFR 71 performance tests in ensuring public and worker safety under normal and accident transport conditions on the Hanford Site. In practice, equivalent safety is to be demonstrated by subjecting the package design to 10 CFR 71 performance tests as amended for Hanford Site conditions and evaluating the package design against criteria equivalent to NRC acceptable performance criteria.

To alleviate confusion, the terminology and acronym for normal conditions of transport (NCT) and hypothetical accident conditions (HAC) specified in the regulations are changed for onsite performance test conditions. The terminology and acronym for Hanford Site normal and accident conditions are normal conditions (NC) and accident conditions (AC), respectively.

B.2 BACKGROUND

Performance criteria stipulated in 10 CFR 71 for the specified performance tests for containment, subcriticality, and shielding shall be maintained by the package. The specified performance tests can be performed analytically or by physical testing. However, NRC staff recognizes the cost of full-scale testing may be prohibitive and scale model-testing technology is not fully developed. Consequently, NRC has developed acceptable performance criteria for design and evaluation of Type B packages to demonstrate conformance with performance requirements specified in 10 CFR 71. The NRC, using a graded approach, has established three categories of acceptable package performance based on the content of the package as described in NUREG-1609, *Standard Review Plan for Transportation Packages for Radioactive Material*. These categories are based on Sections III and VIII of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC). NUREG-1609 indicates that spent fuel and Category I packages be designed and constructed to the requirements of ASME BPVC, Section III, Subsection NB. Subsection NB is used for critical safety components of a nuclear reactor and requires the highest level of quality technologically available. NUREG-1609 also states that Category II and III packages be designed and constructed to the requirements of ASME BPVC, Section III, Subsection ND and ASME BPVC, Section VIII, Division 1, respectively.

To demonstrate acceptable spent fuel and Category I package performance under performance test conditions defined in the regulations, the NRC has established acceptance criteria outlined in Regulatory Guide 7.6. This is used in conjunction with Regulatory Guide 7.8, *Load Combinations for the Structural Analysis of Shipping Casks*, and NUREG/CR-6007, *Stress Analysis of Closure Bolts for Shipping Casks* to demonstrate acceptable NCT and HAC performance of the package, used in general commerce. Regulatory Guide 7.6 is based on Section III, Subsection NB of ASME BPVC and establishes standards and criteria for evaluating structural integrity of Type B packages. The basic assumption of ASME BPVC and Regulatory Guide 7.6 is the components remain linearly elastic and the principle of superposition can be applied to determine combined loads. The NRC recognizes that Section III, Subsection NB contains requirements for nuclear power plants. Subsequently, some requirements are not applicable for package design and evaluation. However, the NRC has adopted portions of ASME BPVC that use a “design-by-analysis” approach to form performance acceptance criteria for the containment boundary of spent fuel and Category I packages. By Regulatory Guide 7.6, evaluation criteria for NCT are defined as criteria for Service Level A Limits (NCs) and HAC are defined as the criteria for Service Level D Limits (faulted conditions). In practice, the NRC staff recognizes that to satisfy these requirements, the structural behavior of critical components on the containment boundary must remain elastic under all loading conditions.

In development of Hanford Site analytical acceptable performance criteria, three key factors are considered:

1. For components on the containment boundary to remain elastic under ACs is extremely conservative. This requirement ignores the energy absorption capability of the material of construction from localized strains without breach of containment or loss of dimensional stability.

2. Development of the regulations by the U.S. Department of Transportation (DOT) and NRC for safe transport in commerce is fundamentally based on maintaining containment and requiring that radiological safety be engineered into the package. The basis is as follows:

    - Packages are shipped via a variety of carriers and conveyances. Therefore, reliance for safe transport must be placed in the package because commercial carriers do not always have adequately trained operators and properly maintained equipment.

    - Operators for commercial carriers may not have training in handling radioactive materials.

    - Local and state authorities may not have adequately trained accident emergency response units readily available.

    - The carriers, and local and state authorities determine transport routes.

    - All transport is on public roadways.

3. Transport of fissile and Type B packages on the Hanford Site are not in commerce when north of Wye Barricade or when shipped under road closure. Subsequently, the following provisions are in place to enhance onsite transportation safety:

    - Access is controlled within the Wye Barricade. Subsequently, the majority of transport is not on public roads.

    - Trained emergency response teams are available and dedicated to the Hanford Site.

    - Roads are closed for transport of uncertified fissile or Type B packages from areas south of the Wye Barricade to the Wye Barricade.

    - Maintenance of equipment and training of personnel are required, monitored, and controlled by Hanford Site authorities.

    - These factors are also considered by the NRC in development of regulations (10 CFR 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste") for commercial storage facilities, which are onsite operations.

B.3 JUSTIFICATION FOR PERFORMANCE

B.3.1 Hanford Site Free Drop Onto Concrete Surface

The free drop target surface specified in the regulations is a hard and essentially unyielding surface. In practice, this has been defined as a thick reinforced concrete pad with a thick (>5 cm [2-in.]) steel plate firmly fixed to the concrete, all of which must be set on compact soil. The International Atomic Energy Agency (IAEA) Safety Series No. 37 Guide states that the total weight of the concrete and steel plate for a proper free drop test must be at minimum 10 times the weight of package. This surface is specified in the regulations for conservatism and test reproducibility. In Finite Element Analysis (FEA) evaluations, the surface is defined as an infinitely rigid and unmovable surface. This FEA theoretical surface absorbs no energy from the impact and reflects all force waves.

On the Hanford Site, the free drop performance test target surface is established as the Central Waste Complex (CWC) storage pad. The pad is a 20 cm (8-in.) thick 21 MPa (3,000 psi) concrete pad, reinforced with No. 7 rebar on 30 cm (12 in.) centers. This free drop surface is the most rigid surface encountered during transport of packages on the Hanford Site. In addition, this surface provides an additional margin of safety for the most common and numerous packages transported onsite, drums and boxes. The additional margin of safety is derived from the behavior of relatively small light packages (less than 4,534 kg [10,000 lb]) impacting a reinforced concrete surface. In such an impact, the small package behaves as though the impact was on a hard unyielding surface. The explanation for this is that small light packages, such as drums, have a hardness value far less than a reinforced concrete surface. Consequently, the drum tends to absorb a majority of the energy of impact in deformation and the concrete surface tends to act as a hard unyielding surface. The larger robust packages, such as spent fuel casks, have a hardness value much higher than the specified concrete surface. This results in a concrete surface absorbing much of the energy of impact. In essence, by specifying this surface, the most numerous and lighter Type B packages transported on the Hanford Site are subjected to the more conservative calculated loading.

B.3.2 NC Acceptable Performance Criteria

On the Hanford Site, packages are used only for onsite transport and storage. In lieu of testing, analytical evaluation and numerical simulations of the package are used to assess a majority of the packages to specified performance tests. Consequently, the NC performance acceptance criteria for all Type B packages will be based on ASME BPVC, Section III, Subsection NE in lieu of Subsection NB specified in Regulatory Guide 7.6. This is justified on the basis that Subsection NE is applicable to the containment vessel of a nuclear facility and has provisions tailored to the special features of bolted flange connections. Subsection NB is applicable to the reactor coolant boundary and has provisions tailored to pumps, vessels, valves, and piping. From a structural standpoint, there is no significant difference between the two code sections relative to determination of allowable stress intensities and combining of loads. Also, there is no major difference between the stress intensity criteria of these two subsections except that the stress intensity value in Subsection NB is S_m while it is defined as S_{mc} in Subsection NE. For materials

related issues including welding, fabrication, and examination, Subsection NE is sufficient because the package is not subjected to the same high temperature, high pressure, and intense radiation as the reactor coolant boundary. The temperature, pressure, and radiation level of the package are closer to those of the secondary metal containment vessel for a nuclear reactor facility.

Also, NC performance acceptance criteria are based on ASME BPVC, Section III, Subsection NE Service Level A and C Limits. Combined stress intensities from temperature, pressure, and free drop are evaluated against requirements defined for Service Level C Limits. Stress intensities from all other load combinations are to be evaluated against requirements defined for Service Level A Limits. For structural evaluation purposes, maintenance of containment is defined as the ability of packaging systems to sustain the applied loading without exceeding ASME allowable stress intensity values.

The use of Service Level C Limits for free drop loads combined with other loads is justified on the basis that during onsite transport a free drop of a package would be considered at best an occurrence and at worst an event. In either case, the situation would dictate an emergency response on the Hanford Site. For this type of scenario, the package would be required to maintain containment, shielding, and subcriticality. After such an occurrence or event, the package would be transported under emergency conditions to a facility for removal and repacking of the contents into a new package. This sequence of actions after a free drop is consistent with the definition for Service Level C as defined in ASME BPVC, Section III, Subsection NCA, General Requirements for Division 1 and 2. In Subsection NCA under subparagraph NCA-2142.2, Service Level C Limits permit large deformation in areas of structural discontinuity without loss of function, which may necessitate removal of the component from service for inspection or repair of damage. Application of this limit is defined in Subsection NE, subparagraph NE-3113.3 as applicable loads subject to Service Level A and B Limits in combination with loads due to natural phenomena for which safe shutdown is required.

B.3.3 Brittle Fracture Acceptable Performance Criteria

For package containment boundaries and critical components that are constructed from ferritic steels, low temperature brittle fracture of the materials needs to be addressed in a manner similar to certified Type B packages. To address this issue, the NRC has developed fracture toughness criteria in Regulatory Guide 7.11, *Fracture Toughness Criteria of Base Material for Ferritic Steel Shipping Cask Containment Vessels with a Maximum Wall Thickness of 4 Inches (0.1 m)*. This regulatory guide establishes material fracture toughness requirements for three categories based on curie content of the payload. The highest category, Category I, requires material fracture toughness testing to requirements specified in NUREG/CR-1815, *Recommendations for Protecting Against Failure by Brittle Fracture in Ferritic Steel Shipping Containers up to Four Inches Thick*. In lieu of these requirements, low temperature material service requirements of ASME BPVC, Section VIII, Division 1 are applied for design and evaluation of Type B packages to demonstrate resistance to brittle fracture based on minimum metal temperature for safe handling and transport of packages. The justification is as follows:

- Methods and requirements provided in Section VIII, Division 1 are based on accumulated years of experience in design, material usage, construction, and operation of pressure vessels by members of ASME.

- Basis for Section III and Regulatory Guide 7.11 requirements are derived from the requirements first established in Section VIII, Division 1.

- Methods and requirements outlined in Section VIII, Division 1, can be readily applied by the engineer without the expense of fracture toughness testing the materials of construction. The number of laboratories qualified to perform fracture toughness tests is limited and testing is expensive.

For packages and components constructed from austenitic stainless steels, no fracture toughness related restrictions are placed on the material. This is justified on the basis that Regulatory Guide 7.11 states that austenitic stainless steel is not susceptible to brittle failure and containment vessels constructed of stainless steel are acceptable to the NRC without testing.

B.3.4 Acceptable Performance Criteria for free drop and Puncture AC

The NRC regulatory position for demonstration of compliance of spent fuel and Category I package design to HAC performance tests defined in 10 CFR 71 is for the package to meet Service Level D Limits specified in ASME BPVC, Section III, Subsection NB as amended by Regulatory Guide 7.6. The intent of Regulatory Guide 7.6 is to demonstrate containment by showing there are no large unconfined plastic strains and system failure due to loss of dimensional stability using linear elastic methods and criteria defined in ASME BPVC. However, accident free drop and puncture loads on Type B packages without impact absorption devices cause highly nonlinear material responses. In particular, contact stresses from impact imposed on packages (especially without impact limiters) when dropped, exceed the yield strength of the material. Evaluating the material response in an impact event assuming a linear elastic material response is inappropriate. Application of ASME criteria to the results of a nonlinear analysis is also inappropriate. Therefore, it is necessary to generate acceptance criteria that go beyond the assumptions of linear elasticity and quasi-static load control. Acceptance criteria used must be consistent with elastic-plastic analysis techniques that are applied to ductile materials (austenitic stainless steel) that are subjected to highly localized impact loadings. Puncture and free drop impacts of Type B packages are energy-controlled events. Subsequently, the use of energy-based parameters as acceptance criteria are required to accurately assess the structural integrity, containment performance, and dimensional stability of the package. At present, there are two acceptance criteria based on energy parameters that have been used at the Hanford Site to assess package performance under accident free drop and puncture loads. They are strain energy density (SED) and triaxial strain limit (TSL).

Both acceptance criteria are energy based. The SED criterion is based on material toughness and the TSL criterion is based on the ultimate elongation of material and principal stresses. The choice in using these criteria has been left to the structural evaluation engineer. In most cases the SED criterion is used for shells, closures lids, and closure bolts. The TSL criterion is used at the more critical locations of joints and at discontinuities. In the case where the package is fitted

with impact absorption devices or for all other loading combination cases (without free drop or puncture loads), performance is assessed to the requirements of ASME BPVC, Subsection NE, Service Level D Limits.

B.3.4.1 Criterion 1

The first and simplest acceptance criteria parameter is SED. The SED (V) of a material is defined as:

$$V = \int \sigma d\varepsilon$$

In other words, the integral of the material stress (σ) versus strain (ε) curve.

The maximum SED of the material is also commonly known as toughness and, at material failure, can be conservatively estimated from results of uniaxial tensile test data. A conservative estimate of SED at material failure is as follows:

$$U_t = \frac{(\sigma_y + \sigma_u)}{2}\varepsilon_f$$

where: σ_y = yield strength of the material
σ_u = ultimate strength of the material
ε_f = elongation at failure.

All these parameters are available from engineering stress-strain data. Use of the SED also minimizes concerns over unavoidable material variations such as heat-to-heat variations in yield strength and strain hardening behavior. In addition, the SED on the material from impact loads can be easily determined from stress and strain data retrieved from the FEA numerical simulation of the impact.

To ensure against ductile failure of the material, the maximum SED on the package is limited to 70% of the SED to failure of the material or material toughness. This is in keeping with the intent of Regulatory Guide 7.6 to prevent large unconfined strain plasticity and system failure due to loss of dimensional stability at key locations. The 70% limit is based on Service Level D limits for material loading, specified in ASME BPVC, Section III.

B.3.4.2 Criterion 2

In the SED measure of performance, no distinction is made between compressive and tensile strains, and all strains are treated as tensile. Consequently, this measure of performance is very conservative because it does not account for the less severe affects of compressive strains (with respect to breaching of the material). A more time consuming, but more accurate measure of performance is comparing the cumulative principal strains or equivalent plastic strains against a limiting value that could initiate local fracture.

These cumulative strains generated by FEA numerical simulations of free drop and puncture events are the difference between the largest and smallest principal logarithmic strains at a specific element. This is, by definition, the strain counterpart of the ASME stress intensity. The equivalent plastic strain is the plastic strains combined in a von Mises manner.

Criteria demonstrating acceptable cumulative strain levels to prevent material rupture are based on establishing limits on the maximum principal cumulative strain. Strain limits are developed based on the Manjoine (1983) *Transaction of the ASME, Journal of Pressure Vessel Technology* observation that tensile elongation measured in a tension test can be adjusted to predict multi-axial failure strain by the following relation:

$$\frac{\varepsilon}{e_t} = 2^{(1-TF)} \quad \text{for} \quad TF \geq 0 \quad \text{and} \quad \frac{\varepsilon}{e_t} = 2 \quad \text{for} \quad TF \leq 0$$

where: ε = the effective strain at failure
e_t = the tensile elongation from tension tests, and
TF = the triaxiality factor.

The triaxiality factor is defined by the principal stresses (σ_1, σ_2, σ_3) as:

$$TF = \frac{\sqrt{2}\,(\sigma_1 + \sigma_2 + \sigma_3)}{\sqrt{\left[(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2\right]}}$$

Based on the ductility versus triaxiality factor curve presented in Manjoine (1983), the following conservative failure strain limits can be established for any ductile material. For a triaxiality factor of 1.0 (uniaxial tension), the cumulative strain limit is the reported ultimate strain of the material at tensile rupture. For a triaxiality factor of 2.0 (maximum value for biaxial tension at the surface), the cumulative strain limit is half the reported ultimate strain of the material at tensile rupture. For negative values of triaxiality factor (significant compressive stress), the cumulative strain limit is double the reported ultimate strain of the material at tensile rupture. This criterion was developed and used by the Canister Storage Building (CSB) Expert Review Panel for evaluating multicanister overpack free drops in the CSB.

B.3.5 Fire Accident Acceptable Performance Criteria

In the case of HAC fire, performance test requirements specified in 10 CFR 71.73 stipulate the fire temperature (800 °C [1,475 °F]), duration (30 minutes), emissivity (0.9), and package absorptivity (0.8). It also stipulates that no artificial cooling be applied and the package must cool naturally. In the case of package absorptivity, the NRC staff position is that testing real emissivities of the package may be used, but must be accounted for by increasing the fire temperature. Also, the sequence of events leading up to the fire is specified. As with all other performance tests, Regulatory Guide 7.6 is the acceptable performance criteria along with

maintenance of shielding. For seal integrity, the NRC staff has traditionally used the manufacturers' recommended continuous operating temperature as the limiting temperature of the seal material.

For onsite transportation, it is proposed that the fire AC parameters for evaluation be as follows:

- Fire temperature of 800 °C (1,475 °F)
- Duration of 30 minutes
- Artificial water cooling is applied to the package immediately after the 30-minute fire
- Effect of solar radiation can be ignored for the entire event
- Emissivity of the fire is 0.9
- Absorptivity of the package is the published absorptivity of the outer surface material at temperature
- Sequence of events leading to the fire is the same as specified in the regulations.

Hanford Site parameters that are not identical to the regulations are justified on the following basis:

- Because there are dedicated Fire Fighting Units trained in fighting radioactive material fires on the Hanford Site, cooling after a 30-minute fire duration is realistic.
- Lower absorptivities of the outer shell of the packaging are justified on the basis that measurements of material emissivities at temperature are much lower than the 0.9 absorptivity specified in the regulations; as an example, the absorptivity of 316 stainless steel is 0.6 at 538 °C (1,000 °F).

Under fire conditions, the limiting value to demonstrate containment performance of the seal is based on the manufacturers' stated high temperature operation for a duration of 1 hour. Structural integrity and safe performance of the package is demonstrated by evaluating thermal loading on the package to the requirements of ASME BPVC Section III, Subsection NE for Service Level D Limits.

B.3.6 Design and Construction Standard for Packages

The NRC has established standards and criteria for design and construction of packages in Regulatory Guides, NUREG/CR-3854, *Fabrication Criteria for Shipping Containers*, and NUREG/CR-3019, *Recommended Welding Criteria for Use in the Fabrication of Shipping Containers for Radioactive Materials*. These standards and criteria are based on the graded-approach application of Section III of ASME BPVC. As an example, spent fuel and

Category I package containment vessels are to be designed and constructed to the requirements of ASME BPVC, Section III, Subsection NB. Category II package containment vessels are to be designed and constructed to the requirements of ASME BPVC, Section III, Subsection ND, and Category III package containment vessels to ASME BPVC, Section VIII, Division 1. Package design and construction quality assurance requirements are defined in 10 CFR 71, Subpart H. The intent of the NRC in establishing these various standards, criteria, and requirements is to ensure quality of the package by imposing controls on construction processes of packages and components.

For the design and construction of packages for transport and storage on the Hanford Site, ASME BPVC, Section VIII, Division 1 or 2 is to be used for the containment vessel of the package. The containment vessel is required to be constructed by an ASME BPVC, Section VIII, certified shop and in some cases the design engineer may require application of a U or U-2 Stamp. In all cases, pressure and leak tests are required. The bases for this are as follows:

- Quality control of basic vessel construction processes such as design, material selection, material handling, inspection, welding, assembly, and heat treatment are fundamentally the same as ASME BPVC, Section III, except additional restrictions are applied depending on the subsection (Subsection NB is the most restrictive).

- Vessels designed and constructed to the requirements of ASME BPVC, Section VIII, Division 1 have an inherent margin of 4. Vessels designed and constructed to the requirements of ASME BPVC, Section III, Subsection NB and Section VIII, Division 2 have an inherent margin of 3.

- Original basis of Section III Subsections are ASME BPVC, Section VIII, Divisions 1 and 2.

- Code philosophies in both sections are the same.

- Weld procedures and welders are qualified to ASME BPVC, Section IX under both Sections III and VIII.

- Nondestructive examination of materials and components are performed to the requirements of ASME BPVC, Section V under Section III and Section VIII.

- Both sections require the same known materials, proven design practices, known fabrication practices for forming, bending, welding and postweld heat treatment, proven nondestructive examination procedures, and pressure testing.

- Containment vessels, when properly designed to the requirements of ASME BPVC, Section VIII, Division 1 or 2 for internal pressure loadings of 1.4 to 2.8 MPa (200 to 400 psig) with standard material sizes, can be demonstrated to meet the proposed acceptable performance criteria for NC and AC loadings. This includes free drops.

- Pressure, radiation, and temperature extremes for a package are far less than for the primary coolant system of a reactor.

- Each vessel must be pressure tested.

- ASME BPVC, Section VIII, Division 1 or 2 provides a known commercial standard from which the containment vessel can be constructed that meets fundamental design and construction requirements of regulatory guides and NUREGs.

Aan example of such a package is a design of a typical small Type B shielded drum package. Total weight of the package is approximately 2,041 kg (4,500 lb) and gross weight of containment vessel is approximately 181 kg (400 lb). The containment vessel is designed for an internal pressure of 1.4 MPa (200 psig) at 204 °C (400 °F), with a maximum normal operating pressure of 0.8 MPa (100 psig) at 93 °C (200 °F). The vessel is designed in accordance with design rules stipulated in ASME BPVC, Section VIII, Division 1, using stock sizes of materials. The package is then evaluated for NC and AC structural integrity and containment maintenance using the Hanford site performance criteria.

B.3.7 Hanford Site Criticality Limits for Packages

The NRC staff position is that transportation packages must have, in addition to the bias and uncertainties, a minimum administrative subcritical margin of 0.05 Δk (p. 2, NUREG/CR-5661, *Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packaging for Radioactive Material*); i.e., a maximum k_{eff} limit of 0.95 considering bias and uncertainties. However, if there is sufficient critical data to adequately determine calculational bias and uncertainty, the subcritical margin may be increased by some amount (NUREG/CR-5661, p. 18). The TSD establishes the upper limit for calculated k_{eff} and associated bias and uncertainties of 0.95, consistent with the NRC position cited above. If justification for specific packages is necessary to increase this limit, an exemption request as described in Chapter 9.0 may be processed for DOE-RL approval.

For transport of arrays of packages, regardless of the actual k_{eff} limit, k_{eff} is not controlled directly, but instead indirectly by controlling enrichment, mass, geometry, other process parameters, or a combination thereof that influences k_{eff}. At the time of evaluation, the values of these physical parameters are fixed, and the criticality evaluation controls k_{eff} by controlling the number of packages on a single shipment. Typically, the magnitude of the safety margin in

terms of the number of packages is not reported for a given safety margin in k_{eff}. However, DOE G 421.1-1 (p. 69), *Criticality Safety Good Practices Program Guide for DOE Nonreactor Nuclear Facilities*, recommends that k_{eff}

> "should be used to assess safety only in conjunction with its relation to parametric curves representing the system under consideration. For example, the often-referenced "safe" condition of $k_{eff} = 0.95$ could be overly conservative at a point on the flat of a k_{eff} vs. H/X parametric curve, but very non-conservative on the steep upward slope of such a curve."

Applying this concept to Hanford Site packages, the adequacy of a safety margin can be demonstrated by a parametric curve of k_{eff} versus the number of packages. For a hypothetical situation where the k_{eff} of X number of packages in ACs is 0.94, but the k_{eff} of an array of 2X packages is 0.96, a k_{eff} limit of 0.95 may be unnecessarily conservative based on as low as reasonably achievable, cost, or schedule considerations because the addition of a large number of packages to the shipment does not increase the k_{eff} significantly (and in no cases will a k_{eff} limit higher than 0.98 be used). An equivalent degree of safety based on a sufficient margin of safety in terms of the controllable physical parameter (the number of packages) may be demonstrated in this manner, where the k_{eff} is on the plateau of the parametric curve, and a k_{eff} limit ≤ 0.98 in this example is both safe and non-arbitrary.

Besides the safety margin in the k_{eff} limit, an additional component of safety analysis is using conservative assumptions. However, an analysis that is excessively conservative is not necessarily desirable. As noted in DOE G 421.1-1, (pp. 64), "excessive conservatism is any approximation or combination thereof that results in an excessive safety margin and thus needlessly hinders the mission of the facility or usurps resources." Furthermore, DOE G 421.1-1, (p. 66) states, "appropriateness in conservatism means not only relevance, but also implies (1) realism in all aspects of evaluations, and (2) cost effectiveness that does not preclude consideration of reasonable alternatives." Thus, conservative assumptions should be relevant, realistic, and not needlessly usurp resources. Criticality safety evaluations should determine whether assumptions are reasonably or excessively conservative.

B.3.8 Hanford Site Environmental Conditions

The equivalent package standards provide an equivalent degree of safety to those provided by 10 CFR 71 and supplemental NRC regulatory guidance. Equivalency is based on site-specific environmental and test conditions, which in the majority of cases, are identical to the regulations. However, as shown in Table 1, in a few cases the site-specific worst case conditions are less severe and in two cases are more severe than those specified in the regulations. The following sections identify and justify the site environmental condition use in the equivalent standards.

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		**NRC Regulatory Acceptance Criteria**	**Hanford Standard Performance Test**	**Hanford Acceptance Criteria**
10 CFR 71.43 General standards for all packages				
10 CFR 71.43 (a)	Smallest overall dimension not less than 10 cm (4 in).	Self-explanatory.	Same as 10 CFR 71.43 (a).	Same as NRC.
10 CFR 71.43 (b)	Outside of package must have tamper-indicating devices.	Self-explanatory.	Same as 10 CFR 71.43 (b).	Same as NRC.
10 CFR 71.43 (c)	Each package must include a positive fastening device.	Self-explanatory.	Same as 10 CFR 71.43 (c).	Same as NRC.

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		**NRC Regulatory Acceptance Criteria**	**Hanford Standard Performance Test**	**Hanford Acceptance Criteria**
10 CFR 71.43 (d)	Package must be made of materials and construction that assure no significant chemical, galvanic, or other reaction among packaging components and package contents.	Self-explanatory.	Same as 10 CFR 71.43 (d).	Same as NRC.
10 CFR 71.43 (e)	Package valve or other device must be protected against unauthorized operation and must be provided with an enclosure to retain any leakage.	Self-explanatory.	Same as 10 CFR 71.43 (e).	Same as NRC.
10 CFR 71.43 (f)	Package must not have loss or dispersal of radioactive contents, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging.	Self-explanatory.	Same as 10 CFR 71.43 (f).	Same as NRC.
10 CFR 71.43 (g)	Package must have, in still air at 38 °C (100 °F) and in the shade, no accessible surface temperature exceeding 50 °C (122 °F) in a nonexclusive use shipment or 85 °C (185 °F) in an exclusive use shipment.	Self-explanatory.	Same as 10 CFR 71.43 (g), except still air requirement is at the higher onsite temperature of 46 °C (115 °F).	Same as NRC.
10 CFR 71.43 (h)	Package may not incorporate a feature intended to allow continuous venting.	Self-explanatory.	Packages with high hydrogen-gas generation rates are allowed to have a filtered vent or package must be demonstrated to withstand deflagration.	Package has HEPA filter, demonstrated to not allow liquid passage and maintain regulatory release limits under all performance tests. Sustaining deflagration demonstrated by meeting Service Level D requirements or test with no loss of containment.
10 CFR 71.45 Lifting and tiedown standards for all packages				

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		**NRC Regulatory Acceptance Criteria**	**Hanford Standard Performance Test**	**Hanford Acceptance Criteria**
10 CFR 71.45 (a)	(1) Lifting attachment must have a minimum safety factor of 3 against yielding. Failure of device not to impair ability of package to meet other safety requirements. (2) Similar parts made inoperable for lifting or meet design requirements.	(1) ANSI N14.6 (a) Lifting 3 x total weight without exceeding yield strength. OR 5 x total weight without exceeding ultimate strength. (b) If failure of devices affects safety-related equipment, device designed for twice above loads or dual load path system provided. (2) Self-explanatory.	(1a) RL Hoisting and Rigging Manual. (1b) RL Hoisting and Rigging Manual. (2) Same as 10 CFR 71.45 (a).	(1a) RL Hoisting and Rigging Manual requirements. (1b) RL Hoisting and Rigging Manual requirements. (2) Same as NRC.
10 CFR 71.45 (b) Tiedown devices	(1) System of tiedown devices that is a structural part of the package must be capable of withstanding static loads of 2, 10, and 5 times the gross weight of the package applied to the center of gravity of the package. (2) Must be capable of being rendered inoperable for tying down the package during transport, or must be designed with strength equivalent to that required for tiedown devices. (3) Failure of the device under excessive load would not impair the ability of the package to meet other requirements.	(1) In this case, the tiedowns to critical components are to meet these requirements when attached to critical components. Loads are to be evaluated to Regulatory Guide 7.6 or applicable ASME subsection per NUREG-1609, for Service Level A. (2) Self-explanatory. (3) Self-explanatory.	(1) Same as 10 CFR 71.45 (b). (2) Same as 10 CFR 71.45 (b). (3) Same as 10 CFR 71.45 (b).	(1) Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE, for Service Level A. (2) Same as NRC. (3) Self-explanatory.
10 CFR 71.71 Normal conditions of transport				
10 CFR 71.71 (a) Evaluation	Evaluation of each package design must include a determination of the effect on that design of the conditions and tests.	Demonstrated by meeting requirements of Regulatory Guide 7.6 or applicable ASME subsection per NUREG-1609, for Service Level A. Load combination per Regulatory Guide 7.8	Same as 10 CFR 71.71 (a).	Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE, for Service Level A.

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		**NRC Regulatory Acceptance Criteria**	**Hanford Standard Performance Test**	**Hanford Acceptance Criteria**
10 CFR 71.71 (b) Initial conditions	Ambient temperature preceding and following tests must remain constant at value between –29 °C (-20 °F) and 38 °C (100 °F). The initial internal pressure must be MNOP consistent with the ambient temperature considered to precede and follow the tests.	Demonstrated by meeting requirements of Regulatory Guide 7.6 or applicable ASME subsection per NUREG-1609, for Service Level A.	Same as 10 CFR 71.71 (b) except extreme temperature range is -33 °C (-27 °F) to 46 °C (115 °F) for the Hanford Site.	Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE, for Service Level A.
10 CFR 71.71 (c) Conditions and tests, (1) Heat	An ambient temperature of 38 °C (100 °F) in still air and insolation in accordance with: Form and location of surface/total insolation for a 12-hour period: • Flat surfaces transported horizontally - base/none - other surfaces/800 g-cal/cm^2 • Flat surfaces not transported horizontally/200 g-cal/cm^2 • Curved surfaces/400 g-cal/cm^2	Package accessible surfaces in still air at 38 °C (100 °F) and in the shade must not exceed 50 °C (122 °F) in nonexclusive use shipments and 85 °C (185 °F) in exclusive use shipment. Also, worst case to be used in combination with other loads as defined in Regulatory Guide 7.8 to develop NCT load combinations.	NC Heat (Hanford Site) • Ambient Temperature= 46 °C (115 °F). • Still air. • Decay Heat. • Solar insolation for 12 h/d specific to the Hanford Site.	Same as NRC except 46 °C (115 °F) ambient temperature.
10 CFR 71.71 (c) (2) Cold	An ambient temperature of -40 °C (-40 °F) in still air and shade.	Criteria for Regulatory Guide 7.11 or 7.12 material brittle fracture requirements. Also, condition for evaluation of NCT and HAC performance.	Hanford Site • Ambient Temperature = -33 °C (-27 °F). • Still air. • In the shade.	ASME BPVC, Section VIII, Division 1 criteria per UCS-66 for brittle fracture. Also, conditions for evaluation of NC and AC.
10 CFR 71.71 (c) (3) Reduced external pressure	External pressure of 25 kPa (3.5 psi) absolute.	Considered as part of Regulatory Guide 7.8 to establish MNOP for NCT load combination development. Acceptance criterion of the worst case load combination is ASME BPVC applicable subsection per NUREG-1609, Service Level A.	Same as 10 CFR 71.71 (c).	Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE, for Service Level A for sealed packages or evaluate for plugged filter for vented packages.

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		NRC Regulatory Acceptance Criteria	Hanford Standard Performance Test	Hanford Acceptance Criteria
10 CFR 71.71 (c) (4) Increased external pressure	External pressure of 140 kPa (20 psi) absolute.	Considered as part of Regulatory Guide 7.8 to develop worst case NCT load combinations. Acceptance criterion of the worst case load combination is ASME BPVC applicable subsection per NUREG-1609, Service Level A.	Same as 10 CFR 71.71 (c).	Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE, for Service Level A when evaluated for packages with plugged filter and external pressure.
10 CFR 71.71 (c) (5) Vibration	Vibration normally incident to transport.	Acceptance criterion is applicable ASME BPVC subsection per NUREG-1609, Service Level A fatigue analysis. For transport vibration, NRC has accepted the argument that the NCT drop is bounding.	Same as 10 CFR 71.71 (c).	Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE, for Service Level A. NC free drop is used as an argument to bound vibration.
10 CFR 71.71 (c) (6) Water spray	Water spray that simulates exposure to rainfall of approximately 5 cm/h (2 in./h) for at least 1 hour.	Normally this is demonstrated by the argument that package is sealed leaktight and remains leaktight during NCT; therefore, it is watertight. Vulnerable areas to water intrusion such as impact limiters and neutron shielding fire vent ports are evaluated.	Same as 10 CFR 71.71 (c).	Same as NRC, except that since venting is allowed, filters must be evaluated.
10 CFR 71.71 (c) (7) Free drop	Between 1.5 and 2.5 hours after the water spray test, a free drop through a distance specified onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected.	For this case, all applicable combined loads from above as specified in Regulatory Guide 7.8. NRC acceptance criteria are Regulatory Guide 7.6 or applicable ASME BPVC subsection per NUREG-1609, Service Level A to demonstrate containment. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Shielding limits are regulatory requirements.	Hanford Site requirements the same except 1.2 m (4.0 ft) to 0.3 m (1.0 ft) onto a worst case Hanford Site target established as a 20 cm (8-in.) thick concrete pad, sufficiently large enough to contain the entire impact event. Concrete shall have a specified minimum strength of 21 MPa (3,000 psi) reinforced with No. 7 rebar on 30 cm (12 in.) centers over compact Hanford soil.	Same as NRC, except demonstrated containment by meeting ASME BPVC, Section III, Subsection NE, for Service Level C with all applicable load combinations. For criticality control, the same as the NRC. Shielding limits based on Hanford Site requirements.

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		**NRC Regulatory Acceptance Criteria**	**Hanford Standard Performance Test**	**Hanford Acceptance Criteria**
10 CFR 71.71 (c) (8) Corner drop	Free drop from a height of 0.3 m (1 ft) onto flat, essentially unyielding, horizontal surface. Test applied only to fiberboard, wood, or fissile material rectangular packages not exceeding 50 kg (110 lb) and fiberboard, wood or fissile material cylindrical packages not exceeding 100 kg (220 lb).	Addressed on a case-by-case basis.	Same as 10 CFR 71.71 (c) (8) except the free drop surface target is the same as described above.	Same as NRC.
10 CFR 71.71 (c) (9) Compression	For packages weighing up to 5,000 kg (11,000 lb), the package must be subjected for 24 hours to a compressive load applied uniformly to top and bottom of package in the position the package would normally be transported. The compressive load must be the greater of the following: (i) The equivalent of 5 times the weight of the package; or (ii) The equivalent of 13 kPa (2 lbf/in^2) multiplied by the vertically projected area of the package.	Not normally performed for large package. For small packages, load combinations above are evaluated with compression to applicable ASME BPVC subsection per NUREG-1609 for Service Level A to demonstrate maintenance of containment.	Same as 10 CFR 71.71 (c).	Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE, for Service Level A.
10 CFR 71.71 (c) (10) Penetration	Impact of the hemispherical end of a vertical steel cylinder of 3.2 cm (1.25 in.) diameter and 6 kg (13 lb) mass, dropped from a height of 1 m (40 in.) onto the exposed surface of the package that is expected to be most vulnerable to puncture. The long axis of the cylinder must be perpendicular to the package surface.	Normally, for large packages, this is evaluated only when ancillary equipment, such as shut off values required to NCT containment, is judged to be vulnerable to hard and light falling projectiles. Small packages with thin walls and/or vulnerable locations must be evaluated to demonstrate containment with only highly localized deformation in the impact region.	Same as 10 CFR 71.71 (c).	Same as NRC.
10 CFR 71.73 Hypothetical accident conditions				

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		**NRC Regulatory Acceptance Criteria**	**Hanford Standard Performance Test**	**Hanford Acceptance Criteria**
10 CFR 71.73 (a) Test procedures	Evaluation for HAC is based on sequential application of the tests, in order indicated, to determine their cumulative effect. An undamaged specimen may be used for the water immersion tests.	Demonstrated by meeting requirements of Regulatory Guide 7.6 or applicable ASME BPVC subsection per NUREG-1609, for Service Level D.	Same as 10 CFR 71.73 (a).	Same as NRC except demonstrated no loss of containment by showing SED or accumulated plastic strain below allowable limits for the material. As an alternative, use ASME BPVC, Section III, Subsection NE, for Service Level D. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Loss of shielding limits is the same as the NRC.
10 CFR 71.73 (b) Test conditions.	Except for water immersion tests to demonstrate compliance with the requirements during testing, the ambient air temperature before and after the tests must remain constant at the value between -29 °C (-20 °F) and 38 °C (100 °F). The initial internal pressure within the containment system must be the MNOP, unless a lower internal pressure, consistent with the ambient temperature assumed to precede and follow the tests, is more unfavorable.	Self-explanatory.	Same as 10 CFR 71.73 (b) except temperature range for Hanford Site is -33 °C (-27 °F) to 46 °C (115 °F).	Self-explanatory.
10 CFR 71.73 (c) Tests	**Tests for HAC must be conducted as follows:**			

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		NRC Regulatory Acceptance Criteria	Hanford Standard Performance Test	Hanford Acceptance Criteria
10 CFR 71.73 (c) (1) Free drop	A free drop through a distance of 9 m (30 ft) onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected.	NRC acceptance criteria are Regulatory Guide 7.6 or applicable ASME BPVC subsection per NUREG-1609, Service Level D to demonstrate containment. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Also shielding must be within HAC limit of ≤ 1,000 mR/h, 1 m (40 in.) from external surface of package.	AC Hanford Site Requirements the same except, free drop onto a worst case Hanford Site target established as a 20 cm (8-in.) thick concrete pad, sufficiently large enough to contain the entire impact event. Concrete shall have a specified minimum strength of 21 MPa (3,000 psi) reinforced with No. 7 rebar on 30 cm (12 in.) centers over compact Hanford soil.	Same as NRC, except demonstrating no loss of containment by showing the SED or accumulated plastic strain is below allowable limits for the material. As an alternative, use ASME BPVC, Section III, Subsection NE, for Service Level D. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Loss of shielding limits is the same as the NRC.
10 CFR 71.73 (c) (2) Crush	Subjection to a dynamic crush test by positioning the specimen on a flat, essentially unyielding, horizontal surface so as to suffer maximum damage by the drop of a 500 kg (1,100 lb) mass from 9 m (30 ft) onto the specimen. The mass must consist of a solid mild steel plate 1 m (40 in.) by 1 m (40 in.) and must fall in a horizontal attitude. Test is required only when the specimen has a mass not greater than 500 kg (1,100 lb), and overall density not greater than 1,000 kg/m^3 (62.4 lb/ft^3), and radioactive contents greater than 1,000 A_2 not as special form radioactive material.	NRC acceptance criteria are Regulatory Guide 7.6 or applicable ASME BPVC subsection per NUREG-1609, Service Level D and must follow free drop (sequentially) to demonstrate containment. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Also shielding must be within HAC limit of ≤ 1,000 mR/h 1 m (40 in.) from external surface of package.	Same as 10 CFR 71.73 (c) (2) except the target surface for the Hanford Site is as specified above and crushing object is an identical package dropping from a height of 9 m (30 ft) onto the damaged package in the orientation to cause the most damage. Specimen on a concrete surface as defined above.	Same as NRC, except demonstrating no loss of containment by showing the SED or accumulated plastic strain is below allowable limits for the material. As an alternative, use ASME BPVC, Section III, Subsection NE, for Service Level D. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Loss of shielding limits is the same as the NRC.

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		**NRC Regulatory Acceptance Criteria**	**Hanford Standard Performance Test**	**Hanford Acceptance Criteria**
10 CFR 71.73 (c) (3) Puncture	A free drop through a distance of 1 m (40 in.) in a position for which maximum damage is expected, onto the upper end of a solid, vertical, cylindrical, mild steel bar mounted on an essentially unyielding, horizontal surface. The bar must be 15 cm (6 in.) in diameter, with the top horizontal and its edge rounded to a radius of not more than 6 mm (0.25 in.), and of a length as to cause maximum damage to the package, but not less than 20 cm (8 in.) long. The long axis of the bar must be vertical.	NRC acceptance criteria are Regulatory Guide 7.6 or applicable ASME BPVC subsection per NUREG-1609, Service Level D and must follow free drop and crush (when required) (sequentially) to demonstrate containment. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Also shielding must be within HAC limit of ≤ 1,000 mR/hr 1 m (40 in.) from external surface of package.	Same as 10 CFR 71.73, except puncture rod mounted on concrete slab described for free drop.	Same as NRC, except demonstrating no loss of containment by showing the SED or accumulated plastic strain is below allowable limits for the material. As an alternative, use ASME BPVC, Section III, Subsection NE, for Service Level D. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Loss of shielding limits is the same as the NRC.

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		**NRC Regulatory Acceptance Criteria**	**Hanford Standard Performance Test**	**Hanford Acceptance Criteria**
10 CFR 71.73 (c) (4) Thermal	Exposure of the specimen fully engulfed in a hydrocarbon fuel/air fire of sufficient extent to provide an average emissivity coefficient of at least 0.9, with an average flame temperature of at least 800 °C (1,475 °F) for a period of 30 minutes. The fuel source must extend horizontally at least 1 m (40 in.), but may not extend more than 3 m (10 ft), beyond any external surface of the specimen, and the specimen must be positioned 1 m (40 in.) above the surface of the fuel source. The surface absorptivity coefficient must be either that value which the package may be expected to possess if exposed to the fire specified or 0.8, whichever is greater. Artificial cooling may not be applied after cessation of external heat input, and any combustion of materials of construction, must be allowed to proceed until it terminates naturally.	NRC acceptance criteria is Regulatory Guide 7.6 or applicable ASME BPVC subsection per NUREG-1609, Service Level D and must follow free drop, crush (when required), and puncture (sequentially) to demonstrate containment. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Also shielding must be within HAC limit of ≤ 1,000 mR/h, 1 m (40 in.) from external surface of package. Also must maintain seal and shielding effectiveness and shielding must not melt and re-cool. Seals not allowed to reach temperature above maximum rated continuous use temperature.	AC Hanford Site: • Exposure of the entire package for not less than 30 minutes. • To a heat flux of not less than a radiation environment of 800 °C (1,475 °F). • With a flame emmissivity coefficient of at least 0.9. • Package surface absorptivity must be published value at temperature. • Significant, convective heat must be included based on still ambient air at 800 °C (1,475 °F). • Artificial cooling of the package is applied after 30 minutes. • Combustion is terminated after 30 minutes.	Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE Service Level D for thermal loading. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Also in this case, water applied after 30 minutes from initiation of fire. Seals must maintain containment and properties for 1 hour. Loss of shielding limits is the same as the NRC.

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test		NRC Regulatory Acceptance Criteria	Hanford Standard Performance Test	Hanford Acceptance Criteria
10 CFR 71.73 (c) (5) Immersion – fissile material	In cases where water inleakage has not been assumed for criticality analysis, immersion under a head of water of at least 0.9 m (3 ft) in the attitude for which maximum leakage is expected.	NRC acceptance criteria are Regulatory Guide 7.6 or applicable ASME BPVC subsection per NUREG-1609, Service Level D and must follow free drop, crush (when required), puncture, and thermal fire (sequentially) to demonstrate containment. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG.	Same as 10 CFR 71.71 (c) when no restriction on transport over large and deep bodies of water.	Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE Service Level D for external pressure loading. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Vented packages require fully flooded conditions for criticality evaluation.
10 CFR 71.73 (c) (6) Immersion – all packages	A separate, undamaged specimen must be subjected to water pressure equivalent to immersion under a head of water of at least 15 m (50 ft). For test purposes, an external pressure of water of 150 kPa (21.7 lbf/in^2) gauge is considered to meet these conditions.	NRC acceptance criteria are Regulatory Guide 7.6 or applicable ASME subsection per NUREG-1609, Service Level D to demonstrate containment. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG.	Same as 10 CFR 71.73 (c) when no restriction on transport over large and deep bodies of water.	Same as NRC, except demonstrated by meeting ASME BPVC, Section III, Subsection NE Service Level D for external pressure loading. For criticality control, load combinations on key components are measured against ASME BPVC, Section III, Subsection NG. Vented packages require fully flooded conditions for criticality evaluation.

Table 1. Hanford Onsite Package System Acceptable Performance Criteria.

10 CFR 71 Standard Performance Test	NRC Regulatory Acceptance Criteria	Hanford Standard Performance Test	Hanford Acceptance Criteria

AC = accident condition
ANSI = American National Standards Institute
ASME = American Society of Mechanical Engineers
BPVC = Boiler and Pressure Vessel Code
CFR = *Code of Federal Regulations*
HAC = hypothetical accident condition
HEPA = high-efficiency particulate air (filter)
NC = normal condition
NCT = normal conditions of transport
NRC = U.S. Nuclear Regulatory Commission
MNOP = maximum normal operating pressure
RL = U.S. Department of Energy, Richland Operations Office
SED = strain energy density

Sources:

DOE/RL-92-36, *RL Hoisting and Rigging Manual*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
NUREG-1609, *Standard Review Plan for Transportation Packages for Radioactive Material*, Chapter 7, Spent Fuel Project Office, U.S. Nuclear Regulatory Commission, Washington, D.C.
Regulatory Guide 7.6, *Design Criteria for Structural Analysis of Shipping Cask Containment Vessels*, U.S. Nuclear Regulatory Commission, Washington, D.C.
Regulatory Guide 7.8, *Load Combinations for the Structural Analysis of Shipping Casks for Radioactive Material*, U.S. Nuclear Regulatory Commission, Washington, D.C.
Regulatory Guide 7.11, *Fracture Toughness Criteria of Base Material for Ferritic Steel Shipping Cask Containment Vessels with a Maximum Wall Thickness of 4 Inches (0.1 m)*, U.S. Nuclear Regulatory Commission, Washington, D.C.
Regulatory Guide 7.12, *Fracture Toughness Criteria of Base Material for Ferritic Steel Shipping Cask Containment Vessels with a Wall Thickness Greater than 4 Inches (0.1 m) But Not Exceeding 12 Inches (0.3 m)*, U.S. Nuclear Regulatory Commission, Washington, D.C.

B.3.8.1 Conditions for Package External Temperature

The regulation states that the maximum package external temperature will be determined in the shade at an ambient still air temperature of 38 °C (100 °F). Based on climatological data reported from 1912 to 1980 in WHC-SD-TP-RPT-004, *Environmental Conditions for On-Site Hazardous Materials Packages*, the highest recorded temperature on the Hanford Site is 46 °C (115 °F). Consequently, site-specific determination of maximum allowable package external temperature is based on a more severe condition than for the regulations. However, the maximum allowable package external temperature is unchanged from the temperatures specified in the regulation of 85 °C (185 °F) for exclusive use and 50 °C (122 °F) for nonexclusive use shipments.

B.3.8.2 Heat and Cold Temperature Test Conditions

The range of heat and cold environmental temperature test conditions specified in the regulations is 38 °C to –40 °C (100 °F to –40 °F). Based on Hanford climatological data provided in WHC-SD-TP-RPT-004, the highest and lowest recorded temperatures on the Hanford Site are 46 °C and –33 °C (115 °F and –27 °F). Consequently, site-specific package heat test condition high temperature extreme is more severe than the regulations. In the case of site-specific package cold test condition, the Hanford Site low temperature extreme is only slightly less severe than the regulations. Equivalency to the regulations is also provided by institutional controls at the Hanford Site, in that at such low temperature extremes all operations (including onsite transport) would be limited to only critical and emergency operations for facility and personnel safety.

B.3.8.3 Package Lifting

The DOE/RL-92-36, *RL Hoisting and Rigging Manual*, is required for all Hanford Site lifting and handling operations and is equivalent to packaging regulatory requirements.

B.3.8.4 Initial Conditions for NCs of Transport

The range of NC test condition temperature specified in the regulations is 38 °C to –29 °C (100 °F to –20 °F). Based on Hanford Site climatological data provided in WHC-SD-TP-RPT-004, the highest and lowest recorded temperatures on the Hanford Site are 46 °C and –33 °C (115 °F and –27 °F). Consequently, site-specific package initial conditions for NC tests are more severe than the regulations for the range of environmental temperatures.

B.3.8.5 Solar Insolation

The Hanford Site solar insolation values are based on a 25-year average of direct and diffuse solar radiation measurements (WHC-SD-TP-RPT-004). These values are normalized to the requirements of 10 CFR 71. Because these values are specific to the Hanford Area, they are used in lieu of the regulatory values.

B.3.8.6 Free Drop Surface

The regulatory requirement for free drop surfaces is a hard, essentially unyielding surface, which according to IAEA guidelines is defined as a target with a mass of 10 times that of the package. As defined by the IAEA the target is to be covered by a 5 cm (2-in.) thick steel plate embedded in concrete. On the Hanford Site, no such hard unyielding surfaces exist. The worst case accident impact surface under all transportation conditions is the CWC storage pad. This is defined as the Hanford Site equivalent to a hard unyielding surface due to its mass and relative hardness to other objects. The CWC storage pad is a 20 cm (8-in.) thick concrete slab, two-way reinforced with number 7 rebar on 30 cm (12-in.) centers constructed for heavy truck loads. This is based on Lawrence Livermore National Laboratory studies in NUREG/CR-4829, *Shipping Container Response to Severe Highway and Railway Accident Conditions*, which has also shown that only impacts onto large massive objects generate significant forces on the package.

In addition, the studies in NUREG/CR-4829 have shown that 48 km/h (30 mi/h) impact speeds onto hard unyielding surfaces are equivalent to impact speeds of 97 km/h (60 mi/h) onto a "medium" hard surface, such as concrete. Because speeds on the Hanford Site are limited to 88 km/h (55 mi/h), this would limit maximum package impact velocity onto a massive concrete surface to an equivalent velocity onto a hard unyielding surface. Also, as demonstrated by Belgium and French Atomic Energy Commission (SAND87-1903, *Summary of Radioactive Materials Package Storage*) tiedown restraints failure and driver reaction time would further limit the package impact velocities to approximately one-half the initial conveyance speed. Based on these studies, the test conditions are equivalent to the regulations and conservatively bound onsite transportation ACs.

A NC free drop, unlike the regulatory scenario where normal operations would continue and be reported later, a NC free drop of a package on the Hanford Site would institutionally and administratively be considered at best an unusual occurrence and at worst an event. Consequently, all operations would stop, proper personnel notified, the area would be secured, steps would be taken to mitigate any release, and recovery from the condition would be initiated. In all cases, the package would be removed from normal transportation service for assessment of damage. These institutional and administrative controls provide a measure of control exceeding any controls applied in commercial transport of radioactive material packages for a NC free drop. In addition, transient load transfers are not routinely allowed onsite, and for those requiring load transfer, due to conveyance break down or unusual circumstances, will be monitored and performed to approved procedures. The majority of routine packaging handling operations is conducted at the shipping or receiving facilities.

B.3.8.7 Puncture Surface

The test puncture bar surface is mounted in the same concrete surface as the free drop condition, and in the prescribed manner as the regulatory puncture bar is mounted onto an essentially hard unyielding surface. Equivalency of the puncture bar test to the regulations is based on the same rationale for the free drop surface, in that no essentially unyielding surface exists on the Hanford Site. However, there are abutments and concrete surfaces at the Hanford Site on which objects firmly mounted to a concrete surface can act as a puncture bar. Assuming a puncture bar is firmly mounted onto a massive concrete surface would bound any puncturing object on the Hanford Site. Also, at the low impacting velocity specified in the regulations, a package impacting a puncture bar mounted to a massive concrete surface would behave in the same manner as a package impacting a puncture bar mounted on a hard unyielding surface. This is due to localized affect of the loading on the package and the distribution of the load from the mounting base.

B3.8.8 Fire AC

The fire test is specified at the same temperature as the regulatory fire test. Also, as specified in the regulations, the package is to be fully engulfed in flames for a duration of 30 minutes. Consequently, the bounding fire is defined as an 800 °C (1,475 °F) temperature fire with a flame emissivity of 0.9, with the specified package material surface emissivities and absorptivities obtainable in published thermal properties data. As specified in the regulations, and package combustibles shall be allowed to completely burn and the packages cooled by natural convection and radiation only. For onsite conditions, based on a dedicated fire department and conservative response time, the package is assumed to have quenching applied after 30 minutes. Accounting for these mitigating factors, the fire AC parameters provides an equivalent degree of safety as provided by the regulations.

B.4 REFERENCES

10 CFR 71, "Packaging and Transportation of Radioactive Material," *Code of Federal Regulations*, as amended.

10 CFR 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste," *Code of Federal Regulations*, as amended.

DOE G 421.1-1, 1999, *Criticality Safety Good Practices Program Guide for DOE Nonreactor Nuclear Facilities*, U. S. Department of Energy, Washington, D.C.

HNF-SD-SNF-CSER-010, *Criticality Safety Evaluation Report for Storage and Removal of Spent Nuclear Fuel from K Basin*, Fluor Hanford, Richland, Washington.

Manjoine, M. J., 1983, "Damage and Failure at Elevated Temperature," *Transaction of the ASME Journal of Pressure Vessel Technology*, Volume 105, pp. 58-62, February 1983.

NUREG-1609, *Standard Review Plan for Transportation Packages for Radioactive Material*, Chapter 7, Spent Fuel Project Office, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-1815, *Recommendations for Protecting Against Failure by Brittle Fracture in Ferritic Steel Shipping Containers up to Four Inches Thick*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-3019, *Recommended Welding Criteria for Use in the Fabrication of Shipping Containers for Radioactive Materials*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-3854, *Fabrication Criteria for Shipping Containers*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-4829, UCID-20733, *Shipping Container Response to Severe Highway and Railway Accident Conditions*, Lawrence Livermore National Laboratory, Livermore, California.

NUREG/CR-5661, *Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packaging for Radioactive Material,* U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-6007, *Stress Analysis of Closure Bolts for Shipping Casks*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Regulatory Guide 7.6, *Design Criteria for Structural Analysis of Shipping Cask Containment Vessels*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Regulatory Guide 7.8, *Load Combinations for the Structural Analysis of Shipping Casks for Radioactive Material*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Regulatory Guide 7.11, *Fracture Toughness Criteria of Base Material for Ferritic Steel Shipping Cask Containment Vessels with a Maximum Wall Thickness of 4 Inches (0.1 m)*, U.S. Nuclear Regulatory Commission, Washington, D.C.

SAND87-1903, *Summary of Radioactive Materials Package Storage*, Sandia National Laboratories, Albuquerque, New Mexico.

WHC-SD-SNF-ANAL-013, *MCNP Criticality Validation and Bias for LEU Systems*, Rev 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-SQA-CSA-20330, *Use of a k_{eff} Subcritical Limit of 0.98*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-TP-RPT-004, *Environmental Conditions for On-Site Hazardous Materials Packages*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SAR-062, 2000, *K Basins Safety Analysis Report*, Rev. 3L, Fluor Hanford, Richland, Washington.

APPENDIX C

UNREVIEWED SAFETY QUESTION FOR TRANSPORTATION (USQ_T) PROCESS

HANFORD SITEWIDE TRANSPORTATION SAFETY DOCUMENT

LIST OF TERMS

CFR	*Code of Federal Regulations*
DOT	U.S. Department of Transportation
DSA	documented safety analysis
JCO	justification for continued operation
OR	Occurrence Report
PISA	potential inadequacy in the safety analysis
POC	point of contact
PSSD	package-specific safety document
RL	U.S. Department of Energy, Richland Operations Office
SER	Safety Evaluation Report documenting DOE approval
TSD	*Hanford Sitewide Transportation Safety Document*
TSR	technical safety requirement
T&P	transportation and packaging
USQ_T	unreviewed safety question for transportation
USQ_TD	unreviewed safety question for transportation determination
USQ_TS	unreviewed safety question for transportation screening

APPENDIX C - UNREVIEWED SAFETY QUESTION FOR TRANSPORTATION (USQ_T) PROCESS

C.1 PURPOSE

This appendix establishes the requirements for the Unreviewed Safety Question for Transportation (USQ_T) process. This process is approved by the U.S. Department of Energy, Richland Operations Office (RL), in accordance with 10 CFR 830, "Nuclear Safety Management," 830.203 (b), "Unreviewed Safety Question Process." Instructions for implementing these requirements are provided in the several attachments to this appendix as listed below:

Attachment C.1 USQ_TS Form (Screening)
Attachment C.2 Screening Guidance
Attachment C.3 USQ_TD Form (Determination)
Attachment C.4 Determination Guidance
Attachment C.5 Guidance for Justifications for Continued Operations (JCO)
Attachment C.6 Payload-Specific Evaluation Format and Contents
Attachment C.7 Guidance for Annual Summary Submittals
Attachment C.8 Occurrence Report Categories.

The USQ_T process is used to determine the required level of approval, not to determine the safety of the proposed activity being evaluated. The USQ_T process permits a contractor to make physical and procedural changes to transportation activities without prior DOE-RL approval, provided the changes do not increase the consequences or frequencies of accidents, reduce effectiveness of controls, or reduce credited margins of safety. The USQ_T process provides a contractor with the flexibility needed to conduct day-to-day operations by requiring that only those changes not bounded by the safety basis be approved by RL. This allows RL to focus its review on those changes significant to safety. The USQ_T is an important tool for keeping the transportation safety basis current by ensuring changes receive the appropriate level of review and approval. The USQ_T process also specifies required actions if a potential inadequacy in the safety analysis is discovered. The process provides a method for contractors to determine if a USQ_T determination is required and the actions to take if the situation involves a positive USQ_T.

The safety basis for transportation activities under this TSD includes the TSD, applicable Package Specific Safety Documents (PSSDs) and related DOE Safety Evaluation Reports (SERs).

C.2 SCOPE

This process is applicable to changes to all transportation and packaging (T&P) activities involving greater than 1 A_2 of radioactive material. All new T&P activities involving greater than 1 A_2 must be approved by RL prior to implementation.

Any change to the technical safety requirements (TSR) requires RL approval; therefore, the USQ_T process is not applied to any changes to the TSR, which require DOE-RL approval prior to implementation. The USQ_T process cannot be used to modify any statement in the TSR. Further, the USQ_T process cannot be used by the contractor to modify credited controls contained in either the TSD or supporting transportation safety documents (PSSD or SER) without RL approval. One Time Requests for Shipment and other DOE Field Office Manager approved exemption requests are also not subject to modification using the USQ_T process.

This process does not apply to facility activities or to activities outside of T&P activities unless those activities could affect the proper operation of equipment important to safety that is relied on in the TSD, could affect critical operations identified as initiators in the accident analysis, or could introduce new T&P accident initiators. In addition, this process does not apply to documents in the following topical areas:

- Guidance documents
- Policy documents
- Procedural documents in the following topical areas:
  - Acquisition Process
  - Contract Management
  - Economic Transition
  - Employee Concerns
  - Financial Management
  - Human Resources
  - Industrial Relations
  - Legal
  - Management Systems
  - Project Control
  - Property Management
  - Public Involvement.

C.3 IMPLEMENTATION

Contractors subject to the TSD must incorporate this process into their own USQ_T procedure within 180 days after publication of this revision to allow adequate time for DOE approval and contractor training and qualification.

C.4 REQUIREMENTS

C.4.1 Situations Requiring the Implementation of the USQ_T Process

1. The USQ_T process shall be implemented in situations where there is a:

    a. Temporary or permanent change in the T&P activity or packaging as described in the existing transportation documented safety analysis (DSA) (for T&P activities this is the TSD, associated PSSDs and related SERs);

    b. Temporary or permanent change in the procedures that implement the safety basis (TSD, associated PSSDs and related SERs);

    c. Test or experiment not described in the safety basis; or

    d. Potential inadequacy in the transportation DSA because the analysis may not be bounding or may be otherwise inadequate.

2. If a USQ_T determination is required, it must be completed before implementing a proposed T&P activity (packaging system modification/change, procedure change, test, or experiment). This means that, for procedures, the USQ_T determination is completed before the procedure change is released for use. For modifications/changes, the USQ_T determination is completed before the modification/change document is released. If the proposed activity involves a positive USQ_T, RL approval must be obtained before implementing the proposed activity. If the proposed activity does not involve a positive USQ_T, the contractor may approve and implement the proposed activity.

3. A comprehensive USQ_T determination may be written for a packaging system modification/change so that an individual determination is not necessary for each modified document and procedure change associated with a modification. However, the comprehensive determination must clearly identify and encompass all activities within the scope of the determination.

4. The USQ_T determination must address the temporary changes that the packaging system experiences before the modification is fully implemented.

C.4.2 Actions Required for Potential Inadequacies In The Transportation Safety Analyses (PISA)

If the contractor T&P program management discovers or is made aware of or has reason to believe that there is a potential inadequacy of the safety analyses (PISA), contractor T&P program management must:

1. Take action, as appropriate, to place or maintain the T&P packaging system or activity in a safe condition until an evaluation of the safety of the situation is completed.

2. Notify RL and other contractors of the situation.

3. Perform an USQ_T determination (USQ_TD) and notify RL and other contractors promptly of the results.

4. Submit the evaluation of safety for the situation to RL for approval prior to removing any operational restrictions initiated to place or maintain the activity or facility in a safe condition.

If an USQ_T is determined to be positive, RL approval is required before the operational restrictions can be removed.

C.4.3 USQT Training and Qualification Requirements

1. All personnel responsible for performing, reviewing, or approving USQ_T documentation shall receive training on this process, the applicable transportation safety basis, transportation-specific USQ_T process implementing documentation, and changes thereof.

2. USQ_T evaluators and other personnel directly involved in implementing the USQ_T process are designated in writing by the contractor T&P manager, and must meet the minimum training and qualification requirements defined below.

3. The minimum training and qualification requirements for personnel involved in performing USQ_T screenings (USQ_TS) or determinations (USQ_TD) are:

   a. Education/Experience – A degree in engineering or science or appropriate related experience as justified and documented by the contractor T&P manager.

   b. Training – Successful completion of training on the USQ_T process, the TSD implementing documentation, and the TSD. Adequacy of the knowledge will be validated by a written test and documented in the contractor training records. T&P-specific qualification requirements shall designate the number of practice or on-the-job screenings and determinations to be performed. However, a minimum of two each must be performed for initial and requalification. Actual screenings and determinations performed as the initial screener or evaluator (i.e., developing the answers and bases) during the initial qualification period while under the guidance of a qualified USQ_T evaluator or during the qualification period can count toward the initial or requalification requirement. Transportation-specific practice or on-the-job qualification requirements may be reduced to screenings only for personnel restricted to performing screenings. Requalification is required every two years.

   NOTE: *A grace period of three months, to facilitate special conditions (e.g., to coordinate refresher training with changes in procedures or safety-basis documents) is allowed as long as the anniversary date of qualification is not changed.*

4. The T&P manager or delegate must designate in writing qualified personnel to perform prescreenings, USQ_TSs, and USQ_TDs.

C.4.4 Implementing Documentation

The contractor T&P program manager shall establish T&P-specific implementing documentation that:

1. Identifies the safety basis for T&P activities

   NOTE: *The safety basis for T&P activities includes the TSD, any applicable PSSDs, and related Safety Evaluation Reports documenting DOE approval. For proposed activities, the USQ_T process should also consider proposed revisions to the safety basis that have been formally submitted to RL for approval, but are not yet approved or implemented. This will assist in the configuration management of the revised safety basis until it is implemented and effective*

2. Defines and lists change control procedures and processes of physical and procedural changes, tests, and experiments that can affect the safety basis

3. Integrates the USQ_T process into T&P change control and work control processes, such as design, engineering, maintenance, inspection, and operation. (The change procedures or processes must contain clear reference to the USQ_T process as a required step prior to implementing any change.)

4. Identifies the contractor-specific training/qualification requirements for personnel completing USQ_T documentation

5. Requires review by a second qualified person of each USQ_TS and USQ_TD

6. Requires contractor T&P management approval of changes that require USQ_TDs so that management is informed of the determination results

7. Requires a review of the Occurrence Reports (OR) filed under the categories listed in Attachment C.8 as a minimum for PISAs

8. Requires a periodic self-assessment of the USQ_T process.

9. Either the first or the second USQ_T evaluator will be a prime contractor employee. The final USQ_T review authority will be a prime contractor employee.

C.4.5 Justification for Continued Operations (JCO)

The specific purpose of a JCO is to document the technical bases for continuing transportation activities before the ultimate resolution of the PISA or to permit resumption of activities that were suspended when the positive USQ_T was determined. The JCO temporarily amends the

T&P safety basis, upon RL approval as documented via SER, to allow interim operations. Evaluations of proposed activities against a JCO are required to ensure the JCO controls are not affected. Caution must be used to ensure that the TSD or PSSD is not expanded to the point that a positive USQ_T would exist when the JCO expires/terminates. (Do not use the JCO to justify changing the safety basis.) The JCO acceptance limits shall not be used to authorize additional activities outside the scope of the JCO because the JCO does not constitute a permanent change to the safety basis.

C.4.6 Safety Review Board

The contractor's T&P management may choose to form a safety review board consisting of multi-discipline experts to advise contractor management on implementation of the USQ_T process. Members of the SRB must be qualified as USQ_T Evaluators. Other subject matter experts may provide input to the SRB at the discretion of the T&P manager.

C.4.7 Report and Record Requirements

1. The contractor's T&P manager shall annually submit to RL a summary of the USQ_TDs performed since the prior submission. This summary is submitted in support of the annual update of the TSD.

2. Contractor T&P program management shall maintain records as shown in Section 7.0. USQ_TD records shall be maintained for the operational life of the Hanford Site and transferred to any subsequent contractor before or at the same time the responsibility for the function is transferred.

C.4.8 Prescreening Proposed Activities

1. Prescreening may be used to determine that the proposed activity does not require the performance of a documented USQ_TS or USQ_TD. For purposes of the USQ_T process, "activity" means any change to procedures, transportation equipment maintenance and configuration, packaging (including prior undocumented or unapproved changes), or other T&P activities as described in the safety basis. The two prescreenings are:

    a. For proposed activities that must be submitted to RL and hence do not require the performance of USQ_TDs to determine if submittal to RL is required. Examples include TSD modifications and Technical Safety Requirement changes. However, the USQ_T process does apply when there is reason to believe that the current safety basis might be in error or otherwise inadequate as discussed in Section C.4.10.

    b. For documents and changes outside the scope of this procedure as identified in Section C.2 of this appendix.

2. Certain changes to packages and associated documents may be exempted from further USQT review by application of a General Categorical Exclusion (GCX). Attachment C.9 contains the approved GCXs that may be applied when changes meet the scope, prerequisites and

boundaries specified in the GCX body. Personnel approving application of GCXs must be knowledgeable of the bases of the GCXs used.

NOTE: A qualified USQ_T screener or evaluator, as applicable, may apply a GCX listed in Attachment C.9. The GCX used and signature of the qualified USQ_T screener or evaluator must be clearly indicated on the change documentation for changes excluded from further USQ_T review by applying the GCX.

C.4.9 Screening Proposed Activities

1. Contractor T&P-specific USQ_T implementing documentation must specify the following screening questions to be used.

   a. Does the proposed activity or occurrence represent a temporary or permanent change to the packaging system, activities, or procedures described in the safety basis (TSD, associated PSSDs and SERs)?

   b. Does the proposed activity or occurrence represent conditions (e.g., new or changed hazards) that have not been analyzed in or are not bounded by the safety basis?

   c. Does the proposed activity represent a test,experiment, or new activity not described in the safety basis?

2. Because knowledge of the TSD, PSSD, USQ_T procedure, and the intent of the USQ_T process is required, concurrence of two qualified USQ_T screeners is required for an USQ_TS.

3. USQ_TDs shall be performed for all changes that cannot be eliminated from the USQ_T process by prescreening or screening.

C.4.10 Identifying A PISA

1. A PISA is defined as an existing condition that is identified as potentially being outside of the bounding conditions of the documented safety basis (TSD, associated PSSDs and SERs), or the safety basis is identified as being otherwise inadequate (e.g., failure to identify a hazard and/or necessary control associated with the transport). The identification of PISAs may come from multiple sources. For example, occurrence screenings, questions from workers or management, questions from a regulatory agency, etc., may be used to question whether a PISA exists.

   NOTE: *The TSD and/or associated PSSDs may be suspected of a potential inadequacy for any number of reasons. In general, it is possible for a potentially inadequate analysis to arise from three circumstances: (1) discovery of a discrepant as-found condition (including prior undocumented changes), (2) an operational event or incident, or (3) new information, including discovery of an error, from an internal or external source or omission. Occurrence USQ_T Ss may be used to determine whether that information indicates a PISA may be present. This information may be contained in ORs or other nonreportable events or*

conditions that identify an issue with a safety basis. The USQ_T process starts when management has information that gives reason to believe that there is the potential that the TSD and/or associated PSSD might be inadequate. A PISA is reported, and a USQ_T determination is required. A PISA is considered to involve a USQ_T until it is shown that the safety basis is bounding and is adequate.

2. When a concern is raised about the adequacy of the safety analyses to the T&P manager or identified representatives, the T&P management shall confirm or refute the reasonableness of the *potential* for having an inadequate safety analysis as soon as possible. This time should be minimized and shall take no longer than five working days without reporting a PISA.

C.4.11 Performing An USQ_T D

1. Documented USQ_TDs of proposed activities are required unless it is shown that:

   a. The proposed change is not a temporary or permanent change to the safety basis or to the procedures as described in the TSD or PSSD,

   b. The proposed change does not involve conditions that have not been analyzed in or are not bounded by the safety basis, and

   c. The proposed activity is not a test, experiment, or new activity not described in the safety basis.

2. A proposed activity or a PISA involves a positive USQ_T if:

   a. The probability of the occurrence or the consequences of an accident or the malfunction of equipment important to safety previously evaluated in the safety basis could be increased;

   b. The possibility of an accident or malfunction of a different type than any evaluated previously in the safety basis could be created;

   c. A margin of safety could be reduced; or

   d. The safety basis may not be bounding or may be otherwise inadequate.

3. The USQ_TD shall address the above conditions by answering the following questions as a minimum:

   a. Could the proposed design modification, activity, change, or PISA increase the probability of occurrence or consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety basis?

b. Could the proposed design modification, activity, change, or PISA create the possibility of an accident or malfunction of equipment important to safety of a different type than any previously evaluated in the safety basis?

c. Does the proposed design modification, activity, change, or PISA reduce a credited margin of safety as defined in the safety basis?

d. Could the proposed design modification, activity, change, or PISA modify or alter any of the administrative controls contained in the safety basis?

NOTE: *Unless the answer to all questions above by both evaluators is "no," the situation involves a positive* USQ_T. *For DOT-compliant and DOT-equivalent packages, the consequence and frequency questions shall be answered based on the credited margin of safety addressed in item 3d above. (See also Table C.4-1 in Attachment C.4.)*

4. The determination is completed by a qualified evaluator and reviewed by a second qualified evaluator. It records the scope of the determination and the logic for determining whether or not an USQ_T exists. A defensible explanation must be documented for the answers to each of the above questions. (The justification should stand alone on its technical merit, but may reference information in supporting documentation by page and/or section.)

5. If a proposed activity involves a positive USQ_T, RL approval shall be obtained prior to implementation. If the proposed activity does not involve a positive USQ_T, the proposed activity may be implemented and the PSSD change submitted with the annual USQ_T report.

6. Also look for 5 year requirement

C.5 PROCESS

This section presents the basic USQ_T process for proposed activities and for PISAs.

C.5.1 Process for Proposed Activities

For the purposes of the USQ_T, "activity" means any change to packaging systems and/or procedures (including prior undocumented changes)

Actionee	***Step***	***Action***
USQ_T Screener or Evaluator	1.	Prescreen the proposed activity to determine if the USQ_T process is applicable. (Refer to prescreening criteria in paragraph C.4.8.1.) • If the USQ_T process is applicable, then go to Step 2 or Step.3. • If the USQ_T process is ***not*** applicable, then go to Step 7. If a CX is applied, record the CX number on the change documentation and sign. Proceed to step 7.
USQ_T Qualified Screeners	2.	Screen the proposed activity to determine whether an USQ_TD is required. (Refer to screening criteria in paragraph C.4.9.1. Refer to Attachment C.2 for instructions and to *the USQ$_T$ Screening (USQ$_T$S) Worksheet* form [a sample is provided in Attachment C.1], or equivalent, for documenting the USQ_TS.) Obtain the signature of a second qualified USQ_T screener or evaluator. • If a determination is required, then go to Step 3. • If a determination is ***not*** required, then go to Step 7.
First USQ_T Qualified Evaluator	3.	Perform an USQ_TD. (Refer to determination questions in paragraph C.4.11.3. Refer to Attachment C.4 for instructions and to the *USQ$_T$ Determination (USQ$_T$D) Worksheet* form [a sample is provided in Attachment C.3], or equivalent, for documenting the USQ_TD.)
Second USQ_T Qualified Evaluator	4.	Review the USQ_TD. **NOTE**: *Unless the answer to all determination questions (paragraph C.4.11.3) by both evaluators is "no," the activity involves a positive USQ$_T$. If the answer to a question is uncertain, the evaluators may consult with the T&P Manager and other subject matter experts to develop the basis and finalize the answer. If the differences between evaluators cannot be resolved, then submit to the T&P Manager for resolution.*
Contractor T&P Program Manager	5.	• If a proposed activity involves a positive USQ_T, then: • Modify the proposed activity and return to Step 3, • Cancel the proposed activity, ***or*** • Go to Step 6.

Actionee	*Step*	*Action*
		• If a proposed activity does ***not*** involve a positive USQ_T, then go to Step 7.
	6.	Submit the associated change to the safety basis for the activity to DOE. Obtain RL approval of the proposed activity and any necessary safety basis changes.
	7.	Implement the proposed activity. If the proposed activity is a physical modification, provide verification that the installed modification is in agreement with the TSD, associated PSSD, and USQ_T documentation prior to start of operations to assure that any new hazards have been identified and incorporated into the hazards analyses and accurately reflected in the USQ_T review.
	8.	Notify the TSD configuration manager of any required changes to the safety basis.
TSD Configuration Manager	9.	Notify the contractor's T&P point of contact (POC).

C.5.2 Process For PISAs

Actionee	*Step*	*Action*
Contractor T&P Program Manager or delegate	1.	Determine whether the event or condition indicates a PISA. (Refer to the definition of a PISA in Section C.4.10. Refer to Attachment C.4 for instructions on use of the USQ_TD form to identify a PISA. ▪ If the event or condition indicates a PISA may exist, go to Step 2. ▪ If the event or condition does ***not*** indicate that a PISA may exist, no further USQ_T process action is required.
Contractor T&P Program Manager	2.	Take action and impose operational restrictions, as appropriate, to place and maintain the transportation activity in a safe condition. If possible, implement temporary hazard controls to maintain the transportation activity within the analyzed conditions of the safety basis. Treat the PISA as a positive USQ_T until a final determination is made in Step 7.
	3.	Notify RL of the situation with an OR. The operational restrictions and temporary hazard controls should be identified in the OR.
	4.	Notify the TSD configuration manager.
TSD Configuration Manager	5.	Notify the contractor's T&P POC .

Actionee	*Step*	*Action*
First USQ_T Qualified Evaluator	6.	Perform an USQ_T determination. (Refer to determination questions in paragraph C.4.11.3. Refer to Attachment C.4 for instructions and to the *USQ_T Determination (USQ_T D) Worksheet* form [a sample is provided in Attachment C.3], or equivalent, for documenting the USQ_TD.
Second USQ_T Qualified Evaluator	7.	Review the USQ_TD. **NOTE**: *Unless the answer to all determination questions (paragraph C.4.11.3) by both evaluators is "no," the activity involves a positive USQ_T and a PISA exists. If the answer to a question is uncertain, the evaluators may consult with the facility manager and other subject matter experts to develop the basis and finalize the answer. If the differences between evaluators cannot be resolved, then submit to the T&P Manager for resolution.*
Contractor T&P Program Manager	8.	Review the results of the USQ_T determination, prepare an evaluation of safety, and submit it along with the USQ_T determination to RL as follows: ▪ If a situation involves a positive USQ_T, then go to Step 9. ▪ If a situation does ***not*** involve a positive USQ_T, then go to Step 11.
	9.	Revise/upgrade the OR as appropriate. Determine whether the activity or facility is within the analyzed conditions of the safety basis. ▪ If temporary hazard controls alone can maintain the activity or facility within the analyzed conditions of the safety basis or if Natural Phenomena Hazard concerns are the cause of the USQ_T, then continue to implement the controls identified in Step 2 and either prepare and submit a JCO (or safety-basis change) to RL within 30 work days of completion of the USQ_T determination or request an extension for the submittal. ▪ If temporary hazard controls are **not** sufficient to maintain the activity or facility within the analyzed conditions of the TSD (e.g., shutdown of a process is required) and operation is to resume with an USQ_T outside the analyzed conditions of the safety basis, then cease unanalyzed operations, submit a JCO (or safety-basis change) to RL, and obtain approval before continuing operations. ▪ If temporary hazard controls are not feasible or appropriate and shutdown is not defined (e.g., transporter with a package that cannot be unloaded immediately), prepare the necessary safety-basis changes and submit to RL as soon as possible, but no longer than 90 days, or request an extension for the submittal. Go to Step 10. **NOTE**: *A safety-basis change or a JCO will suffice for the evaluation of safety. The JCO may be limited to the identified operational restrictions and temporary hazard controls with a simple justification as to why they are sufficient.*

Actionee	*Step*	*Action*
		.
	10.	Obtain RL approval of any safety basis changes needed to resolve the USQ_T and to remove operational restrictions initiated (in Step 2) in accordance with the approved safety basis. Exit this procedure.
	11.	Revise the OR as appropriate. Include the evaluation of safety as part of the forwarding letter for the USQ determination. See Attachment C.7 for the suggested content of the evaluation of safety.
	12.	Operational restrictions and temporary hazard controls initiated (in Step 2) may be removed in accordance with the safety basis. Incorporate changes in the associated PSSD and submit any changes to the TSD to RL, as applicable, by the time of the next annual USQ_T report .
	13.	Notify the contractor's T&P POC.
TSD Configuration Manager	14.	Incorporate changes in the documented safety basis in the next annual update, as appropriate.

C.6 FORMS

The forms listed below shall be used to document USQ_T reviews.

USQ_T Screening (USQ_TS) Worksheet (Attachment C.1)
USQ_T Determination (USQ_TD) Worksheet (Attachment C.3)

C.7 RECORD IDENTIFICATION

Table 7-1. Records Capture Table

Name of Document	Submittal Responsibility	Retention Responsibility
USQ_T prescreen / screen / determination.	USQ_T screener / evaluator	Contractor T&P program manager
T&P program implementing documents.	Contractor T&P program manager	Contractor T&P program manager
Training records related to USQ process.	Trainers	Contractor T&P program manager

C.8 REFERENCES

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*, as amended.

DOE Guide 424.1-1, *Implementation Guide for Use in Addressing Unreviewed Safety Question (USQ) Requirements*, U.S. Department of Energy, Washington, D.C.

DOE Guide 460.1-1, *The Packaging and Transportation Safety Implementation Guide*, U.S. Department of Energy, Washington, D.C.

DOE Order 460.1B, *Packaging and Transportation Safety*, U.S. Department of Energy, Washington, D.C.

ATTACHMENT C.1: USQ_TS FORM (SCREENING)

USQ_T Screen (USQ_T S) WORKSHEET

USQ_T S Number: **Page 1 of 511**

1.0 IDENTIFICATION

Packaging System Name or Transportation Activity or Procedure Number:
Change Title or Procedure Title:
Change Number:

2.0 RESULTS SUMMARY

Based on the information developed in the following worksheet:

☐ The Screen was **Negative** (an USQ_TD IS NOT required)
☐ The Screen was **Positive** (an USQ_TD IS required)

3.0 PREPARATION, REVIEW, AND APPROVAL SIGNATURES

USQ_TS First Evaluator's Name (Printed or Typed):	
Signature:	Date:
USQ_TS Second Evaluator's Name (Printed or Typed):	
Signature:	Date:

4.0 EVALUATION

Proposed Change: (Clearly state and describe the proposed change, occurrence, or activity being evaluated.)

References: (List all documents directly related to this activity or procedure that were reviewed [e.g., TSD, PSSD, Package-Specific Evaluation, Categorical Exclusion, SERs, etc.])

Screening Evaluation Questions:	
1. **Does the proposed activity or occurrence represent a temporary or permanent change to the packaging system, activities, or procedures described in the safety basis (TSD, associated PSSDs and SERs)?** Provide the technical basis for the answer in the space below.	☐ Yes ☐ No
(e.g., new or changed hazards) in are not 2. Does the proposed activity or occurrence represent conditions (e.g., new or changed hazards) that have not been analyzed in or are not bounded by the safety basis? Provide the technical basis for the answer in the space below. The technical basis should address contents, radiological risk, containment, shielding, criticality, structural, thermal, gas generation, and tiedown as a minimum.	☐ Yes ☐ No
3. **Does the proposed activity or occurrence represent a test, experiment, or new activity not described in the safety basis?** Provide the technical basis for the answer in the space below.	☐ Yes ☐ No

ATTACHMENT C.2: SCREENING GUIDANCE

This attachment provides guidance for answering the questions identified in the *USQ_T Screening (USQ_TS) Worksheet* form. If any of these questions is answered "yes," the proposed activity or issue is considered to constitute the need for an USQ_T determination (USQ_TD).

Consistent with the intent of the USQ_T process, the following provides general guidance for each question on the USQ_TS form.

1. For each screening question provide a “Yes” or “No” response.

2. Review the safety basis (TSD, associated PSSDs and SERs) before conducting the USQ_TS.

3. Provide a separate basis to justify the answer to each question.

   - A restatement of the question does not constitute a satisfactory justification or basis.

   - An adequate justification provides sufficient explanation such that an independent reviewer could reach the same conclusion.

4. State all references used to support the questions/basis conclusions. References may include applicable sections of the PSSD identified in the description section, documents directly referenced (first generation) in the PSSD or TSD, and any other applicable technical and safety documentation.

The following provides guidance in preparing responses to screening questions on the USQ_T S form:

1. Does the proposed activity or occurrence represent a temporary or permanent change to the packaging system, activities, or procedures described in the safety basis (TSD, associated PSSDs and SERs)?

The following guidance should be considered when completing an USQ_T S. Deciding if there is a change to the transportation activities or procedures, as described in the safety basis, requires an understanding of how “as described” can be implicit or explicit. Also, understanding the term “change” as it applies to transportation activities or processes is also important.

Does the proposed activity accomplish the following, or is the occurrence the result of a prior action that did:

- Alter the design of a transportation activity as described in the safety basis?

- Modify, add, or delete the description of operation, operating environment, or analyses of any system or component described in the safety basis?

- Modify, add, delete, or conflict with any of the design bases stated in the safety basis?

- Conflict with the principle or general design criteria stated in the safety basis?
- Modify, add, or delete a flow diagram or transportation activity drawing provided in the safety basis?

2. **Does the proposed activity or occurrence represent conditions (e.g., new or changed hazards) that have not been analyzed in or are not bounded by the safety basis?**

   The following questions may be useful in determining if the change has resulted in a condition not analyzed or bounded by the existing safety basis:

Package:

- Did the payload physical form, chemical composition, radiological composition, or radionuclide mix change?
- Has the total activity or DE-Ci value of the package increased or decreased?
- Has the heat loading of the package increased or decreased?
- Has the package design or hardware changed?
- Have maintenance requirements or operating conditions changed?
- Have procedures been revised or new procedures developed?

Criticality:

- Has the fissile grams and/or fissile gram equivalent of the package increased or decreased?
- Has the payload fissile status changed? (Fissile excepted to fissile.)
- Has a new K-effective been determined that exceeds the approved value in the PSSD?

Structural:

- Does the proposed change altar structural components critical to the containment system or structural performance of the packaging?
- Did the thermal load increase to the extent that critical components cannot perform as previously evaluated? Have component thermal limits been exceeded?

- Is there a gross weight change, and has the change been evaluated to demonstrate that the structural performance of the packaging has not been altered? (Note: A reduction in payload weight can have a negative impact on the structural performance of a packaging.)

Thermal

- Have thermal properties changed that can affect critical structural and shielding components or change the gas generation rate?

Gas Generation

- Did the change in chemical composition introduce a new source for gas generation?
- Did the change in the physical form cause an increase in the gas generation rate? (This could be a change in surface area.)
- Did the change in the radioisotopes inventory increase the gas generation rate?
- Did the packaging change increase the amount of material available for generation of gas?
- Did the thermal change increase the gas generation rate?
- Did the generation rate decrease the shipping window?

Shielding

- Did the radioisotopic change increase the contact dose rate?
- Did the thermal change exceed the thermal limits of the shielding material?
- Does the chemical composition reduce the effectiveness of the shielding?

Containment

- Has the containment system been altered?
- Has the change been evaluated to demonstrate that the containment system can perform as previously analyzed?

Tiedown

- Did the gross weight change exceed the tiedown requirements authorized in the PSSD?
- Did the package or transporter change require a different tiedown?

Risk

- Have any of the changes affected the consequence of an accident authorized in the PSSD?

- Have any of the changes affected the frequency (probability) of an accident authorized in the PSSD?

If the results of the screen are positive, then a determination must be done to determine if the margin of safety established in the TSD has been reduced.

3. **Does the proposed activity or occurrence represent a test, experiment, or new activity *not* described in the safety basis?**

   If the change does not represent a new test, experiment, or activity not evaluated in the safety basis, then a "No" response is appropriate and the reason that it is not considered to be a test, experiment or new activity will be provided as justification.

ATTACHMENT C.3: USQ_TD FORM (DETERMINATION)

USQ_T Determination (USQ_T D) WORKSHEET

USQ_T D Number: **Page 1 of 511**

1.0 IDENTIFICATION

PACKAGING SYSTEM NAME OR TRANSPORTATION ACTIVITY:
CHANGE TITLE:
CHANGE NUMBER:
PAYLOAD SPECIFIC EVALUATION :_____ (Required for changes requiring analysis to determine changes in risk and before proceeding with this USQ_TD - format and required contents are found in Appendix H of the TSD. This PSE is the basis for changes to the PSSD associated with this activity.)

2.0 RESULTS SUMMARY

BASED ON THE INFORMATION DEVELOPED IN THE FOLLOWING THE WORKSHEET:

☐ This issue was processed as a **routine USQ_T D** (that is, a proposed change)
- ☐ The determination was **Negative** (Proposed change is bounded by the TSD and PSSD)
- ☐ The determination was **Positive** (Proposed change is not bounded by the TSD and PSSD)

☐ This issue was processed as a **special PISA USQ_T D**
- ☐ The determination was **Negative** (an actual inadequacy of the safety analyses DOES NOT exist)
- ☐ The determination was **Positive** (an actual inadequacy of the safety analyses DOES exist)

3.0 PREPARATION, REVIEW, AND APPROVAL SIGNATURES

First USQ_TD Evaluator's Name (Printed or Typed):	
Signature:	Date:
Second USQ_TD Evaluator's Name (Printed or Typed):	
Signature:	Date:
T&P Manager or Delegate's Name (Printed or Typed):	
Signature	Date:

4.0 EVALUATION

Proposed Change: (Clearly state and describe the proposed change, occurrence, or activity being evaluated.)	
References: List all documents directly related to this activity, change or PISA that were reviewed (e.g., TSD, PSSD, Package Specific Evaluation, Categorical Exclusion, SERs, etc.):	
Determination Evaluation Questions	
1. PISA of equipment important to safety Could the proposed design modification, activity, change, or PISA increase the probability of occurrence or consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety basis? WHY (explain the technical basis for the answer):	☐ Yes ☐ No
2. PISA of equipment important to safety of a type than Could the proposed design modification, activity, change, or PISA create the possibility of an accident or malfunction of equipment important to safety of a different type than any previously evaluated in the safety basis? WHY (explain the technical basis for the answer):	☐ Yes ☐ No

MARGIN OF SAFETY DETERMINATION: Use the following checklist to determine whether the proposed design modification, activity, change, or issue reduces the margin of safety or otherwise affects the frequency and probability of accidents for DOT compliant and equivalent packages as defined in the Table C.4-1 in Attachment C.4 as applicable in the following areas. Then answer Question # 3 below. Explain all No answers in this checklist in the basis for the answer to Question # 3 below.	
A. General Requirements	
i. Tamper-Indicating Devices	☐ Yes ☐ No
ii. Positive Closure	☐ Yes ☐ No
iii. Chemical and Galvanic Reaction/Corrosion	☐ Yes ☐ No
iv. Package Construction	☐ Yes ☐ No
v. Accessible Exterior Temperature	☐ Yes ☐ No
vi. Venting	☐ Yes ☐ No
vii. Material and Construction Codes and Standards	☐ Yes ☐ No

B. Lifting & Tiedown Standards	
i. Lifting Attachments	☐ Yes ☐ No
ii. Tiedown Attachments	☐ Yes ☐ No
C. Normal Condition Performance Tests	
i. Initial Conditions	☐ Yes ☐ No
ii. Heat	☐ Yes ☐ No
iii. Cold	☐ Yes ☐ No
iv. Reduced External Pressure	☐ Yes ☐ No
v. Vibration	☐ Yes ☐ No
vi. Water Spray	☐ Yes ☐ No
vii. Free Drop	☐ Yes ☐ No
viii. Compression	☐ Yes ☐ No
ix. Penetration	☐ Yes ☐ No
x. Combustible Gas Generation	☐ Yes ☐ No
xi. Shielding	☐ Yes ☐ No
xii. Containment	☐ Yes ☐ No
xiii. Criticality	☐ Yes ☐ No
xiv. Tiedown	☐ Yes ☐ No
D. Accident Condition Performance Tests for DOT and Hanford Site Equivalent Packages	
i. Initial Conditions	☐ Yes ☐ No ☐ N/A
ii. Free Drop	☐ Yes ☐ No ☐ N/A
iii. Crush	☐ Yes ☐ No ☐ N/A
iv. Puncture	☐ Yes ☐ No ☐ N/A
v. Fire	☐ Yes ☐ No ☐ N/A
vi. Immersion (Fissile)	☐ Yes ☐ No ☐ N/A
vii. Immersion (All Packages)	☐ Yes ☐ No ☐ N/A
D. Accident Condition Performance Tests for Risk-Based Packages	
i. Free Drop	☐ Yes ☐ No ☐ N/A
ii. Free Drop and Fire	☐ Yes ☐ No ☐ N/A
iii. Deflagration	☐ Yes ☐ No ☐ N/A
iv. Criticality	☐ Yes ☐ No ☐ N/A
v. Preventative Administrative Controls	☐ Yes ☐ No ☐ N/A
vi. Transportation Operating Procedures or Site requirements	☐ Yes ☐ No ☐ N/A
vii. Mitigating Administrative Controls	☐ Yes ☐ No ☐ N/A

3. PISAacredited Does the proposed design modification, activity, change, or PISA reduce a credited margin of safety as defined in the safety basis? WHY (explain the technical basis for the answer):	☐ Yes ☐ No

4. Could the proposed design modification, activity, change, or issue change, modify or alter any of the Administrative Controls contained in the safety basis? WHY (explain the technical basis for the answer):	☐ Yes ☐ No
Note: If the answer to any of these four questions is Yes, the USQ_T Determination is positive.	

ATTACHMENT C.4: DETERMINATION GUIDANCE

This attachment provides guidance for answering the questions identified in the *USQ_T Determination (USQ_TD) Worksheet* form. If any of these questions are (*this is opposite to the change made in Attachment C2, 1st paragraph*) answered "yes," the proposed activity or issue is considered to constitute an USQ_T. A safety analysis (payload-specific evaluation) is required at a level adequate to show the safety of the change prior to conducting the USQ_TD.

Consistent with the intent of the USQ_T, the following provides general guidance for each question on the USQ_TD form.

1. For each determination question provide a “Yes” or “No” response.

2. Provide a separate basis for each question to justify the answer to the question.

   - A restatement of the question does not constitute a satisfactory justification or basis.

   - An adequate justification provides sufficient explanation such that an independent reviewer could reach the same conclusion.

3. State all references used to support the questions/basis conclusions. References may include applicable sections of the safety basis identified in the description section, documents directly referenced (first generation) in the safety basis, and any other applicable technical and safety documentation.

QUESTIONS:

1. **Could the proposed design modification, activity, change, or PISA increase the probability of occurrence or consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety basis?**

   In answering this question, the first step is to determine the accidents that may be affected by the proposed activity, which have been evaluated in the SAFETY BASIS. By focusing on the initiators of the previously evaluated accidents, an evaluation is made as to whether there is an increased likelihood that a given accident would occur. The following questions may provide a useful approach in making this evaluation.

   a. Will the proposed activity meet the design, material, and construction standards applicable to the packaging system being modified? If the answer is "yes," this aspect of the proposed activity is judged not to increase the likelihood of the occurrence of an accident. If the answer is "no" to any of the items, either a justification for saying there is no increase in the likelihood of the occurrence of an accident will need to be developed or it is concluded that the likelihood of the occurrence of an accident is increased.

b. Does the proposed activity affect overall packaging system performance in a manner that could increase the probability of a previously analyzed accident? Possible questions to ask are:

   1) Does the proposed activity use instrumentation with accuracies or response characteristics that are different from those of existing instrumentation such that an accident is more likely to occur?

   2) Does the proposed activity cause packaging systems to be operated outside their design or testing limits?

   3) Does the proposed activity cause system vibration, fatigue, corrosion, thermal cycling, or degradation of the environment for packaging systems that would exceed the design limits?

   4) Does the proposed activity cause a change to any packaging system interface in a way that could increase the likelihood of an accident?

When evaluating for "increases in consequences" of an accident, if the previously bounding case for that family of accidents remains the bounding case, then generally there is no increase in the consequences within the USQ_T. In this regard, it is important the family of accidents be related, not only being of the same type (e.g., fires), but also use the same set of preventative and mitigative measures.

In answering this question, the first step is to determine which accidents evaluated in the safety basis may have their radiological and hazardous material consequences altered as a direct result of the activity. The next step is to determine whether the activity does, in fact, increase the consequences of any of the accidents evaluated in the existing safety analyses. It is important to note that consequences to workers (in-facility and outside, or co-located), as well as to the public, are considered. Examples of questions that assist in this evaluation are:

a. Does the proposed activity degrade or prevent safety functions described or assumed in the existing safety analyses?

b. Does the proposed activity alter any assumptions previously made in evaluating the radiological and hazardous material consequences in the existing safety analyses?

c. Does the proposed activity play a direct role in mitigating the radiological or hazardous material consequences assumed in the existing safety analyses?

d. Does the proposed activity affect the integrity or function of any fission product barrier or any radioactive or hazardous material barriers?

2. **Could the proposed design modification, activity, change, or PISA create the possibility of an accident or malfunction of equipment important to safety of a different type than any previously evaluated in the safety basis?**

   In answering this question, the first step is to determine the types of accidents evaluated in the existing safety analyses. The types of credible accidents that the activity could create can then be identified and listed from the payload specific evaluation of safety. Evaluating the differences between the two lists will determine the answer to the question. The accidents evaluated in the existing safety analyses are generally chosen to be bounding for a broad class of credible accidents. Thus, comparison of a new accident to the existing analyses may require referral to the underlying hazard analyses.

   An accident or malfunction that involves an initiator or failure not considered in the existing safety analyses is potentially an accident or malfunction of a different type.

   To answer this question, the types of failure modes of packaging systems that have been previously evaluated in the existing safety analyses and that would be affected by the activity are identified. Then the types of failure modes that the activity could create need to be identified. Comparing the two lists can provide an answer to the question.

3. **Does the proposed design modification, activity, change, or PISA reduce a credited margin of safety as defined in the safety basis?**

   To answer this question, first determine whether a margin of safety is involved. To do this, the basis for each proposed activity should be identified. If a margin of safety is defined in the safety basis, a margin of safety is involved and the effects of the activity on it should be assessed.

   Use the credited margin of safety checklist on the USQ_TD form as the basis for answering this question. Discuss any negative answers checked on the checklist. Use this checklist to guide preparation of the basis to justify the answer to Question # 3.

   The following section discusses the bases RL uses to evaluate packagings and the areas where credited margins of safety apply.

Credited Margins Of Safety For USQ_T Determinations For DOT-Compliant And Hanford DOT-Equivalent Packages

Suggested questions to evaluate reductions inin Credited Margins of Safety (CMOS) are provided in the table below. Note “a” at the end of the table provides an explanation of the regulatory and ASME BPVC view of margins of safety. Basically, the underlying margin of safety of the ASME BPVC used by the regulations for Category I content material is 2 (Section III, Division 1, Subsection NB), while for Category II and III contents the underlying margin of safety is 2.5 (Section III, Division 1, Subsections NC and ND). The underlying ASME BPVC margin of safety used by the TSD is 2.5 (Section VIII, Division 1).

The underlying basis for onsite transportation safety of any Hanford risk based packaging system is to minimize the risk to the public and worker. This is done by supplementing the known performance capability of the system with preventative administrative and/or engineering controls, site transportation environment, and communication measures. Consequently, the USQ_T evaluator must view any change in the context of the entire the packaging system, which comprises not only the packaging but also the content, conveyance, route, and transportation environment, all supplemented by preventative controls and mitigating measures. The evaluator must recognize that the risk determined in the PSSD for any risk based packaging is predicated on accident statistics, and engineering judgment of key parameters, such as packaging capabilities and failure modes, beneficial onsite transportation environment, effectiveness of administrative and institutional controls, content release fractions, and dispersal mechanisms in the event of an accident. These key parameters form the basis of the implicit and/or explicit margins of safety stated in the PSSD, in preventing accidents or mitigating consequences.

Consequently, the USQ_T evaluator must not only assess any change to dose consequence and probability, but also the implicit and/or explicit margins of safety of the packaging system originally provided in the approved PSSD. As a result, for any change, an increase in risk above those permitted in the TSD, PSSD and accompanying SERs, or reduction in any margins of safety of the packaging system must be considered a positive USQ_T. As an example of a reduction in margin of safety, a change of the semi-trailer required for a package system that relies on the conveyance performance under normal and accident conditions. The change specifies an equivalent semi-trailer by a different manufacturer with a higher rated load capacity but a narrower wheelbase. Since the wheelbase is narrower than the original semi-trailer, the margin of safety implicitly stated in the PSSD has been reduced and the USQ_T is positive. In this case the implicit margin of safety is the static rollover threshold.

Table C.4-1 Credited Margin of Safety Review Questions

Requirement to be addressed	Basis for Credit Margin of Safety (CMOS)	Guidance/remarks
GENERAL REQUIREMENTS		
Tamper-indicating devices	The package retains the tamper-indicating device specified in the SARP or PSSD. When not specified, apply 10 CFR 71.43(b) or Section 6.5.2.6.1(b) of the TSD	If tamper-indicating devices are eliminated or are not present, then the USQ_T is positive.
Positive closure	The package retains the positive closure specified in the SARP or PSSD. When not specified, apply 10 CFR 71.43(c)or Section 6.5.2.6.1(c) of the TSD	If positive closure devices are altered in such a way that performance of the device is reduced, if the device is eliminated, or if the device is not present, then the USQ_T is positive.
Chemical and galvanic reaction/corrosion	The package maintains resistance to chemical and galvanic reactions and corrosion as specified in the SARP or PSSD, and 10 CFR 71.43(d) or Section 6.5.2.6.1(d) of the TSD.	Dissimilar materials that come into contact with each other must be addressed. Changes in internal and external coatings, increased potential for chemical and galvanic reactions, eutectic formation or increased generation of hydrogen or other gases from chemical or radiolytic interaction, or acceleration of corrosion are cause for a positive USQ_T. If chemical and galvanic reactions and corrosion are not addressed in the SARP or PSSD, then the USQ_T is positive.
Package construction	The package shall maintain its capabilities under normal conditions as specified in the SARP and PSSD, and 10 CFR 71.43(f)or Section 6.5.2.6.1(f) of the TSD.	If there is a reduction in the packaging capabilities to a point below that which delivers satisfactory performance under normal conditions in the SARP or PSSD, then the USQ_T is positive.
Accessible exterior temperature	The package remains at or below the surface temperature limits specified in the SARP or PSSD. When not specified, apply 10 CFR 71.43(g) or Section 6.5.2.6.1(g) of the TSD.	If the specified surface temperature on the package exceeds the limits specified in 10 CFR 71.43(g) for DOT-compliant packages and Section 6.5.2.6.1(g) of the TSD for Hanford DOT-equivalent packages, then the USQ_T is positive.
Venting	The package remains within the design or performance limits specified in the approved SARP or PSSD under conditions specified in 10 CFR 71.43(h) or Section 6.5.2.6.1(h) of the TSD.	If any change in the design limits or performance specified in the SARP or PSSD; 10 CFR 71.43(h); or when not specified, then the USQ_T is positive.

Table C.4-1 Credited Margin of Safety Review Questions

Requirement to be addressed	Basis for Credit Margin of Safety (CMOS)	Guidance/remarks
Material and construction codes and standards	The package construction and modification shall be in accordance with appropriate internationally and nationally recognized authoritative standards normally used in packaging.[a]	Modification to the package or components must in accordance with the original standard or code from which the package was constructed as stated in the SARP or PSSD (as approved by DOE). Any deviation from the standard or code, or if such modification is not addressed in the original standard or code, or if the package was not initially constructed to any appropriate code or standard, then the USQ_T is positive.
LIFTING AND TIEDOWN STANDARDS		
Lifting attachments	The package remains within the design or performance limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.45(a) or Section 6.5.2.6.2 of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive.
Tiedown attachments	The package remains within the design or performance limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.45(b) or Section 6.5.2.6.3 of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive.
Normal condition performance test		
Initial conditions	The package meets the initial conditions specified in the approved SARP or PSSD. When not specified, apply the conditions in 10 CFR 71.71(a) and (b) or Section 6.5.2.5.1(a) and (b) of the TSD.	If the normal conditions initial conditions are not met, then the USQ_T is positive.
Heat	The package remains within the design limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.71(a), (b), and (c)(1)or Section 6.5.2.5.1(a), (b), and (c)(1) of the TSD.	If any normal condition bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to prevent creep and other high temperature affects and/or violating material thermal cycling or high temperature continuous service limits.
Cold	The package remains within the design limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.71(a), (b), and (c)(2)or Section 6.5.2.5.1(a), (b), and (c)(2) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to prevent brittle fracture and/or violating material low temperature service limits. Guidance for adequate protection from brittle fracture is provided in RGs 7.11 and 7.12

Table C.4-1 Credited Margin of Safety Review Questions

Requirement to be addressed	Basis for Credit Margin of Safety (CMOS)	Guidance/remarks
Reduced external pressure	The package remains within the design limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.71(a), (b), and (c)(3)or Section 6.5.2.5.1(a), (b), and (c)(3) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Loading must be based on the load combinations defined in RG 7.8 or TSD Section 6.5.2.6.10(a). Acceptance criteria for establishing margins of safety must be to recognized and appropriate international or national standards[a] and based on the MNOP.
Increased external pressure	The package remains within the design limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.71(a), (b), and (c)(4)or Section 6.5.2.5.1(a), (b), and (c)(4) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Loading must be based on the load combinations defined in RG 7.8 or TSD Section 6.5.2.6.10(a). Acceptance criteria for establishing margins of safety must be based on recognized and appropriate international or national standards.[a]
Vibration	The package remains within the design limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.71(a), (b), and (c)(5)or Section 6.5.2.5.1(a), (b), and (c)(5) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Loading must be based on the load combinations defined in RG 7.8 or TSD Section 6.5.2.6.10(a). Acceptance criteria for establishing margins of safety must be based on recognized and appropriate international or national standards.[a]
Water spray	The package remains within the design limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.71(a), (b), and (c)(6)or Section 6.5.2.5.1(a), (b), and (c)(6) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes any increased possibility for in-leakage of water into the containment system, increased possibility of chemical or galvanic reaction and/or corrosion, and/or possibility of increased gas generation.

Table C.4-1 Credited Margin of Safety Review Questions

Requirement to be addressed	Basis for Credit Margin of Safety (CMOS)	Guidance/remarks
Free drop	The package remains within the design limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.71(a), (b), and (c)(7)or Section 6.5.2.5.1(a), (b), and (c)(7) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Loading must be based on the load combinations defined in RG 7.8 or TSD Section 6.5.2.6.10(a). Acceptance criteria for establishing margins of safety must be based on recognized and appropriate international or national standards.[a]
Compression	The package remains within the design limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.71(a), (b), and (c)(9)or Section 6.5.2.5.1(a), (b), and (c)(8) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Acceptance criteria for establishing margins of safety must be based on recognized and appropriate international or national standards.[a]
Penetration	The package remains within the design limits specified in the approved SARP or PSSD under the conditions specified in 10 CFR 71.71(a), (b), and (c)(10)or Section 6.5.2.5.1(a), (b), and (c)(9) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Acceptance criteria for establishing margins of safety must be based on recognized and appropriate international or national standards.[a]
Combustible gas generation	The package remains within the bounding limits determined in the approved SARP or PSSD. When not specified, apply the limits specified in NUREG-1609 (*Standard Review Plan for Transportation Packages for Radioactive Material*), NUREG-1617 (*Standard Review Plan for Transportation Packages for Spent Nuclear Fuel*), and UCID-21218 (*Packaging Review Guide for Reviewing Safety Analysis Reports for Packaging*)or Section 7.3.1.2.7 of the TSD.	If the package exceeds the bounding limits in the approved SARP or PSSD; or when not specified, the limits specified in NUREG-1609, NUREG-1617, and UCID-21218, then the USQ_T is positive for DOT-compliant packages. The limit specified in the guidance states that combustible gases generated in the package during a period of one year must not exceed 5% (by volume) of the free gas volume in any confined region of the package. No credit shall be taken for getters, catalysts, or other recombination devices. In the case of Hanford DOT-equivalent or risk based packages, apply the requirements or lower flammability limits of Section 7.3.1.2.7. If exceeded or the requirements are not met, then the USQ_T is positive.

Table C.4-1 Credited Margin of Safety Review Questions

Requirement to be addressed	Basis for Credit Margin of Safety (CMOS)	Guidance/remarks
Shielding	The package remains within the bounding limits specified in the SARP or PSSD. When not specified, apply the limitsas specified in 10 CFR 71.47, or Section 6.5.2.6.4 of the TSD.	If the package exceeds the bounding limits specified in the SARP or PSSD; or when they are not specified in either of these, the limits for DOT-compliant packages in 10 CFR 71.47 or Section 6.5.2.6.4 of the TSD, then the USQ_T is positive.
Containment	The package remains within the bounding limits specified in the SARP or PSSD. When not specified, the limitsare as specified in 10 CFR 71.51, or for Sections 6.5.2.6.8 and 6.5.2.6.9 of the TSD.	If the package exceeds the bounding limits specified in the SARP or PSSD; or when they are not specified in either of these, the limits in 10 CFR 71.51 or Sections 6.5.2.6.8 and 6.5.2.6.9, then the USQ_T is positive.
Criticality	The package remains within the bounding limits specified in the SARP or PSSD. When not specified, the limitsare as specified in 10 CFR 71.55 and 10 CFR 71.59 or Sections 6.5.2.6.5 and 6.5.2.6.7 of the TSD. The limiting k_{eff} must be less than 0.95 in all cases.	If the package exceeds the bounding limits specified in the SARP or PSSD; or when they are not specified in either of these, the limits for DOT-compliant packages in 10 CFR 71.55 and 10 CFR 71.59 or Section 6.5.2.6.5 and 6.5.2.6.7 for Hanford DOT-equivalent or risk based packages, then the USQ_T is positive. The USQ_T will also be positive if the k_{eff} exceeds 0.95.
Tiedown	The package tiedown system remains within the bounding limits specified in the SARP or PSSD. When not specified, the requirementsare as specified in 49 CFR 393.100 or Section 6.5.2.6.13 of the TSD.	If the package tiedown system exceeds the bounding limits specified in the SARP or PSSD; or when they are not specified in either of these, the limits for DOT-compliant tiedown systems in 49 CFR 393.100 or Section 6.5.2.6.13 of the TSD for Hanford DOT-equivalent or risk based packages, then the USQ_T is positive.
ACCIDENT CONDITION PERFORMANCE TESTS FOR DOT COMPLIANT AND EQUIVALENT PACKAGES		
Initial conditions	The package meets the initial conditions specified in the approved SARP or PSSD. When not specified, the conditions are in 10 CFR 71.73(a) and (b)or Section 6.5.2.5.2(a) and (b) of the TSD.	If the accident conditions initial conditions are not met, then the USQ_T is positive.
Free drop	The package remains within the design limits specified in the SARP or PSSD under the conditions specified in 10 CFR 71.73(a), (b), and (c)(1)or Sections 6.5.2.5.2(a), (b), and (c)(1) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Loading must be based on the load combinations defined in RG 7.8 or TSD Section 6.5.2.6.10(a). Acceptance criteria for establishing margins of safety must be based on recognized and appropriate international or national standards.[a]

Table C.4-1 Credited Margin of Safety Review Questions

Requirement to be addressed	Basis for Credit Margin of Safety (CMOS)	Guidance/remarks
Crush	The package remains within the design limits specified in the SARP or PSSD under the conditions specified in 10 CFR 71.73(a), (b), and (c)(2)or Sections 6.5.2.5.2(a), (b), and (c)(2) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Acceptance criteria for established margins of safety must be based on recognized and appropriate international or national standards.[a]
Puncture	The package remains within the design limits specified in the SARP or PSSD under the conditions specified in 10 CFR 71.73(a), (b), and (c)(3)or Sections 6.5.2.5.2(a), (b), and (c)(3) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Loading must be based on the load combinations defined in RG 7.8 or TSD Section 6.5.2.6.10(a). Acceptance criteria for establishing margins of safety must be based on recognized and appropriate international or national standards.[a]
Fire	The package remains within the design limits specified in the SARP or PSSD under the conditions specified in 10 CFR 71.73(a), (b), and (c)(4)or Sections 6.5.2.5.2(a), (b), and (c)(4) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Loading must be based on the load combinations defined in RG 7.8 or TSD Section 6.5.2.6.10(a). Acceptance criteria for establishing margins of safety must be based on recognized and appropriate international or national standards.[a]
Immersion (fissile material)	The package remains within the design limits specified in the SARP or PSSD under the conditions specified in 10 CFR 71.73(a), (b), and (c)(5)or Sections 6.5.2.5.2(a), (b), and (c)(5) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Acceptance criteria for established margins of safety must be based on recognized and appropriate international or national standards.[a]

Table C.4-1 Credited Margin of Safety Review Questions

Requirement to be addressed	Basis for Credit Margin of Safety (CMOS)	Guidance/remarks
Immersion (all packages)	The package remains within the design limits specified in the SARP or PSSD under the conditions specified in 10 CFR 71.73(a), (b), and (c)(6)or Sections 6.5.2.5.2(a), (b), and (c)(6) of the TSD.	If any bounding limit is exceeded or none have been previously determined, then the USQ_T is positive. This includes exceeding margins of safety to maintain structural integrity of the component or package and/or violating material structural limits. Acceptance criteria for established margins of safety must be based on recognized and appropriate international or national standards.[a] Not normally required for onsite packages.

[a]Based on NRC guidance, acceptable standards for construction of regulatory packaging are the requirements from the ASME BPVC. In ASME BPVC terms, the word "construction" is an all-inclusive term encompassing design, material selection, fabrication, NDE, and testing of vessels. The NRC guidance uses a graded approach (presented in NUREG/CR-3854, *Fabrication Criteria for Shipping Containers*) to establish packaging and component construction requirements based on appropriate ASME BPVC sections relative to content hazard and component importance. As an example, the construction requirements for a Category I content (>3,000 A_2) containment vessel are ASME BPVC, Section III, Subsection NB. In the case of a Category III content (<30 A_2) containment vessel, the construction requirements are ASME BPVC, Section VIII, Division 1.

For onsite DOT-equivalent or risk based packages, the TSD, Section 6.5.2.6.10(a) establishes the minimum acceptable standard for construction as ASME BPVC, Section VIII, Division 1. However, since ASME BPVC, Section VIII, Division 1 has no provision for evaluating loads other than those associated with a pressure vessel, the TSD has specified analytical acceptable performance criteria in Section 6.3.1.1.2(g)(3). This section specifies the acceptable performance criteria as ASME BPVC, Section III, Subsection NE under normal conditions. Acceptable performance criteria for accident conditions are based on either Strain Energy Density or cumulative strain limits. Justification for use of these criteria for onsite package design is provided in the TSD, Appendix B, Section 3.4.

4. **Could the proposed design modification, activity, change, or issue change, modify or alter any of the Administrative Controls contained in the safety basis?**

This question is included to ensure that changes that require DOE approval are not inadvertently subjected to the USQ_T process and appropriate approval authority thereby bypassed. All changes to administrative controls require DOE approval prior to implementation.

ATTACHMENT C.5: GUIDANCE FOR JUSTIFICATIONS FOR CONTINUED OPERATIONS (JCO)

1.1.1.1.1.1.1.1.1 When Continuing Operations Is Justifiable

In cases in which the USQ_T determination of an event or condition leads to the determination of an USQ_T, the T&P activity manager has the inherent responsibility for ensuring activity is in a known-safe status and within the safety basis, if possible. In some cases, this may require T&P activity shutdown.

However, there are cases in which safe operation can be ensured despite the existence of an USQ_T. In addition, there are activities (e.g., shipments underway) for which the concept and implications of a shutdown are nebulous.

In some of these cases, shutdown should be interpreted as cessation of all activities except for those that clearly could not result in events or risk that have not been accepted by RL in the safety basis. Some or all of the secured activities might later be shown to be appropriate and therefore resumed with proper precautions and RL approval.

1.1.1.1.1.1.1.1.2 What a JCO Shows

The many different situations that may lead to a JCO make it impossible to provide detailed instructions for preparing the document itself. However, in each case in which safe interim operations may be requested, the objective of the justification is to document the analysis supporting the conclusion that safe operations may continue.

The justification should convincingly demonstrate that risk acceptance by RL can be recommended or that the increase in risk has sufficient quantification for RL to evaluate for acceptance. Otherwise, the JCO should show the incremental risk of continued operation or conduct of the activity is small compared to the risk previously accepted in the safety basis.

1.1.1.1.1.1.1.1.3 Use of JCO

The specific purpose of a JCO is to document the bases for continuing T&P activities before the ultimate resolution of the safety issue associated with an USQ_T or to permit resumption of specific activities suspended when the USQ_T safety question was determined. The JCO amends the safety basis (upon RL approval) until it is terminated.

PREPARING JCO

Address the Safety Question

The declaration of a PISA or USQ_T means the activity or operation is outside the approved safety basis. The JCO should convincingly demonstrate the proposed activity (continuation or resumption of an operation or activity) is consistent with the requirement that all activities and operations represent acceptable public and onsite safety risk.

CONTENT OF A JCO

The JCO content should include the following:

1. A description of the issue determined to involve an USQ_T.

2. The interim controls and/or restrictions based on the best available information, analysis, and engineering judgment; including any restriction on the use of the JCO to authorize additional work or activity. This discussion should include justification of the adequacy of the proposed controls.

3. An estimate of the risk associated with the interim operation.

4. A description of the margins of safety to be maintained.

5. A description of how existing controls/restrictions maintain safe conditions.

6. A description of the additional controls needed and how they ensure safe conditions.

7. The date or event that will permit closure or termination of the JCO. The JCO may remain in effect until the safety basis has been updated and approved by RL or the discovered condition that initiated the USQ_T and JCO has been eliminated.

1.1.1.1.1.1.1.1.4 Show That Overall Risk Is Acceptable

For example, if a failure to satisfy a package design requirement after years of successful use is discovered, an USQ_T would be determined if the situation significantly increases the accident consequences or chance of occurring. But, continued operations for a short period before correcting the deficiency (hours, days, perhaps even months) may well be acceptable if the chance of an event that would adversely affect that particular design requirement can be shown to be adequately remote. An example may be discovery of the use of A-36 steel in a package without addressing nil ductility temperature concerns. It may be acceptable to use the package under JCO conditions that limit its use to periods when the temperatures are not expected to fall below the associated NDT of the steel. The justification is that the period of exposure to an

event is very low and so the risk (probability times consequence) is also very low and is therefore acceptable to RL.

1.1.1.1.1.1.1.1.5 Place Limits on the Operations

It may be possible to bound (restrict) the operations so that the increased likelihood of an accident is acceptable. Process limitations can be imposed to regain the previously acceptable low-accident consequence or probability.

For example, a reduction in allowed radioactive material inventory may provide an acceptable basis for continued operation, even if an exhaust filter efficiency was inaccurately used in the safety analyses. Here the justification is that operating restrictions can be used to make the design basis accident less severe compared to as analyzed in the final safety analysis (based on the worst case initial conditions for the accident).

1.1.1.1.1.1.1.1.6 Additional Administrative Controls

Special administrative steps can sometimes be specified to avert a potential hazard. For example, continuous operator surveillance for a short period may be shown to be an adequate substitute for an annunciator assumed to trigger operator response in the safety basis. Here the justification is that the critical function (alerting the operator) can be maintained in the presence of the failed component.

1.1.1.1.1.1.1.1.7 Additional Analyses

Reanalyzing the accident may show a capability for safe operation when credit is taken for design features that were not used in the original analysis of an accident. These features may be shown to equal or even outweigh the effects of a discovered deficiency. Here, the justification is made by showing operation is within the safety basis. Credit may also be taken for current measured parameters rather than the conservatively assumed values in the safety analyses, e.g., measured vs. assumed concrete strength.

ATTACHMENT C.6: PAYLOAD-SPECIFIC EVALUATION FORMAT AND CONTENTS

1.0 Purpose

A payload-specific evaluation is performed for a specific package or campaign when the requirements and safety basis for the shipment are exceeded or changed. Examples of when to conduct an evaluation include an unauthorized source term, an increase in payload weight, the addition of hydrogenous material affecting gas generation, an unevaluated transport vehicle, and a change to the package configuration.

2.0 Justification

A detailed justification shall be prepared explaining why the DOT or the Hanford Site equivalent packaging requirements have not been met. The justification may include discussions involving limiting circumstances such as costs, technical information, operational requirements, and programmatic needs.

3.0 Package Evaluations

Each safety-basis evaluation topic listed below will be reviewed for possible changes affecting the stated requirements because of the change being evaluated. The examples listed are not meant to be a complete listing, but rather typical aspects relative to payload-specific evaluations.

3.1 Contents

A review of the contents evaluation shall include changes to the radioactive isotopes, fissile material, physical form (solid, liquid, gas, powder, fixed contamination), absorbents, and hydrogenous material. The contents evaluation performed for the specific payload shall be compared to the requirements in Section 6.5 of the TSD, and to those presented in the associated PSSD.

3.2 Containment

A review of the containment evaluation shall include changes to the contents that could affect a leak rate calculation. The containment evaluation results performed for the specific payload shall be compared to the requirements in Section 6.5 of the TSD, and to those presented in the associated PSSD..

3.3 Risk

A review of the risk evaluation for risk-based packages shall include changes affecting the dose consequence evaluation or accident frequency evaluation.

3.3.1 Dose Consequences

The dose consequence evaluation may be affected by changes to the contents such as increasing the payload limits, physical form of the payload, changes to the packaging, or changes to the location of the package. This evaluation shall discuss the payload-specific dose consequences utilizing the methodology identified in Chapter 7.0 and compare them to the requirements in Section 6.5 of the TSD.

3.3.2 Accident Frequencies

The accident frequency evaluation may be affected by changes to the number of shipments, mileage, administrative controls, and gross weight of the vehicle. This evaluation shall discuss the payload-specific impacts to any previously analyzed frequency calculations utilizing the methodology in Section 6.5 of the TSD.

3.4 Shielding

A review of the shielding evaluation shall include changes to the contents, packaging, or vehicle. The shielding evaluation results performed for the specific payload shall be compared to the requirements in Section 6.5 of the TSD.

3.5 Criticality

A review of the criticality evaluation shall include changes to the fissile material contents, packaging, number of packages per vehicle, or proximity to bodies of water. The criticality evaluation results performed for the specific payload shall be compared to the requirements in Section 6.5 of the TSD.

3.6 Structural

A review of the structural evaluation shall include changes to the packaging, lift fixtures, payload weight, packages per vehicle, allowable transport vehicle. Furthermore, changes to the contents that could affect the thermal and gas generation evaluations may also affect the material properties and internal pressure. The structural evaluation results performed for the specific payload shall be compared to the requirements in Section 6.5 of the TSD.

3.7 Thermal

A review of the thermal evaluation shall include changes to the contents and the package heat loading, and possibly a change to the receiving facility's requirements. The thermal evaluation results performed for the specific payload shall be compared to the requirements in Section 6.5 of the TSD.

3.8 Gas Generation

A review of the gas generation evaluation shall include changes to the contents, allowable shipping window, or payload configuration. Items that directly affect the radiolytic production of hydrogen gas are the radioactive contents, hydrogenous material, "G" value, and void space. The gas generation evaluation results performed for the specific payload shall be compared to the requirements in Section 6.5 of the TSD.

3.9 Tiedown

A review of the tiedown evaluation shall include changes to the package weight, transport vehicle, and number of packages. The tiedown evaluation results performed for the specific payload shall be compared to the requirements in Section 6.5 of the TSD.

4.0 Additional Controls

Based on the results of the package-specific evaluation, additional controls may be placed on the transport of the package.

4.1 Administrative Controls

The addition of an administrative control must be documented in the applicable procedures and/or transportation requirement. An example of an administrative control would be limiting the speed of the transport vehicle such that the maximum speed is less than the failure threshold of the package.

4.2 Engineering Controls

The addition of an engineering control must be documented in the applicable procedure and or transportation requirement. An example of an engineering control would be to vent the package through a filter rather than sealed to extend the shipping window.

5.0 CONCLUSION

For a payload-specific evaluation, it is necessary to provide a clear justification explaining why the DOT or Hanford Site equivalent packaging requirements were not met and perform the affected safety basis evaluations. A complete review must be performed for all safety basis evaluations supporting the shipment following any payload-specific changes to verify full compliance with all requirements.

ATTACHMENT C.7: GUIDANCE FOR ANNUAL SUMMARY SUBMITTALS

Summarize each USQ_TD performed since the last annual summary and provide the following:

1. Identifying number of the determination and/or change.
2. Title of the determination.
3. Date of the determination.
4. Summary of the change and any pertinent basis information.
5. Results of the determination.

Note: Any positive USQ_T determinations should have already been resolved separately from the annual submittal.

ATTACHMENT C.8: OCCURRENCE REPORT CATEGORIES

Group 8 – Transportation

No.	SC	Criterion[1]
(1)	1[2]	Any offsite transportation incident involving hazardous materials that would require immediate notice pursuant to 49 CFR 171.15, namely: (a) As a direct result of hazardous materials: (i) A person is killed, (ii) A person receives injuries requiring hospitalization, (iii) Estimated property damage exceeds $50,000, (iv) An evacuation of the general public occurs lasting 1 hour or more, (v) One or more transportation arteries or facilities are closed or shut down for 1 hour or more, or (b) Fire, breakage, spillage, or suspected radioactive contamination occurs involving shipment of radioactive materials, or (c) Fire, breakage, spillage, or suspected contamination occurs involving shipment of infectious substances (etiologic agents), or (d) There has been a release of a marine pollutant in a quantity exceeding 450 liters (119 gallons) for liquids or 400 kilograms (882 pounds) for solids, or (e) The operational flight pattern or routine of an aircraft is altered.
(2)	3	Any offsite transport of hazardous material, including radioactive material, whose quantity or nature (e.g., physical or chemical composition) is different than intended, such that the receiving organization's operations were impacted/disrupted or the transport resulted in the initiation of corrective actions by the originating organization.
(3)	1	A loss of multiple nuclear criticality process-condition controls, where processes include operation, transport, and storage of fissionable materials, such that no valid controls are available to prevent a criticality accident.
(3)	2	A loss of one or more nuclear criticality process-condition controls such that an accidental criticality is possible from the loss of an additional process-condition control, where processes include operation, transport, and storage of fissionable materials.
(3)	4	Any onsite transport of hazardous material, including radioactive material, whose quantity or nature (e.g., physical or chemical composition) is different than intended, such that the receiving organization's operations were impacted/disrupted or the transport resulted in the initiation of corrective actions by the originating organization.
(4)	4	Any packaging or transportation activity involving the onsite release of radioactive materials, etiologic agents, hazardous substances, hazardous waste, or marine pollutants.

[1]DOE Manual 231.1-2, 2003, *Occurrence Reporting and Processing of Operations Information*, Section 6, "Reporting Criteria," U.S. Department of Energy, Washington, D.C.

[2]Requires prompt U.S. Department of Energy-Headquarters notification.

49 CFR 171, "General Information, Regulations, and Definitions," 171.15, "Immediate notice of certain hazardous materials incidents," *Code of Federal Regulations*, as amended.

SC = Significance Category

ATTACHMENT C.9 GENERAL CATEGORICAL EXCLUSIONS

GCX-1

TITLE: Categorical Exclusion for Document Changes That Implement the *Hanford Sitewide Transportation Safety Document* (TSD) or Other DOE Approved Safety Basis Documents

MINIMUM QUALIFICATION TO APPLY: USQ_T Evaluator

CATEGORICAL EXCLUSION:
Changes to existing, and issuance of new, procedures, technical documents, administrative documents, drawings, Engineering Document Changes, and other supporting documents that solely implement a approved new or revised safety basis that was just approved by DOE are excluded from further review in the USQ_T process.

PREREQUISITES:

The DOE approved changes have been accurately incorporated into the contractor implementation documents.

CATEGORICAL EXCLUSION SCOPE AND BOUNDARIES:

The changes included under this categorical exclusion are limited to only those necessary to initially implement a new or revised DOE approved safety basis, provided the changes are effective with or following the implementation of the safety basis.

This CX **does not apply** to:

- Changes to documents unrelated to the implementation of DOE-approved safety basis requirements, or implementation of changes to documents prior to the effective date of the safety basis.

JUSTIFICATION SUMMARY:

This GCX includes proposed activities that have been approved by the DOE. Since the DOE has approved these activities, no further USQ_T review is required and these activities cannot represent an Unreviewed Safety Question.

The scope of changes under this categorical exclusion is limited such that excluded changes cannot represent a USQ_T. The changes excluded by this categorical exclusion are limited to those necessary to initially implement a new or revised RL approved safety basis.

GCX-2

TITLE: Categorical Exclusion for Editorial Changes to Existing Documents

MINIMUM QUALIFICATION TO APPLY: USQ_T Screener

CATEGORICAL EXCLUSION:

Editorial changes written to the existing documents or drawings that control the implementation of the safety basis are excluded from further review in the USQ_T process.

PREREQUISITES:

None

CATEGORICAL EXCLUSION SCOPE AND BOUNDARIES:

Editorial changes to existing documents are those that:

- Correct grammatical, typographical, or spelling errors that:
    - Do not affect numbers other than page, table, figure title numbers, or obvious and demonstrable typographical errors. (Changes in decimal points, units of measure or nameplate information/data are not editorial changes.)
    - Do not affect units of measure other than obvious and demonstrable typographical errors.
    - Do not affect acceptance criteria other than obvious and demonstrable typographical errors.
- Update position or organization names or titles.
- Change the format of the document (for example, rearrange unnumbered lists of items, rescale items, move details to new sheets, pagination, table, or figure title number changes. etc.),
- Add/update document references (provided changes to the references have already been appropriately USQ_T reviewed), or
- Add, change, delete or clarify notes or cautions that do not direct operator actions.

AND

Provided the editorial changes do not:

- Make any **technical changes**;
- Change the meaning, overall scope, or purpose of the existing document or drawings;
- Create a new procedure, document, or drawing; or
- Change a Technical Safety Requirement (TSR) or its bases.

JUSTIFICATION SUMMARY

Editorial changes under this categorical exclusion do not make **technical changes** to the transportation activity, packaging system, or its procedures. Therefore, these changes cannot lead to a condition that could be a USQ_T.

GCX-3

TITLE: Maintenance

MINIMUM QUALIFICATION TO APPLY: USQ_T Screener

CATEGORICAL EXCLUSION:

Work instructions/packages and associated technical information to perform **periodic maintenance** or **corrective maintenance** in accordance with requirements in the applicable transportation safety basis, and that meet the prerequisites and conditions of this categorical exclusion are excluded from further review in the USQ_T process.

PREREQUISITES:

Compliance with all applicable safety basis requirements is maintained during the course of the activity.

CATEGORICAL EXCLUSION SCOPE AND BOUNDARIES:

Maintenance work packages (including changes) are excluded from the USQ_T process provided:

- No physical modifications or software changes are included.
- Packaging systems components replaced will meet the exact design criteria and functions in every respect as the component being replaced ("like for like").
- Packaging systems will be removed from service, restored, and tested to verify they meet operability requirements prior to return to service.

JUSTIFICATION SUMMARY:

Maintenance activities, included under this CX, allow no modification to the packaging system. Temporary changes to the packaging system (as described in the safety basis), if needed, will be covered by written procedures that have been subjected to the USQ_T process. Maintenance includes periodic or preventive maintenance or corrective maintenance. Control of these activities is ensured through the formal work control process. The basic premise of performing these types of maintenance activities is that the packaging system will be returned to the same condition as described in the safety basis it was in prior to the need for maintenance, and the safety basis requirements are maintained during the maintenance activity. The functional condition will continue to meet or exceed those performance capabilities set forth in the safety basis. Any pre-approved procedures necessary to accomplish these tasks are evaluated separately for USQ_T applicability.

APPENDIX D

TECHNICAL SAFETY REQUIREMENTS FOR HANFORD ONSITE T&P

HANFORD SITEWIDE TRANSPORTATION SAFETY DOCUMENT

APPENDIX D

TECHNICAL SAFETY REQUIREMENTS FOR HANFORD ONSITE T&P

PREFACE

The technical safety requirements (TSR) for Hanford Onsite Transportation and Packaging (T&P) define the administrative controls and limits for the T&P of radioactive materials and waste in quantities greater than 1 A_2. These controls and limits ensure that the T&P of hazardous materials are completed in a safe manner and provide protection to the environment, Hanford Site personnel, and the public. Controls required for public safety, significant worker safety, and for maintaining radiological consequences below the limits and guidelines are included.

In the T&P program, packaging system design is passive and the TSRs are administrative. The TSRs are based on the preventive and mitigative features determined to be required in the body of this *Hanford Sitewide Transportation Safety Document* (TSD). The TSRs constitute an agreement or contract between the various U.S. Department of Energy (DOE), Hanford Field Office Managers and their respective Hanford Site contractors regarding the safe packaging and transportation of hazardous materials on the Hanford Site. As such, the TSRs cannot be changed without the approval of DOE.

The format and content of the TSRs are based on (1) 10 CFR 830, Subpart B. Nuclear Safety, (2) DOE G 421.1-2, Implementation Guide for use in developing Documented Safety Analyses to meet Subpart B of 10 CFR 830, (3) DOE G 423.1-1, Implementation Guide For Use In Developing Technical Safety Requirements; (4) NUREG 1431, *Standard Technical Specifications, Westinghouse Plant*s; (5) guidance provided by contractor policy, such as (6) HNF-SD-MP-TSR-001, *TSR Writers' Guide*. The TSRs are maintained as part of this TSD, which is a controlled document.

The TSRs do not apply to offsite shipments of hazardous materials. Offsite shipments are done in full compliance to U.S. Department of Transportation (DOT) requirements as found in 49 *Code of Federal Regulations* (CFR) 171-180 and 10 CFR.71

Protection of occupational workers from radiological hazards as a result of the packaging and transportation of radioactive materials is achieved by compliance with this TSD and the TSRs contained herein.

LIST OF TERMS

CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
LCO	limiting conditions for operation
LCS	limited control settings
NUREG	U.S. Nuclear Regulatory Commission Regulatory Guide
ORP	Office of River Protection
PSSD	package specific safety document
RL	Richland Operations Office
SL	safety limit
SR	surveillance requirement
T&P	transportation and packaging
TSD	Hanford Sitewide Transportation Safety Document
TSR	technical safety requirement

APPENDIX D - TECHNICAL SAFETY REQUIREMENTS FOR HANFORD ONSITE T&P

D.1 USE AND APPLICATION

D.1.1 Definitions

----------NOTE----------

The defined terms of this section are unique definitions. They appear in CAPITALIZED type and are applicable throughout these technical safety requirements (TSRs) and BASES. Some terms in this section refer the user to another section for the definition. This approach will prevent a shortened definition from being supplied and used out of context.

Term	Definition
ACTIONS	ACTIONS shall be that part of the limiting conditions for operation (LCO) that prescribes required actions to be taken under designated conditions within specified completion times.
ADMINISTRATIVE CONTROL	Refer to Section 1.2, ADMINISTRATIVE CONTROLS.
BASES	Refer to Attachment 1, BASES.
DESIGN FEATURES	DESIGN FEATURES are those design characteristics, primarily passive in nature, that are of a special importance to maintaining adequate control, shielding, or containment of radiological or toxicological material for which indiscriminate changes are to be prevented. See Attachment 2, "DESIGN FEATURES," for DESIGN FEATURES criteria.
VIOLATION	Refer to Section 1.5, Technical Safety Requirement VIOLATIONS.

D.1.2 Administrative Controls

ADMINISTRATIVE CONTROLS are the provisions relating to organization and management, procedures, recordkeeping, reviews, audits, and specific program requirements for risk reduction necessary to ensure safe operation of the packaging system. The TSRs (i.e., safety limit [SL], limited control setting [LCS], LCO, and ADMINISTRATIVE CONTROLS) establish administrative requirements that ensure TSRs are met in the operation of the packaging system and the procedures that are followed should a TSR not be met. ADMINISTRATIVE CONTROLS are generally written at the program level and contain program key elements, as applicable. ADMINISTRATIVE CONTROLS are established if (1) a safety function is best satisfied by a program instead of a hardware system; (2) control of a condition is not measured in real-time or near to real-time; (3) control of a condition is not under the immediate control of the operator; (4) a condition does not require immediate action and sufficient recovery time exists to permit mitigating action; or (5) a condition requires an evaluation based on prevalent conditions. ADMINISTRATIVE CONTROLS do not require ACTION statements or surveillance requirements (SR). SRs necessary to demonstrate compliance with an ADMINISTRATIVE CONTROL and the actions taken, should an ADMINISTRATIVE CONTROL requirement not be met, are performed according to procedures.

ADMINISTRATIVE CONTROLS are established for those programs required to prevent or mitigate accidents with unacceptable radiological consequences to the offsite public or onsite worker, to provide significant defense in depth, or provide significant worker safety.

D.1.3 SL, LCO, and Surveillance

For T&P activities, the packaging system design is passive. No SLs are expected for transportation activities because there are no processes or activities in which the operator causes a process variable to be manipulated, which if left unchecked or uncontrolled would result in catastrophic failure of a passive safety barrier. For example, there are no operator-initiated processes to increase temperature, pressure, electrical, or mechanical insult to the cargo that could lead to catastrophic failure. Because there are no SLs protected by LCOs, TSR level Surveillance Requirements are not included in this TSR. This does not eliminate other surveillances required by administrative controls.

D.1.4 Alternate Emergency Actions

In an emergency, if a situation develops that is not addressed by the TSRs, staff members are expected to use their training and expertise to take actions to correct or mitigate the situation. Also, staff members may take actions that depart from a requirement in the TSRs provided that:

- An emergency situation exists;
- These actions are needed immediately to protect the worker and public health and safety; and
- No ACTION consistent with the TSR can provide adequate or equivalent protection.

Such actions shall be approved, as a minimum, by the contractor's T&P approval authority or the RL Manager. If emergency actions are taken, verbal notifications shall be made to DOE in accordance with contractor occurrence reporting procedures.

D.1.5 Technical Safety Requirements VIOLATION

SLs, LCSs, LCOs, or SRs are not associated with the T&P program; therefore, there are no ACTION statements. Accordingly, a VIOLATION of a TSR occurs as a result of failure to comply with an ADMINISTRATIVE CONTROL.

A VIOLATION of an AC occurs when a specific requirement in the AC is not met. A VIOLATION of an AC also occurs when discrepancies in a program or procedure non-compliances indicate a programmatic breakdown, which occurs if they are significant enough to render the safety analysis assumptions invalid. Individual programmatic discrepancies or procedure non-compliances do not by themselves constitute a VIOLATION of an AC.

An AC VIOLATION shall require the following actions to restore AC compliance:

(a) Suspend those activities that cannot be conducted safely in light of the AC VIOLATION;

(b) Notify DOE of the VIOLATION in accordance with Occurrence Reporting requirements;
(c) Prepare an Occurrence Report in accordance with Occurrence Reporting requirements; and
(d) Prepare and implement a Recovery Plan describing the steps leading to compliance with an AC.

D.1.6 Reporting Requirements

In the event a TSR VIOLATION occurs, make notifications and report the event to RL. Reporting requirements are contained in DOE 232.1, *Occurrence Reporting and Processing of Operations Information*.

Additionally, should a discrepancy between the facility transportation packaging or activity and a TSR be discovered, it must be reported to RL in accordance with DOE 232.1 and an evaluation must be performed to determine if an unreviewed safety question exists as defined in 10 CFR 830.

D.2 SAFETY LIMITS

There are no SLs associated with the T&P program.

D.3 LIMITING CONDITIONS FOR OPERATION/LIMITED CONTROL SETTINGS

There are no LCOs or LCSs associated with this TSD.

D.4 SURVEILLANCE REQUIREMENTS

There are no SRs associated with this TSD.

D.5 ADMINISTRATIVE CONTROLS

D.5.1 Purpose and Applicability

D.5.1.1 The purpose of the ADMINISTRATIVE CONTROL is to state the provisions relating to organization and management, procedures, record keeping, reviews, audits, and specific program requirements for risk reduction necessary to ensure safe packaging and transportation of radioactive materials on the Hanford Site.

D.5.1.2 Applicability

These ADMINISTRATIVE CONTROLS apply to the activities associated with the T&P of radioactive materials on the Hanford Site in quantities exceeding 1 A_2.

D.5.2 Onsite Shipments and Transfers

D.5.2.1 Each contractor must have a formal program in place and sufficient staffing to perform the actions identified in the TSD.

D.5.2.2 Applicability

Overall responsibility for this TSD is assigned to RL. The other Hanford DOE Field Office Managers (DOE-RL, ORP and PNSO) through contract, shall identify those contractors and their roles in the performance of this TSD.

D.5.2.3 Contractor Responsibilities

The contractor shall address the following organizational components as addressed in Chapter 4 of the TSD and Appendix C, Unreviewed Safety Question Process for Transportation:

- A T&P Functional Organization
- Contractor specific policies and procedures
- A document configuration control program (e.g., shipping papers, package specific safety documents, unreviewed safety questions, training and qualification records, etc.)
- Assessment program

- T&P manager responsibilities
- T&P activity manager responsibilities
- Unreviewed safety question process for transportation program
- Training program
- QA program.

D.5.2.4 Minimum Package Performance Standards

The contractor SHALL assure that all packaging systems used for transport of greater than 1 A_2 of radioactive material meet the general design requirements in 49CFR173.410. Compliance with this requirement SHALL be documented in the transportation safety basis document submitted to DOE for approval.

D.5.3 Nuclear Criticality Safety

D.5.3.1 The contractor program (Section 5.2) must contain provisions for nuclear criticality safety that implement the criticality requirements defined in the TSD. The K_{eff} limit is an underlying assumption and credited margin of safety for the accident analysis that is required to be performed per Chapters 6 and 7 of the TSD. This limit protects the assumptions and ensures that the analytical basis for the probability of a criticality accident during transport is not invalidated.

The maximum K_{eff} for all packages subject to the TSD is 0.95, including allowances for bias and uncertainty to provide an adequate margin of safety for transportation activities on site.

D.5.3.2 Background

Package loading is conducted under the originating facility safety analysis. The primary features of the criticality prevention conducted under transportation activities are the package array and spacing defined in the PSSD or other packaging system approval. Other features that could be utilized include over packing with neutron absorbers. A more detailed discussion is contained in Section 7.3.1.2.6 of the TSD.

The upper bound limit for K_{eff} of 0.95 is to include allowances for bias and uncertainty and provides a credited margin of safety to ensure that the probability of occurrence of a criticality event under hypothetical accident conditions during transport remains incredible. Surveillance and compliance with this AC will be determined in accordance with contractor criticality safety programs.

D.5.4 Gas Accumulation Minimization

D.5.4.1 The contractor program (Section D.5.2) must contain provisions to identify gas accumulation controls in packaging to minimize the potential for loss of package integrity from over-pressurization, deflagration, or explosion during transportation.

D.5.4.2 Key Features

Methods commonly used to control gas accumulation include those listed below. The specific method used must be documented and documentation maintained.

- Venting
- Time limits of transport (shipping window)
- Package inventory controls (e.g., hydrogenous material limits)
- Chemical compatibility.

D.5.5 Package Damage Ratio Minimization for Risk-Based Packages

D.5.5.1 The contractor program (Section D.5.2) must contain provisions to identify controls to minimize the potential for damage to packages from accidents during transportation activities.

D.5.5.2 Key Features

Methods commonly used to achieve package damage control include those listed below. These features may be used singularly or in combination to minimize adverse impacts of transportation related accidents.

- Speed limits
- Dunnage
- Tiedown systems.

D.5.6 Surveillance and Maintenance Program

D.5.6.1 The contractor must implement a surveillance and maintenance program to ensure preservation of the key transportation safety functions provided by the package.

D.5.6.2 Applicability

This administrative control applies to all packaging identified in the TSD or used for onsite transportation. Packages that are no longer used for transportation, but only for storage of material are exempted from these surveillance and maintenance program requirements.

D.5.6.3 Key Features

The program will:

1. Identify specific surveillance and maintenance requirements, applicable when a package is not currently in use for transportation, but has the potential for future transportation use, such that the package does not degrade and is readily available for use.

2. Ensure the specific surveillance and maintenance requirements identified in the individual PSSDs are met during package use, and prior to initial use following periods when they were not in use to transport material.

3. Assure that packages shall not be used for transportation if the surveillance and maintenance has lapsed or if the qualifications for transportation use have otherwise fallen into question unless the following steps have been completed:

   a) A plan has been developed that outlines the actions that must be performed by the user to ensure package integrity during transportation; and
   b) DOE approval of the plan has been obtained; and
   c) The plan has been implemented prior to shipping the package.

4. The process to request deviations from the surveillance and maintenance program requirements SHALL include definition of contractor approval authorities and documentation requirements. Such deviations shall be submitted to RL for approval.

5. The process to request removal of a package from the TSD, when the package is not in current use and will not be used in the future for transportation SHALL include definition of contractor approval authorities and documentation requirements. Such requests shall be submitted to RL for approval.

D.5.7 Configuration Management Program

D.5.7.1 The contractor's transportation program must have a configuration management feature that ensures changes to packages are evaluated for their impact on all safety functions identified in the PSSD that are provided by the package design.

D.5.7.2 Applicability

This administrative control applies to all packaging identified in the TSD or used for onsite transportation. Packages that are no longer used for transportation, but only for storage of material are exempted from these surveillance and maintenance program requirements.

D.5.7.3 Key Features

The configuration management feature of the contractor's transportation program must address the following key features.

1. All changes to a package will be controlled through the configuration management process.

2. All safety functions provided by the package design, as identified in the PSSD, will be considered prior to initiating a change.

3. The configuration management process will interface with the Unreviewed Safety Question to identify the need for RL approval of package changes.

D.6 REFERENCES

10 CFR 830, "Nuclear Safety Requirements," *Code of Federal Regulations*, as amended.

10 CFR 71, "Packaging and Transportation of Radioactive Material," *Code of Federal Regulations*, as amended.

DOE 232.1, *Occurrence Reporting and Processing of Operations Information*, U.S. Department of Energy, Washington, D.C.

DOE G 423.1-1, *Implementation Guide for Use in Developing Technical Safety Requirements*, approved for technical use, U.S. Department of Energy, Washington D.C.

HNF-SD-MP-TSR-001, *TSR Writers' Guide*, Fluor Hanford, Richland, Washington.

NUREG 1431, *Standard Technical Specifications, Westinghouse Plants*, U.S. Nuclear Regulatory Commission, Washington, D.C.

ATTACHMENT 1 - BASES

According to DOE G 423.1-1, a BASES attachment is required to summarize the reasons for establishing SLs, LCOs, LCSs, and associated SRs. This TSD does not include SLs, LCOs, LCSs, and associated SRs, so there are no BASES provided.

ATTACHMENT 2 – DESIGN FEATURES

DESIGN FEATURES are those features not covered elsewhere in the TSRs and that, if altered or modified, would have a significant effect on safety. There are no DESIGN FEATURES identified in this TSD that require further TSR level controls.

APPENDIX E

PACKAGE-SPECIFIC SAFETY DOCUMENT CONTENTS AND FORMAT

APPENDIX E - PACKAGE-SPECIFIC SAFETY DOCUMENT CONTENTS AND FORMAT

This appendix provides guidance in formatting and preparing an onsite package-specific safety document (PSSD) to demonstrate the adequacy of the packaging in providing an equivalent degree of safety as required in the regulations. It also aids in ensuring the completeness of the information for timely review and approval. This PSSD is the principal document in which information and bases are provided for determining if the package provides an equivalent degree of safety to the regulations.

The following sections provide an outline showing the expected contents and general format for PSSDs. Additional guidance on content and depth of information to be provided can be found in Appendix F of this TSD.

E.1 PACKAGE EVALUATION

E.1.1 General Information

This section will present an introduction and general package description.

E.1.2 Introduction

This section will include the use of the package, model number, number of packages, and any other pertinent introductory information.

E.1.3 Evaluation Summary and Conclusions

Briefly summarize the results of each section of the document (e.g., structural, thermal). This section will be considered an executive summary of the evaluations performed. Any specific restrictions, payloads, etc., will be identified and explained.

E.1.4 References

Provide section references here.

E.2 STRUCTURAL EVALUATION

E.2.1 Introduction

This section will identify, describe, discuss, and analyze the structural engineering design of the packaging, components, and systems.

E.2.2 Structural Evaluation of the Package

E.2.2.1 Structural Design and Features

This section will describe the package, materials, and fabrication methods; discuss the use of codes and/or standards; and specify any special design features.

E.2.2.2 Mechanical Properties of Materials

This section will evaluate the strength of the specified materials and other physical properties related to structural design of the packaging.

E.2.2.3 Chemical and Galvanic Reactions

This section will discuss potential reactions between packaging materials, contents, and other factors that may impact the integrity of the packaging.

E.2.2.4 Size of the Package and Cavity

E.2.2.5 Weights and Center of Gravity

This section will include the packaging gross weight, weight of the package with maximum payload, center of gravity of the package, and center of gravity of the fully loaded package.

E.2.2.6 Tamper-Indicating Feature

E.2.2.7 Positive Closure

This section will describe the closure system and why the package cannot be inadvertently opened.

E.2.2.8 Lifting and Tiedown Features

The section will describe all devices and attachments that can be used to lift the package or its lid, identify all devices that are a structural part of the package and can be used as tiedowns, and discuss the overall tiedown system.

E.2.2.9 Brittle Fracture

This section will include a discussion of the affects of brittle fracture on the fabricated packaging materials. ASME BPVC, Section VIII, Division 1 will be used to evaluate brittle fracture.

E.2.3 Structural Model

This section will discuss model description and assumptions, and the code description and validation.

E.2.4 Normal Conditions

E.2.4.1 Conditions to be Evaluated

This section will discuss specific tests that will be performed and/or analyzed (drop tests, penetration tests) for normal conditions.

E.2.4.2 Acceptance Criteria

This section will provide the allowable leak rates, stress categories, and failure modes.

E.2.4.3 Initial Conditions

E.2.4.3.1 Environmental Heat Loadings. This section will discuss the worst case temperature with and without solar insolation for normal conditions.

E.2.4.3.2 Maximum Thermal and Pressure Stresses. This section will discuss the effects of thermal and pressure stresses on the components for normal conditions.

E.2.5 Accident Conditions

E.2.5.1 Conditions to be Evaluated

This section will discuss specific tests that will be performed and/or analyzed (drop tests, penetration tests) for accident conditions.

E.2.5.2 Acceptance Criteria

This section will provide the allowable leak rates, stress categories, and failure modes.

E.2.5.3 Initial Conditions

E.2.5.3.1 Environmental Heat Loadings. This section will discuss the worst case temperature with and without solar insolation for accident conditions.

E.2.5.3.2 Maximum Thermal and Pressure Stresses. This section will discuss effects of thermal and pressure stresses on the components for accident conditions.

E.2.6 Puncture

As applicable to packagings, this section will discuss the affects of puncture.

E.2.7 Structural Evaluation and Conclusions

This section will discuss the drop orientation with the most severe loading.

E.2.7.1 Normal Conditions Evaluation and Conclusions

This section will discuss all normal conditions drop test results.

E.2.7.2 Accident Conditions Evaluation and Conclusions

This section will discuss all accident conditions drop test results.

E.2.8 Drawings

Drawings and sketches showing details of the packaging systems should be included.

E.2.9 References

Provide section references here.

E.2.10 Appendices

If required, provide section appendices here.

E.3 THERMAL EVALUATION

E.3.1 Introduction

This section will identify, describe, discuss, and analyze thermal engineering design of the packaging, components, and systems.

E.3.2 Thermal Source Specification

E.3.3 Summary of Thermal Properties of Materials

This section will list thermal properties of all materials used.

E.3.4 Thermal Evaluation for Normal Conditions

E.3.4.1 Conditions to be Evaluated

This section will indicate specific tests that will be performed and/or analyzed (drop test, penetration tests) to support thermal evaluation of the package for normal conditions.

E.3.4.2 Acceptance Criteria

This section will discuss failure modes, thermal conditions, etc., as required to provide a basis for accepting thermal data from tests and/or analyses.

E.3.4.3 Thermal Model

This section will provide model description and assumptions, and code description and validation.

E.3.4.4 Thermal Analyses

E.3.4.4.1 Internal Temperature.

E.3.4.4.2 Maximum Surface Temperature.

E.3.5 Thermal Evaluation for Accident Conditions

E.3.5.1 Conditions to be Evaluated

This section will indicate specific tests that will be performed and/or analyzed (drop test, fire tests) to support thermal evaluation of the package for accident conditions.

E.3.5.2 Acceptance Criteria

This section will discuss failure modes, thermal conditions, etc., as required to provide a basis for accepting thermal data from tests and/or analyses.

E.3.5.3 Package Conditions and Environment

E.3.5.4 Thermal Model

This section will provide model description and assumptions, and code description and validation.

E.3.5.5 Thermal Analyses

E.3.5.5.1 Internal Temperatures.

E.3.5.5.2 Maximum Surface Temperatures.

E.3.6 Conclusions

This section will include evaluations of designated tests and analyses performed to assure the package is thermally acceptable following designated normal conditions and accident conditions during transfer.

E.3.7 References

Provide section references here.

E.3.8 Appendices

If required, provide section appendices here.

E.4 CONTAINMENT/CONFINEMENT EVALUATION

E.4.1 Introduction

This section will discuss the methodology used to evaluate containment and/or confinement performance of the package (e.g., package leakage or release rates).

E.4.2 Contents Information

E.4.2.1 Characterization

This section will discuss content information, present specific characterization data, and provide evaluations for the content analysis data used to determine qualities of material, fissile content, and other data that are acceptable.

E.4.2.2 Restrictions

This section will provide a discussion of content restrictions and include information to assure that generic or specific content restrictions are sufficient.

E.4.2.3 Size and Weight

This section will evaluate size and weight of the contents to assure they are correctly listed and in accordance with the packaging size and structural load requirements.

E.4.3 Containment Source Specification

This section will provide a detailed description of the contents of the package and assess dispersability of the material if required. A detailed listing of the contents will be provided in this section.

E.4.4 Normal Conditions

E.4.4.1 Conditions to be Evaluated

This section will indicate the specific tests that will be performed and/or analyzed (e.g., drop test, penetration test) to support the evaluation of the package containment system for normal transfer conditions.

E.4.4.2 Containment Acceptance Criteria

This section will discuss allowable leak rates or dose consequences, failure modes, etc., as required to provide a basis for accepting data from tests or analyses. If the data are qualitative, the basis of evaluation must be justified.

E.4.4.3 Containment Model

This section will include the release rate or dose consequence model description, release assumptions, and code description and evaluation.

E.4.4.4 Containment Calculations

E.4.5 Accident Conditions

E.4.5.1 Conditions to be Evaluated

This section will indicate specific tests that will be performed and/or analyzed (e.g., drop test, fire test) to support evaluation of the package containment system for accident conditions.

E.4.5.2 Containment Acceptance Criteria

This section will discuss the allowable leak rates or dose consequences, failure modes, etc., as required to provide a basis for accepting data from tests or analyses. If data are qualitative, the basis of evaluation must be justified.

E.4.5.3 Containment Model

This section will include release rate or dose consequence model descriptions, release assumptions, and code description and evaluation.

E.4.5.4 Containment Calculations

E.4.6 Conclusions

This section will contain a discussion on the containment system and determine if the package will safely contain contents within acceptable release or dose consequence limits for the designated normal conditions and accident conditions identified.

E.4.7 References

Provide section references here.

E.4.8 Appendices

If required, provide section appendices here.

E.5 SHIELDING EVALUATION

E.5.1 Introduction

This section will identify, describe, discuss, and analyze shielding design of the packaging, components, and systems.

E.5.2 Direct Radiation Source Specification

This section will state contents, and gamma and neutron source terms used in the analyses.

E.5.2.1 Gamma Source

This section will state the quantity of radioactive material included as contents. The method used to determine gamma source strength and distribution will be described in detail.

E.5.2.2 Beta Source

This section will state the quantity of radioactive material included as contents. The method used to determine beta source and distribution will be described in detail.

E.5.2.3 Neutron Source

This section will state the quantity of radioactive material included as contents. The method used to determine neutron source strength and distribution will be described in detail.

E.5.3 Summary of Shielding Properties of Materials

E.5.4 Normal Conditions

E.5.4.1 Conditions to be Evaluated

This section will indicate specific tests that will be performed and/or analyzed (e.g., drop test, penetration test) to support evaluation of the package shielding system for normal conditions.

E.5.4.2 Acceptance Criteria

This section will include failure modes, dose rates, radiation levels, etc., as required to provide a basis for accepting data from tests and/or analyses.

E.5.4.3 Shielding Model

This section will include model description and assumptions, and code description and validation.

E.5.4.4 Shielding Calculations

E.5.5 Accident Conditions

E.5.5.1 Conditions to be Evaluated

This section will indicate specific tests that will be performed and/or analyzed (e.g., drop test, fire test) to support evaluation of the package shielding system for accident conditions.

E.5.5.2 Acceptance Criteria

This section will include failure modes, dose rates, radiation levels, etc., as required to provide a basis for accepting data from tests and/or analyses.

E.5.5.3 Shielding Model

This section will include model description and assumptions, and code description and validation.

E.5.5.4 Shielding Calculations

E.5.6 Conclusions

This section will include evaluations for designated tests and analyses performed to verify integrity of the package shielding during designated normal conditions and accident conditions.

E.5.7 References

Provide section references here.

E.5.8 Appendices

If required, provide section appendices here.

E.6 CRITICALITY EVALUATION

E.6.1 Introduction

This section will identify, describe, discuss, and analyze principal criticality engineering-physics design of the packaging, components, and system important to safety and necessary to comply with demonstration of package subcriticality.

E.6.2 Criticality Source Specification

E.6.3 Summary of Criticality Properties of Materials

E.6.4 Normal Conditions

E.6.4.1 Conditions to be Evaluated

This section will indicate specific tests that will be performed and/or analyzed (e.g., drop test, penetration test) to support criticality evaluation of the package for normal conditions.

E.6.4.2 Acceptance Criteria

This section will include failure modes, criticality conditions, etc., as required to provide a basis for accepting criticality data from tests and/or analyses.

E.6.4.3 Criticality Model

This section will include the model description and assumptions, and code description and validation.

E.6.4.4 Criticality Calculations

E.6.5 Accident Conditions

E.6.5.1 Conditions to be Evaluated

This section will indicate specific tests that will be performed and/or analyzed (e.g., drop test, fire test, etc.) to support criticality evaluation of the package for accident conditions.

E.6.5.2 Acceptance Criteria

This section will include failure modes, criticality conditions, etc., as required to provide a basis for accepting criticality data from tests and/or analyses.

E.6.5.3 Criticality Model

This section will include model description and assumptions, and code description and validation.

E.6.5.4 Criticality Calculations

E.6.6 Critical Benchmark Experiments

This section will provide justification for the validity of the calculational method and neutron cross-section values used in the analysis by presenting results of the calculations for selected critical benchmark experiments.

E.6.6.1 Benchmark Experiments and Applicability

This section will provide a general description of selected critical benchmark experiments that are to be analyzed. Applicability of the benchmarks in relation to the package and its contents will be shown.

E.6.6.2 Details of Benchmark Calculations

Actual nuclear and geometric input parameters used for benchmark calculations will be provided.

E.6.6.3 Results of Benchmark Calculations

Results of the benchmark calculations will be given.

E.6.7 Conclusions

This section will include evaluations of designated tests and analyses performed to assure radioactive contents of the package remains consistent with applicable limits and controls during designated normal conditions and accident conditions.

E.6.8 References

Provide section references here.

E.6.9 Appendices

If required, provide section appendices here.

E.7 GAS GENERATION EVALUATION

E.7.1 Gas Generation

This section will include a discussion of hydrogen gas build-up and provide an evaluation of data to assure packaging design specifications are acceptable to prevent excessive hydrogen gas build-up. Consideration will include the use of venting and/or devices such as catalysts.

E.7.2 Package Pressure

This section will include a discussion of estimated internal package pressure and provide an evaluation of data to assure that packaging design specifications are acceptable to prevent excessive internal pressures. Consideration will include the use of pressure relief systems, vents, or other devices. It will be assured the package design is sufficient to safely contain the contents at the estimated operation pressure of the system during transfers.

E.7.3 References

Provide section references here.

E.7.4 Appendices

If required, provide section appendices here.

E.8 TIEDOWN EVALUATION

E.8.1 System Design

This section will discuss the general tiedown system, evaluate tiedown system design drawings (if provided), and indicate restrictions and other concerns for safely securing the package to the vehicle.

E.8.2 Attachments and Ratings

This section will provide an evaluation of load ratings for attachment devices on the vehicle and straps/chains or other devices used to tiedown the package.

E.8.3 References

Provide section references here.

E.8.4 Appendices

If required, provide section appendices here.

E.9 PACKAGING QUALITY ASSURANCE

E.9.1 Introduction

This section is considered as a guideline for developing quality assurance plans and other documents to assure the packaging was designed and fabricated in accordance with identified codes, standards, and associated criteria.

E.9.2 Quality Requirements

In this section, assigned safety class(s) and approval designators will be identified. In addition, specific guidance for development of quality assurance plans, inspection and maintenance plans, and training plans will be provided.

E.9.3 Organization

In this section, information and charts to describe the quality assurance organization that must be in place to develop quality assurance plans, complete inspections, control changes, and maintain records will be provided.

E.9.4 References

Provide section references here.

E.9.5 Appendices

If required, provide section appendices here.

E.10 OPERATING PROCEDURES

E.10.1 General Requirements

This section will contain recommended guidelines for using the packaging. As necessary, specific operating procedures will be noted and included. Specific requirements that could adversely affect the integrity of the packaging should be directed to operations. Packagings that may be reused will have requirements discussed in sufficient detail to ensure the packaging is not damaged during transfer and unloading operations.

E.10.2 Package Loading

This section will contain information on installing package contents, closure of package, and lifting of package.

E.10.3 Package Unloading

This section will contain information on lifting the package, opening package, and removing package contents.

E.10.4 Empty Package (Packaging)

This section will contain information on cleaning, inspecting, closing, handling, storage, and transfer.

E.10.5 References

Provide section references here.

E.10.6 Appendices

If required, provide section appendices here.

E.11 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

E.11.1 New Packaging

E.11.1.1 Acceptance Requirements

This section will describe requirements that a new packaging must meet prior to approving the package for transport of contents. This section will include the extent of inspection required, specific requirements, etc.

E.11.1.2 Inspection and Testing

This section will indicate specific inspection and testing (if applicable) necessary to accept a new packaging for use, describe how the task should be performed, and criteria that should be used for accepting results of the inspection and testing.

E.11.1.3 Documentation

This section will indicate specific documents that will be developed to ensure packaging is acceptable, who will provide the documents, and where and how long they will be maintained.

E.11.2 Packaging for Reuse

E.11.2.1 Acceptance Requirements

The type of packaging and circumstances under which packaging will be reused will be considered. The requirements under which the packaging will be acceptable for reuse will be determined and identified. Requirements will include physical inspections, possible testing and/or retesting, new gaskets or other seals, painting, load tests, corrosion checks, etc.

E.11.2.2 Inspection and Testing

This section will contain specific inspections and testing (if applicable) to accept a package for reuse, describe how tasks should be performed, and criteria that should be used for accepting the results of inspection and testing.

E.11.2.3 Documentation

This section will contain specific documents that will be developed to ensure the packaging is acceptable, indicate who will provide the documents, and where and how they will be maintained.

E.11.3 General Maintenance Requirements

This section will discuss tasks that will be completed to ensure that a new or reused packaging is maintained in good condition for use. Requirements will include periodic inspections and testing for conditions such as corrosion and physical damage.

E.11.4 Inspection and Verification Schedules

This section will indicate specific inspection and testing, describe how tasks will be performed, and criteria that will be used for accepting the results of inspection and testing.

E.11.5 Records and Documentation for Maintenance

This section will indicate specific documents that will be developed to ensure the packaging is acceptable, who will provide the documents, and how long they will be maintained.

E.11.6 References

Provide section references here.

E.11.7 Appendices

If required, provide section appendices here.

E.12 PREPARATION OF ONE-TIME REQUESTS FOR SHIPMENT (OTRS)

A graded approach should be used to determine the depth and extent of information required to support any exemption requests, such as One-Time Requests for Shipment (OTRS). At a minimum, the OTRS must address the following topics, using the guidance in the previous sections of this Appendix for clarification and a description of contents:

1. General Information
   - 1.1 Introduction,
   - 1.2 Package Description
     - 1.2.1. Drawings
     - 1.2.2. Other Information Including Materials Specifications And Product Data
   - 1.3 Payload Description
   - 1.4 Compliance with TSD Packaging Standards
     - 1.4.1 Statement of Compliance to TSD Packaging Standards
     - 1.4.2 Summary of Evaluation
2. Structural
3. Thermal
4. Containment
5. Shielding
6. Criticality
7. Gas Generation
8. Tie Down and Package Rigging
9. Quality Assurance
10. Operating Procedures
11. Acceptance Tests and Maintenance Program Review

APPENDIX F

ADDITIONAL GUIDANCE FOR PREPARATION OF PACKAGE SPECIFIC SAFETY DOCUMENTS

APPENDIX F - ADDITIONAL GUIDANCE FOR PREPARATION OF PACKAGE SPECIFIC SAFETY DOCUMENTS

DOE has established a Packaging Review Guide (PRG),UCID-21218 Rev. 2, *Packaging Review Guide for Reviewing Safety Analysis Reports for Packagings*, Lawrence Livermore National Laboratory, Livermore, CA 94550, to ensure compliance with regulatory requirements and that packaging descriptions and analyses are consistent and thorough. The evaluation process described in the PRG relies substantially on 10 CFR Part 71 and the following other NRC documents:

NUREG-1609, *Standard Review Plan for Transportation Packages for Radioactive Material*

NUREG-1617, *Standard Review Plan for Transportation Packages for Spent Nuclear Fuel*

Regulatory Guide 7.9, *Standard Format and Content of Part 71 Applications for Approval of Packaging for Radioactive Material*

Other regulatory guides and NUREG reports that provide guidance on criteria for evaluating transportation packages.

Additionally, Regulatory Guide 7.10, *Establishing Quality Assurance Programs for Packaging Use in Transport of Radioactive Material*, and the *SARP Completeness Checklist* provide further details on expected contents of SARPs to demonstrate equivalent safety to full NRC licensing. For the purposes of this TSD, the guidance for preparation of SARPs can be applied to preparation of PSSDs, using the graded approach commensurate with the significance of the items being evaluated.

The foregoing documents provide a substantial body of detailed information on expected contents and depth of coverage of the topics required to be addressed that should be consulted for guidance in preparation of PSSDs.

APPENDIX G

JUSTIFICATION AND BASIS FOR SHIPMENT OF RISK-BASED PACKAGES

HANFORD SITEWIDE TRANSPORTATION SAFETY DOCUMENT

LIST OF TERMS

AC	accident conditions
ARF	airborne release fraction
CEDE	committed effective dose equivalent (50 year)
CFR	*Code of Federal Regulations*
DCF	dose conversion factor
DE-Ci	dose-equivalent curie
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DR	damage ratio
HMR	Hazardous Materials Regulations
LPF	leak path factor
MAR	material at riskNC normal conditions
NRC	U.S. Nuclear Regulatory Commission
PSSD	package-specific safety documents
RF	respirable fraction
RL	Richland Operations Office
DSA	documented safety analysis
SARAH	*Hanford Safety Analysis and Risk Assessment Handbook (SARAH)*
TRU	transuranic
TSD	*Hanford Sitewide Transportation Safety Document*
USQ_T	unreviewed safety question process for transportation
V/R	velocity/radius

APPENDIX G - JUSTIFICATION AND BASIS FOR SHIPMENT OF RISK-BASED PACKAGES

G.1 INTRODUCTION

Section 1.1 summarizes application of the unreviewed safety question process for transportation (USQ_T) on the approval process for risk-based packages. Section 1.2 summarizes the approach for demonstrating equivalence to U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR) for risk-based packages. Section 1.3 describes the methodology to analyze onsite transportation accidents and a typical data set example used to calculate accident release frequencies and consequences from transportation accident scenarios..

G.1.1 Highlights of the USQ_T for Risk-Based Packages

The shipment of risk-based packages is subject to approval requirements. Appendix A lists package-specific safety documents (PSSD) for risk-based packages authorized for onsite transportation. Each PSSD has specific requirements, limits, and controls governing the shipment of that particular risk-based package. The shipment of these risk-based packages within the bounds of the PSSD is approved by the U.S. Department of Energy (DOE), Richland Operations Office (RL). Changes to these packages, whether a modification to the design of the package or changes in the requirements, limits, or controls on the package or shipment are subject to the USQ_T process prior to shipment of the package to determine whether the change is within the safety basis envelope of the *Hanford Sitewide Transportation Safety Document* (TSD) and associated PSSD. If the change is within the safety basis, then the USQ_T is negative, and the shipment of the package with the changes considered in the USQ_T may be made. However, if the change is outside the safety basis, then the USQ_T is positive, and RL approval is required prior to the shipment of the package. Details of the USQ_T process are given in Chapter 6 and Appendix C.

The packaging is only the first line of defense in the transportation operation, and all other available administrative and engineering controls that reasonably reduce the frequency of an accidental release should be implemented as practical, consistent with the as low as reasonably achievable principle. The combination of the calculated shipment-specific payload limits and the administrative and engineering controls designed to preclude and mitigate a release provides a degree of safety equivalent to the DOT HMR for onsite shipments of radioactive material packages.

G.1.2 Approach for Showing Equivalency to DOT HMR

DOE Order 460.1B, *Packaging and Transportation Safety*, requires that onsite shipments of radioactive material packages comply with the DOT HMR (49 *Code of Federal Regulations* [CFR] 171-180) or be shown to meet a degree of safety equivalent to the regulations. The purpose of the HMR is to protect the public, which includes those who work in transportation, from harmful exposure to radiation. To protect the public, the DOT HMR requires that the

packaging provide adequate shielding, maintain subcriticality, and contain its contents within specified limits during normal and accident conditions (AC). The criticality and shielding requirements for risk-based packaging are not substantially different than the requirements for DOT and equivalent packaging given in Chapter 6 of the TSD. However, risk-based packaging, by definition, may not maintain the same level of containment as DOT or equivalent packaging. Therefore, packaging containment performance requirements are derived that consider the specific characteristics and controls of onsite shipments of risk-based packages to limit the intake of radionuclides to equivalent levels to those provided by compliance with the regulations. One of these controls is that the public is not in the immediate vicinity of a damaged package, as is assumed in the derivation of the DOT containment requirements, because of restricted public access during onsite shipments and the large distances to the Hanford Site boundary. Other assumptions behind the DOT containment requirements that can be revised for onsite shipments include the dispersability of the payload, damage to the package, and potential leak paths. The effect of the characteristics and controls of onsite shipments of risk-based packages is that package-specific release limits may be calculated such that the intake of radioactive material is no greater than the intake by the public from the DOT allowable release limits in commerce.

49 CFR 173.467, "Tests for demonstrating the ability of Type B and fissile materials packagings to withstand ACs in transportation," requires that each certified Type B packaging or packaging for fissile material meet the test requirements prescribed in 10 CFR 71, "Packaging and Transportation of Radioactive Material," for ability to withstand ACs in transportation. Additionally, Type B packages that meet the applicable requirements of 10 CFR 71 and approved by the U.S. Nuclear Regulatory Commission (NRC) are authorized for shipment per 49 CFR 173.416, "Authorized Type B packages." Therefore, to show an equivalent degree of safety, NRC regulations in 10 CFR 71 must be considered in addition to the DOT HMR.

Within the boundaries of the Hanford Site, DOE has established radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from DOE activities. 10 CFR 835.1302, "Emergency exposure situations," regulates emergency exposure situations. These regulations state the following:

- The risk of injury to those individuals involved in rescue and recovery operations shall be minimized.

- Operating management shall weigh actual and potential risks against the benefits to be gained.

- No individual shall be required to perform a rescue action that might involve substantial personal risk.

- Each individual authorized to perform emergency actions likely to result in occupational doses exceeding the values of the limits provided in 10 CFR 835.202(a), "Occupational dose limits for general employees," shall be trained in accordance with 10 CFR 835.901(b), "Radiation safety training," and briefed beforehand on the known or anticipated hazards to which the individual will be subjected.

Therefore, minimizing worker risk (consisting of dose consequence and frequency) is a requirement of 10 CFR 835, "Occupational Radiation Protection." Administrative and engineered controls can be used to reduce the frequency of a release, the severity of the forces on the package, and/or the consequences of a release.

A degree of safety equivalent to the DOT HMR can be achieved by minimizing the radiological risk (dose consequence and frequency) from a transportation accident.

G.1.3 Onsite Transportation Accidents

G.1.3.1 Overall Framework

The overall framework for estimating the frequencies of accidents was tailored to consider Hanford Site-specific road conditions where possible. The Hanford Site is a relatively benign area with respect to potential accident scenarios and subsequent damage to packaging systems. The Hanford Site is characterized by moderate terrain; there are no long, steep grades; few rocky hills and valleys; little rail traffic; predominantly soft (sand) wayside structures; and no bridges, tunnels, freeway overpasses or underpasses. Consequently, the likelihood of encountering road conditions that can lead to severe accidents is less than that on a typical interstate or state highway in the United States. Consequently, it can be concluded that the frequencies of severe accidents on the Hanford Site are lower than on interstate and state highways. Furthermore, because the Hanford Site is a controlled access area, officials can implement controls to reduce the frequencies of accidents even further, e.g., by closing the road when a shipment occurs.

The other key attribute of the accident frequency framework is that it must be sensitive to the calculated failure thresholds of the packaging systems involved. In other words, if a certain package is determined to fail when subjected to a 48 km/h (30 mph) impact event, the methodology must be flexible enough to calculate the frequency of accidents on the Hanford Site in which the impact velocity is 48 km/h (30 mi/h) or greater. Similarly, the methodology must be capable of calculating the frequencies of accidents that involve fires of varying duration to reflect the thermal resistance of specific packaging systems. The accident frequency framework is used to determine the frequency bin into which accidents would likely fall.

G.1.3.2 Hazard Analysis

A hazard analysis was conducted to identify and evaluate the hazards associated with transporting radioactive material on the Hanford Site. The purpose of the hazard analysis was to review potential sources of hazards during transport and construct potential accident scenarios that could be applied to the shipments and packagings and lead to loss or dispersal of radioactive materials. A generic hazard "checklist" was used to guide the analysis and ensure a comprehensive review of the potential hazards. A columnar format was used to review the hazards and record their presence or absence with respect to Hanford Site transportation. If a hazard was determined to be present, one or more accident scenarios were constructed that describe the potential effects of the hazard on a packaging system and the subsequent effects on the radioactive materials in the package. In addition, the engineering and administrative barriers that prevent or mitigate the potential accident scenarios are recorded. Information on the engineering and administrative barriers was recorded to support a determination of whether the potential accident scenarios were credible events.

The hazard analysis developed to support the Hanford Site accident frequency analysis framework is presented in Table1. The following conclusions were derived from the information in Table1:

- DOE considers the occurrence of an inadvertent criticality event as unacceptable, regardless of the projected consequences of such an event. For this reason, DOE emphasizes prevention of inadvertent criticality and generally requires packages to be designed such that inadvertent criticality accidents will not occur even under severe conditions that promote a nuclear reaction (e.g., optimum moderation). The sequence of events leading to a potential criticality accident was judged to be incredible due to the engineering and administrative controls in place to prevent criticality accidents. These include, where appropriate, limiting the fissile inventory, preventing ingress of moderator materials (such as water) into the package, geometry controls, adding poisons, etc. These requirements remain in effect for equivalent as well as risk based packages.

Table 1. Hazards Analysis of Hanford Site Transportation Activities

Hazard	Potential Accident	Available Controls		Remarks
		Physical	Administrative	
Electricity	Package struck by high voltage power line	Packages protect contents from alternating current		Not credible (judgment)
Explosives	Solid or liquid explosive ignites and fails package due to overpressure or missile	Package design provides resistance to pressure and missiles, commensurate with hazard	Solid and liquid explosives packaged in accordance with DOT requirements; segregated from radioactive materials	Not credible (judgment)
	Hydrogen gas generated by radiolysis ignites within package	Package strength Vents in packages	Shipping windows; Liquid content limits; Source limits; Venting procedures	Gas generation analysis required; controls ensure accident is not credible
Cryogenic systems	Liquid nitrogen, liquid argon not present when transporting radioactive materials			Not credible (judgment)
Direct radiation sources	Loss of shielding occurs as a result of a transportation accident	Package design, resistance to loss of shielding; personnel barriers	Exposure distance restrictions; Radiation protection training; Detection instrumentation; Emergency Preparedness Program and Procedures	Shielding is generally an integral component of package and not likely to become degraded as a result of an accident
Radioactive materials	Release of radioactive materials from a transportation accident	Package design and containment requirements commensurate with radioactive hazard	Package certification; Radiation protection training; Emergency Preparedness Program and Procedures	Containment of radioactive materials under NCs and ACs addressed in DSA for Packaging; public access restrictions
	Uncontrolled nuclear reaction (i.e., inadvertent criticality)	Geometry controls; Presence of neutron absorbers, poisons	Inventory limits; Exclusion of water; Emergency Preparedness Program and Procedures	Accident involving water immersion incredible at arid Hanford Site; Firefighters trained not to fight fires that involve fissile materials with water; Criticality controls ensure accident is not credible
Flammable materials	Fire affects integrity of transportation package	Package design, thermal resistance, commensurate with radioactive hazard	Hanford Fire Department Emergency Preparedness Program and Procedures	Most likely sources are gasoline, diesel vehicle fuels; Flammable liquids are shipped in accordance with DOT requirements
Compressed gases	Compressed gas tank or bottle explodes and affects integrity of radioactive material transportation package	Package design commensurate with radioactive hazard	Compressed gases not shipped with radioactive materials	Packages resistant to external pressure; Compressed gases shipped in accordance with DOT requirements
Thermal energy (internal decay heat source)	Package overheats, fails due to inadequate or loss of cooling	Package design	Thermal power limits	Packages normally designed to dissipate heat naturally

Table 1. Hazards Analysis of Hanford Site Transportation Activities

Hazard	Potential Accident	Available Controls		Remarks
		Physical	Administrative	
Thermal energy (local temperature extreme)	Package failure to high ambient temperature	Package design resists hot ambient conditions	None	Hanford requirements exceed DOT and NRC NCs of transport; Degradation limited by short trip duration
Thermal energy (extreme cold)	Package degradation due to cold ambient temperature causes failure in transit	Package design resists cold ambient conditions	None	Extreme cold has little effect on package integrity; Degradation limited by short trip duration
High pressure	Traffic accident leads to package immersion under a head of water	Package design commensurate with hazard	None	Incredible event because river depth not sufficient to threaten package integrity
Kinetic energy	Package involved in traffic accident (impact, rollover) that fails containment	Package design, impact resistance, commensurate with radioactive hazard; Impact limiters; Tiedown systems	Driver training awareness; Road closure if necessary; Emergency Preparedness Program and Procedures; Time-of-day restrictions to avoid traffic congestion	Credible event, impact covered by DOT and NRC regulations; Low probability of striking a "hard" target on Hanford Site
	Package involved in traffic accident that generates puncture conditions that fail containment	Package design, puncture resistance, commensurate with hazard; Impact limiters; Tiedown systems	Driver training awareness; Road closure if necessary; Emergency Preparedness Program and Procedures; Time-of-day restrictions to avoid traffic congestion	Credible event; Puncture covered by DOT and NRC regulations
	Package involved in traffic accident that generates crush condition that fails containment	Package design, resistance to crush, commensurate with hazard; Impact limiters; Tiedown systems	Driver training awareness; Road closure if necessary; Emergency Preparedness Program and Procedures; Time-of-day restrictions to avoid traffic congestion	Applicable to only small (<500 kg [1,102 lb]) packages; Credible event; Crush covered by DOT and NRC regulations
	Material handling accident	Not applicable	Not applicable	Handling accidents while loading and unloading packages are covered in facility DSA
Potential energy	Package falls from bridge or overpass	See "Remarks"	See "Remarks"	No bridges or overpasses at the Hanford Site
	Package dropped during loading/unloading	Package design commensurate with hazard; Lifting equipment design	Control of heavy loads requirements; Operating procedures; Personnel training	Credible event, free drop covered by DOT and NRC regulations; Addressed in facility DSA
	Heavy object dropped on package	Package design, puncture resistance	Personnel training (heavy load controls)	Not credible to lift heavy object over package and drop it; Addressed in facility DSA

Table 1. Hazards Analysis of Hanford Site Transportation Activities

Hazard	Potential Accident	Available Controls		Remarks
		Physical	Administrative	
Toxic, hazardous chemicals	Toxic or hazardous chemical co-released with radioactive materials	Package design resists release of toxic, hazardous chemicals	Emergency preparedness procedures and training; Driver awareness of package contents	Unless co-contaminants, radioactive and toxic/hazardous materials are shipped separately; DOT packaging requirements applicable to toxic/hazardous material shipments apply
Corrosion	Corrosion leads to package degradation and failure in transit	Package design considers internal and external corrosion; Corrosion-resistant materials	Visual inspection; Package maintenance program requirements	Package internal atmosphere inverted when required to prevent cargo degradation
Sabotage	Terrorist or sabotage incident threatens package integrity	Package design commensurate with hazard (shipment of highly-radioactive payloads are in accident-resistant packages); Hanford security personnel and equipment	Public access restrictions	Hanford shipments not highly-attractive to terrorists/saboteurs; Judged to be incredible event
Natural phenomena	Earthquake, tornado, high wind, flood, meteorite, or other natural phenomena causes package failure in transit	Package design commensurate with hazard	Emergency preparedness procedures and training; Driver awareness of weather conditions; Travel restrictions under extreme weather conditions	Incredible event because of low probability of such conditions occurring at the same time a package is in transit; Hanford Meteorological Station
High-intensity magnetic fields; Lasers; High noise levels; Biohazards; Non-ionizing radiation sources; Inert atmosphere	Not applicable or not capable of causing package damage			

AC = accident condition.
DOT = U.S. Department of Transportation.
NC = normal condition.
NRC = U.S. Nuclear Regulatory Commission.
DSA = documented safety analysis.

- Thermal energy from radioactive decay of the cargo must be dissipated to prevent package failure regardless of whether the package is equivalent or risk based. Any engineered or administrative controls implemented to ensure adequate heat dissipation (e.g., source limits, cooling systems) must be adhered to.

- Extreme ambient conditions (heat and cold) that could lead to package failure were not included in the Hanford Site accident risk framework because they are already included in the approach for equivalent packages.

- Flammable gas deflagrations were judged to be extremely unlikely as long as the requirements to prevent or minimize the buildup of flammable gas for equivalent packages are adhered to. The primary source of the flammable gas hazard is radiolytic decomposition of hydrogenous materials within a package that generates hydrogen gas. The hydrogen gas concentration could build within the package to the lower explosive limit and then be ignited by some mechanism (e.g., spark created by a traffic accident). An analysis of hydrogen generation is required for each package, equivalent or risk based, and any engineered or administrative barriers required to prevent a hydrogen explosion must be followed. Alternatively, the package may be shown by analysis or test to be capable of withstanding the most energetic hydrogen explosion capable of being generated within the package. For these reasons, the potential for explosions involving the package is addressed by the bounding analysis specified in the Hanford Site framework. See Section G.2.5.2.3 and Table 3.

- Immersion of a package under a head of water and subsequent failure due to the hydrostatic pressure load was judged to be incredible. This is because the shipments would not be transported over or near a body of water of sufficient depth to be an immersion concern or a concern about retrieving the package in a timely manner. Thus, immersion scenarios are not considered further.

- Potential energy hazards (e.g., package falling from a bridge or overpass and heavy objects being dropped on a package) were determined to be incredible. There are no bridges or overpasses on the Hanford Site that a package could fall from and heavy object lifting requirements preclude them from being lifted over a radioactive material package except under controlled and previously approved conditions. Other elements of heavy lifting (e.g., package dropped during loading or unloading) are addressed in facility-specific documented safety analyses (DSA).

- Toxic and hazardous chemicals are, in general, not a threat to Hanford Site packages. The chemicals may be an issue related to industrial hygiene and worker protection, but do not represent a credible threat to the package. Similarly, corrosion was removed as a potential accident scenario because of the long-term nature of the threat and the existing package maintenance program in which inspections are conducted periodically to identify potential corrosion or other form of package degradation.

- Potential acts of sabotage or terrorism were not considered further because of the absence of credible threats. Hanford shipments are not considered attractive to potential saboteurs and terrorists because most shipments are in support of cleanup that is supported by most groups and because of the absence of a potentially large body count sought by terrorist organizations. Furthermore, the Hanford Site is provided with its own security forces that are capable of rapidly responding to and dealing with potential saboteurs and terrorists.

- Natural phenomena threats to packages include earthquakes, high winds, tornadoes, and floods. However, the likelihood of such events are low and the likelihood that such an event occurs at the same time a package is in transit, combined with the likelihood that the natural phenomena event is severe enough to threaten package integrity makes these incredible occurrences. Furthermore, shipping is restricted during periods of highly hazardous weather, such as dust storms and high winds that decrease visibility and snowstorms that lead to dangerous road conditions. For these reasons, natural phenomena hazards were eliminated from further consideration.

Based on the above, the Hanford Site accident frequency analysis framework must address potential ACs including impact (such as vehicular crashes and rollovers), puncture, crush, and fire. Note that these events are the same as the hypothetical ACs defined in 10 CFR 71. However, package requirements and controls that were developed based on the deterministic analyses conducted to support traditional package certification or Hanford Site performance-based certification must also be met (e.g., criticality controls, hydrogen gas generation limitations).

G.1.4 Example

Assume that a packaging system for Type B quantities of radioactive material has been determined to be risk based via detailed structure and thermal modeling. The loaded weight of the package is 2,000 kg (4,409 lb). The detailed modeling determined the following containment failure thresholds:

- Mechanical failure occurs when the package is subjected to a 40 km/h (25 mi/h) collision with an unyielding target

- Puncture failure occurs when the package is subjected to a 9 m/sec (30 ft/sec) impact onto a 20 cm (8-in.) diameter puncture probe

- Failure occurs after a 25-minute fire following a collision or after 45 minutes when no collision occurs (i.e., fire only).

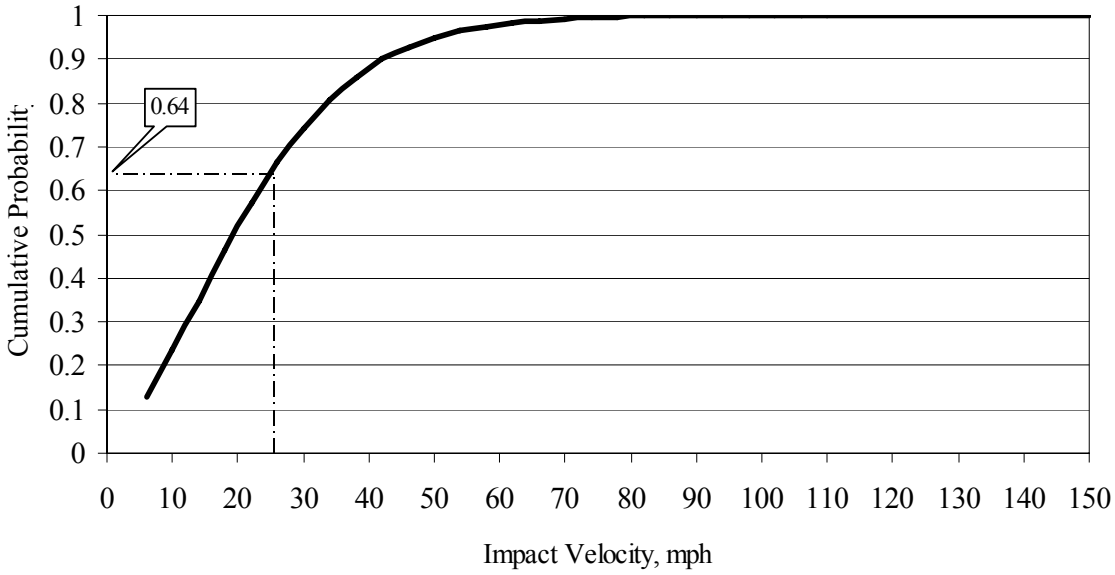
In addition, it is known that the package will be used to transport waste materials from the 300 Area to the Low-Level Waste Burial Ground in the 200 West Area, a distance of approximately 25 km (40 mi), and is planned to be used twice per year.

Solution

1. Determine Collision Failure Frequency:

   a. Determine Conditional Probability. The conditional probability of a collision/overturn is 0.7412. Referring to Figure 1, which was constructed using Figure 7-10, Chapter 7 of the TSD, it can be seen that the probability of collision/overturn that produces a 40 km/h (25 mi/h) impact velocity or less is about 0.64. Therefore, the probability of encountering collisions that could potentially fail the package (i.e., at 40 km/h [25 mi/h] or greater) is about (1 – 0.64) or 0.36.

Figure 1. Example Illustrating Collision Failure Probability.



   b. Calculate Frequency. The frequency of collision failure on the Hanford Site is the product of the accident rate, one-way distance, number of annual shipments, the conditional probability of a collision/overturn occurring, and the conditional probability that the impact velocity generated in a collision/overturn accident is 40 km/h (25 mi/h) or greater. The frequency is:

   Frequency = (3.2×10^{-7} accidents/mile per WHC-SD-TP-RPT-021)(40 miles/trip)
   (2 trips/yr)(0.7412)(0.36)
   = 6.8×10^{-6} collision/overturn failures per year

2. Determine Puncture Accident Failure Frequency:

   a. Determine Puncture Failure Probability. This is a Type B package so the puncture failure probability is determined using Figure 7-13, Chapter 7 of the TSD. The structural analysis of the package determined that failure could occur when the package is subjected to a 30 ft/sec drop onto a 20 cm (8-in.) diameter puncture probe. Thus, V/R is equal to (30 ft)(12 in/ft)/8 in. = 45 sec^{-1}. Referring to Figure 7-11 from the TSD, Chapter 7, the probability of encountering puncture conditions characterized by V/R = 45 sec^{-1} is about 0.028, given that a collision/overturn accident occurs.

   b. Calculate Frequency. Similar to Step 1.b above, the annual frequency of a release due to a collision followed by puncture is:

   Frequency = (3.2×10^{-7} accidents/mi.)(40 miles/trip)(2 trips/yr)(0.741) (0.028)
   = 7.2×10^{-7} puncture failures per year

3. Determine Crush Failure Frequency:

   a. Determine Crush Failure Probability. Crush is not applicable, since the package weight exceeds 500 kg (1,102 lb)

4. Determine Fire Failure Frequency:

   a. Determine Fire Failure Probability. This fire failure probability is determined using Figures 7-13 and 7-14, Chapter 7 of the TSD. The thermal analysis of the package determined that failure of a damaged package (i.e., following the collision/overturn impact event discussed above) could occur when subjected to a 25-minute regulatory fire or after 45 minutes for a non-damaged package. Referring to Chapter 7, Figure 7-13, the probability of a fire lasting 25 minutes or less following a collision or overturn is about 0.7. The probability that a fire lasts 25 minutes or longer, and threatens the integrity of the package, is (1 – 0.7) or about 0.3. For non-collision accidents, the probability that a fire lasts longer than 45 minutes is (1 – 0.9985) = 0.0015.

   b. Calculate Frequency. Similar to Step 1.b above, the annual frequency of a release due to a collision followed by 25 minute fire or longer is:

   Collision and Fire
   Frequency = (3.2×10^{-7} accidents/mile)(40 miles/trip)(2 trips/yr)
   (0.7412)(0.36) (0.3)
   = 2.4×10^{-6} failures per year
   Collision/Puncture and Fire
   Frequency = (3.2×10^{-7} accidents/mile)(40 miles/trip)(2 trips/yr)
   (0.7412)(0.028) (0.3)
   = 1.6×10^{-7} failures per year

Fire-Only
Frequency = (3.2 x10^{-7} accidents/mile)(40 miles/trip)
(2 trips/yr)(0.2588)(0.0015)
= 1.0 x10^{-8} failures per year

5. Summary:

The accident frequencies used to compare against the risk evaluation guidelines are as follows:

1. Collision failure – 6.8 x10^{-6} per year
2. Puncture failure – 7.2 x10^{-7} per year
3. Collision and fire failure – 5.7 x10^{-6} per year
4. Collision/puncture and fire – 1.6 x10^{-7} per year
5. Fire-only failure – 1.0 x10^{-8} per year

The consequences of this accident would then be determined and the (frequency, consequence) pair plotted on the risk evaluation guideline plot to determine the acceptability of such an accident. Note that the consequences are determined separately using the methodology and data described in Section 7.3.2.1. The consequence estimates must consider the specific conditions generated in each accident scenario. For example, the amount of material released from an impact-only package failure should be calculated using release fractions that are representative of releases from mechanical damage to the material form. For scenarios involving fires, the release fractions that represent releases from applying thermal stress to the material form should be selected. Additional information used to develop consequence estimates are presented in the TSD, Section 7.3.2.1.

G.1.5 Dose Consequence Evaluation

G.1.5.1 Inhalation Exposure Pathway

The dose consequence due to inhalation of airborne particulate material created from a hypothetical accident during transportation is given by the 50-year committed effective dose equivalent (CEDE). The CEDE per unit intake for each radionuclide is tabulated in several references and is referred to as the inhalation dose conversion factor (DCF). The Hanford site SARAH (HNF-8739, *Hanford Safety Analysis and Risk Assessment Handbook [SARAH])* provides the bases for selection of the parameters involved in the bounding accidents. Effective DCFs are prescribed in units of dose-equivalent curie (DE-Ci), which normalizes the inhalation dose relative to that from ^{239}Pu.

Intake by inhalation requires that the radioactive material first transform into an aerosol that is transported through the atmosphere to a downwind receptor and is inhaled. Transformation into an aerosol is caused by the accident conditions described in Section 1.3, and the amount of aerosol formed depends on the accident scenario and form of the radioactive material. The amount of aerosol that is formed and leaks out of the package is known as the airborne source term and is given by the first five variables (DOE-

HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, p. 1-2) in equation (1). The sixth variable is the concentration of aerosol at a particular downwind location, integrated over time, and normalized to the amount of aerosol released. The seventh variable is the breathing rate of a receptor. The product of the first seven variables in equation (1) below represents the intake of radionuclides into the body due to inhalation. The last variable is the inhalation DCF.

$$CEDE = (MAR \times DR \times ARF \times RF \times LPF) \times \chi/Q' \times BR \times DCF \quad (1)$$

(airborne source term)

where:

CEDE=50-year committed effective dose equivalent due to inhalation, in rem
MAR = material at risk, in DE-Ci
DR = damage ratio, dimensionless
ARF = airborne release fraction, dimensionless
RF = respirable fraction, dimensionless
LPF = leak path factor, dimensionless
χ/Q' = time-integrated normalized airborne concentration, in s/m^3
BR = breathing rate, in m^3/s
DCF = inhalation dose conversion factor for ^{239}Pu, in rem/DE-Ci.

Neglected in this definition of the airborne source term is the coagulation of smaller particles into larger particles and the resultant increase in gravitational settling of the larger particles. Because no credit is taken for the reduction of the MAR that would occur from the settling of larger particles, the results of the calculations are be conservative.

G.1.5.2 MAR

The MAR is the radiological inventory per shipment and per package in DE-Ci. MAR limits are determined by limiting the consequences of the analyzed accidents. The form of the material being shipped is to be specified to determine applicable release characteristics.

G.1.5.3 DR

The DR is the fraction of the MAR (i.e., the fraction of the contents of a single package or the fraction of the MAR in the conveyance) actually affected by the accident-generated conditions. For the unmitigated case, it is assumed that all of the individual packages are affected given an accident, and the DR is taken to be 1. The DR for a mitigated collision is reduced based on the analyses of the damage expected to be caused by the accident with implementation of the administrative and engineering controls called out in the applicable PSSD or other authorization.

G.1.5.4 ARF and RF

The ARF is the fraction of the radioactively contaminated material that is converted to particulate matter and becomes airborne during a hypothetical accident. The RF is the fraction of the ARF that is sufficiently small to be capable of being inhaled into the human respiratory system. The ARF is a function of the accident scenario, the physical and chemical form of the waste, the initial packaging configuration, and the energy input. The RF is a function of the same variables as the ARF, but also is a function of the initial particle size distribution.

The recommended values of the ARF and RF for Hanford site accidents are generally taken from DOE-HDBK-3010, and are tabulated in *SARAH.* Values used must be justified and consistent with the SARAH methodology.

G.1.5.5 LPF

The LPF is the cumulative fraction of airborne radioactive material that escapes through the containment boundary. This factor depends on the structural response of the package to the hypothetical accident conditions. The LPF is conservatively assumed to be 1.0 for unmitigated cases.

G.1.5.6 χ/Q'

The χ/Q' defines the downwind concentration of airborne radioactivity at a particular location, integrated over the duration of the release and normalized to the amount released. The recommended χ/Q' values are obtained from SARAH and RADIDOSE.

G.1.5.7 BR

The BR is the volume of air inhaled per unit time. The International Commission on Radiological Protection (ICRP 23, *Report of the Task Group on Reference Man*) reports that the breathing rate for reference man during light activity is 3.3×10^{-4} m^3/s. This value is conservatively applied for both the co-located worker and the Maximum Exposed Offsite Individual.

G.1.5.8 DCF

The DCF correlates the amount of radioactivity inhaled to the CEDE. Because the activity is given in units of DE-Ci, which normalized the inhalation dose relative to that from ^{239}Pu, the DCF used in the dose consequence calculations is that for ^{239}Pu. For workers, given ^{239}Pu, an absorption type of M, and an aerodynamic diameter of 5 µm, the DCF is 3.2×10^{-5} Sv/Bq or 1.18×10^{8} rem/Ci or approximately 3.2×10^{6} rem/A_2. Absorption type M and aerodynamic diameter of 5 µm are appropriate for the plutonium oxide materials shipped on the Hanford Site and are consistent with values specified in SARAH. For members of the public, the corresponding ^{239}Pu DCF, given absorption

type M and an aerodynamic diameter of 1 μm, is 5.0 x 10^{-5} Sv/Bq or 1.85 x 10^{8} rem/Ci or approximately 5.0 x 10^{6} rem/A_2.

G.1.5.9 Summary of the Inhalation Dose Consequence Calculations

The dose consequences and parameter values determined for shipping an array of TRU waste packages due to a collision, fire, or hydrogen deflagration are shown in Tables 2a and 5b of this appendix. The risks indicated in this table are representative of the level of risk that can be accepted by DOE, based on the analyses and factors for specific risk based packages.

G.2 SUMMARY

This section contains the assumptions and methodologies used to develop Tables 2a and 2b. For future risk-based package evaluations, specific characteristics of the package or contents may warrant different assumptions.

Bounding radiological dose consequence and release frequency evaluations were performed for three accident scenarios for a single package containing generic solid payloads and generic transuranic (TRU) and non-TRU wastes. Results are reported for both unmitigated and mitigated accidents. With the assumptions given, the mitigated dose consequence and release frequency are consistent with DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, Appendix A. These results are for bounding accidents selected to ensure the analyses cover the classes of activities conducted under transportation. The combined release and resultant consequences from multiple packages on the conveyance, if applicable, are bounded by the inventory limit and controlled by administrative controls. Administrative controls should be designed to mitigate the consequences, mitigate the severity of the accident, and/or reduce the frequency of the accident to satisfy the assumptions in these calculations. These controls are required when the shipment payload contains greater than 1 A_2 of radioactive material.

G.2.1 Packages

The packages considered in this report are the same package types considered and accepted by the DOT, plus those unique packages that DOE has accepted as having acceptably low levels of risk. The content limits based on the mitigated accident analysis results should be applied only to packages that are shown to pass the performance requirements for DOT Type A packages. The content limits, based on the unmitigated results, may be applied to all packages including those that do not meet the performance requirements for Type A packages, because no credit is taken for the package in ACs in the table of unmitigated results in this example.

G.2.2 Accident Scenarios

The accident scenarios selected are those selected by DOT as representing the deterministic conditions required to be survived during transportation. A hazard analysis and accident selection for transportation is described in Section 1.3.

G.2.2.1 Collision

Collision is the most common type of transportation accident. In a collision accident, the truck hits an obstacle, causing the truck to decelerate at a rapid rate. The package, however, is still traveling at the initial velocity of the truck. The velocity of the package is reduced by the amount of energy required to break the tiedown hardware (which is small). The package then collides with the front of the conveyance, which had stopped because of the collision with the obstacle. The collision between the package and the

conveyance is an impact event because the force on the package is localized on one side; this is the same type of force created when an object is dropped and hits the ground.

If there are additional packages on the conveyance that are behind the front package, then an inertial crush force is generated as these packages collide with and push against the front package, which is being resisted by the front of the conveyance. Impact and crush forces are differentiated by the application of the force to the package. If the force occurs on one side of the package, it is considered an impact, and if it occurs on multiple sides of the package, it is considered crush.

Puncture is a type of impact in which a small diameter probe impacts the package. It occurs less frequently than a collision, as described in Sections 7.3.2.2.1.2 and 7.3.2.2.1.3, and the release from puncture is bounded by the release from the impact described above.

G.2.2.2 Fire

A fire may follow the collision. Transportation statistics show that fire occurs in approximately 1.6% of all accidents, as described in Section 7.3.2.2.1.5. These fires have variable diameter, temperature, duration, and location relative to the cargo. Unvented Type A 210 L (55-gal) drums, on average, will lose containment 3 minutes after exposure to a fully-engulfing fuel fire.

G.2.2.3 Hydrogen Deflagration

Hydrogen gas deflagrations may occur anytime, not just during transportation. Hydrogen can build up in a package due to chemical reactions between different materials of the payload and due to radiolytic decomposition of water or other hydrogenous materials. Another flammable gas (methane) can build up due to the anerobic respiration by organisms on organic material, although this mechanism has not been observed to produce significant quantities of flammable gas in drums at the Hanford Site.

G.2.3 Payloads

The payload of the package is assumed to consist of debris generated during cleanup activities at the Hanford Site. This debris most likely consists of surface contaminated equipment and combustible items. It is assumed for conservatism that particulate material may be present, which is modeled as powder. For simplicity, the isotopic composition is assumed to consist of either TRU or non-TRU material, which is modeled as plutonium.

G.2.4 Risk-based Packaging System Typical Assumptions

The assumptions described here are typical of those that can be applied to control risks, and serve to mitigate the consequences, mitigate the severity of the accident, or reduce the frequency of the accident. These assumptions are discussed quantitatively in the results section.

The speed of the truck can be limited. In this example, the speed of the truck is assumed to be limited to 56 km/h (35 mi/h). This assumption limits the energy that must be dissipated in a collision accident. More importantly, it reduces the severity of the injuries to the driver because of the collision.

For arrays of packages, the least-hazardous packages (measured by DE-Ci) are assumed to be placed at the front of the conveyance and the most hazardous packages are assumed to be placed at the rear of the conveyance, although this arrangement shall not result in an unacceptable direct external dose rates. This assumption mitigates the total amount released, because the packages in the front experience the largest crush forces.

For arrays of packages, impact-limiting devices, such as sandbags or empty drums, are assumed to be placed at the front of the conveyance. This limits the damage to the packages by absorbing more energy than the front structure of the conveyance, thus mitigating the release.

The road is assumed to be closed to all other traffic during the shipment for this example. This reduces the frequency of multi-vehicle accidents and limits the total fuel available for a fire to only the fuel in the transport vehicle's fuel tank.

Packages are assumed to be vented prior to shipping, and chemically reactive contents are assumed not to be present to preclude a buildup of hydrogen above its lower flammability limit. The PSSD shall evaluate the buildup of hydrogen during shipment to establish a shipping window.

G.2.5 Results

The dose consequences and the release frequency from an array of packages due to a collision, fire, or hydrogen deflagration are shown in Tables 2a and 2b of this appendix. A brief description of the calculations is provided in the following subsections.

G.2.5.1 Data Sources

The material at risk is the total material at risk on the conveyance, except for the case of hydrogen deflagration, which is the total material at risk in one package. Therefore, two limits are imposed on risk based shipment inventories: 1) a shipment-level (conveyance) limit and 2) a package-level limit.

Because the purpose of this example is to provide an indication of the risks from transportation accidents involving risk based Type B packages, conservative assumptions must be used so that the results bound the risk from the majority of packages. Use of this example is limited to packages, together with the planned payload, that satisfies the conditions normally incident to transport as defined in Section 6.5.2.3. Packages with payloads that are capable of withstanding accident environments that are more severe than the Type A packaging tests would retain more of its contents in an accident and would be bounded by the results in Tables 2a and 2b. The 210 L (55-gal) drums are

considered in the calculations as a representative Type A package because they are commonly used onsite.

G.2.5.1.1 Fire Release Fraction. Studies of 210 L (55-gal) drums in fire tests show that in a fully engulfing fire, the lid may be completely blown off the drum, or the lid may rupture but be partially held in place by the closure ring. In either case, failure occurred in an average of 3 minutes. Drums not completely engulfed by the fire fail by lid seal degradation (WHC-SD-WM-TRP-246, *Solid Waste Drum Array Fire Performance*, Section 8.1). The two components of the airborne source term for the fire scenario are considered to be adequately represented by the value in RADIDOSE for the burning of contents of the packages of 5×10^{-4} and 1, respectively, from DOE-HDBK-3010-94, Section 5.1, which are the bounding values for packaged mixed combustible and noncombustible waste.

G.2.5.1.2 Hydrogen Deflagration Release Fraction. Three components of the airborne source term for the hydrogen deflagration scenario are considered. The first component is the airborne release caused by the blast effects of the deflagration, which applies to all of the contents of the package. The other two components are the same as for the fire release: the burning of ejected combustible waste and the burning of combustible waste remaining in the package.

In a hydrogen deflagration, a powder payload will have a greater airborne release due to the explosive stress than combustible or noncombustible payloads. However, the combustible payload will have a greater airborne release due to the subsequent burning after the hydrogen deflagration. Therefore, reasonably representative values for the ARF and RF for internal explosions such as hydrogen deflagrations in drums are 1.0×10^{-3} and 1.0, respectively, as given in RADIDOSE for this accident type.

G.2.5.1.3 Other Parameters

The breathing rate, 3.3×10^{-4} m^3/s, is taken from ICRP 23 for the reference man during light activity.

The DE-Ci factors are taken from HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*.

The accident frequency is taken from Section 7.3.2.2.1.1, which is from NUREG/CR-6672, *Reexamination of Spent Fuel Shipment Risk Estimates*, with the conditional probability of fire taken from SLA-74-0001, *Severities of Transportation Accidents Volume III--Motor Carriers*. The probability of a drum deflagration is taken from SAR 1996, *Rocky Flats Environmental Technology Site Safety Analysis Report*.

G.2.5.2 Effect of Assumptions

G.2.5.2.1 Collision. To mitigate the consequences from a collision accident, the speed of the truck shall be limited to 56 km/h (35 mi/h), the drums at the front of the conveyance shall contain no radioactive material, and the most hazardous drums (measured by DE-Ci) shall be placed at the rear.

In a head-on collision accident, the front row of drums impacts the front of the conveyance, and the following rows of drums impact the front row of drums. This creates a crush environment, which is defined as forces impinging on more than one side of the package. A crush environment is usually more severe than an impact environment, such as a drop, in which the forces impinge on only one side of the package. Sacrificial dunnage drums in the front row will act as an impact limiter at the front of the conveyance to absorb most of the kinetic energy of the drums in following rows and ensure that the highest crush forces occur on drums containing no radioactive material. The magnitude of the crush force depends on the speed and mass of the moving object; the lower the speed or mass, the lower the crush force. Therefore, in a head-on collision, the lowest crush forces will be at the back of the trailer. The last row of drums will not be crushed, because there is nothing behind it; the drums will only experience the impact when they collide with the row of drums in front of them. Therefore, the most hazardous drums in terms of amount release should be placed at the back of the array to minimize the crush force.

Table 2a. Risk-Based Package Accident Summary (Dose Consequences) for Maximum Exposed Offsite Individual.

Case	Area	Scenario	Accident condition	MAR[1,2] (DE-Ci)	MAR[1] (g)	MAR[1] (A_2)	DR	ARF[3]	RF[3]	LPF	BR[4] (m^3/s)	Distance (m) to receptor[5]	χ/Q' (s/m^3)[6]	DCF[7] (rem/Ci)	Dose (rem)	Accident frequency (yr^{-1})[8]	Risk class	Credited controls[9]
1	100/200	Collision	UM	353	5,680	13,070	1.0	1.00 E-3	0.10	1.0	3.3 E-4	10,000	4.68 E-5	1.85 E+8	0.10	EU	IV	None
2	100/200	Collision	M	353	5,680	13,070	0.1	1.00 E-3	0.10	1.0	3.3 E-4	10,000	4.68 E-5	1.85 E+8	0.01	EU	IV	(a), (b)
3	100/200	Fire (0.5 MW)	UM	1130	18200	41800	1.0	5.00 E-4	1.00	1.0	3.3 E-4	10,000	1.51 E-5	1.85 E+8	0.53	EU	IV	None
4	100/200	Fire (0.5 MW)	M	1130	18200	41800	1.0	5.00 E-4	1.00	1.0	3.3 E-4	10,000	1.51 E-5	1.85 E+8	0.53	EU	IV	None
5	100/200	Hydrogen deflagration	UM	239	3850	8850	1.0	1.00 E-3	1.00	1.0	3.3 E-4	10,000	3.68 E-5	1.85 E+8	0.54	Anticipated	III	None
6	100/200	Hydrogen deflagration	M	239	3850	8850	1.0	1.00 E-3	1.00	1.0	3.3 E-4	10,000	3.68 E-5	1.85 E+8	0.54	EU	IV	(c), (d)
7	300	Collision	UM	158	2540	5850	1.0	1.00E-3	0.10	1.0	3.3 E-4	1400	3.95 E-4	1.85 E+8	0.38	Unlikely	II	None
8	300	Collision	M	158	2540	5850	0.1	1.00 E-3	0.10	1.0	3.3 E-4	1400	3.95 E-4	1.85 E+8	0.038	Unlikely	III	(a), (b)
9	300	Fire (0.5 MW)	UM	495	7970	18300	1.0	5.00 E-4	1.00	1.0	3.3 E-4	1400	6.43 E-5	1.85 E+8	0.98	EU	III	None
10	300	Fire (0.5 MW)	M	495	7970	18300	1.0	5.00 E-4	1.00	1.0	3.3 E-4	1400	6.43 E-5	1.85 E+8	0.98	EU	III	None
11	300	Hydrogen deflagration	UM	112	1800	4150	1.0	1.00 E-3	1.00	1.0	3.3 E-4	1400	3.61 E-4	1.85 E+8	1.5	Anticipated	I	None
12	300	Hydrogen deflagration	M	112	1800	4150	1.0	1.00 E-3	1.00	1.0	3.3 E-4	1400	3.61 E-4	1.85 E+8	1.5	EU	III	(c), (d)

[1]MAR adjusted to maintain approved CW and MOI doses. Specific activity of ^{239}Pu is 6.20 E-2 Ci/g, and 1 A_2 = 2.7 E-2 Ci.
[2]The MARs for collision and fire are conveyance limits while the MAR for hydrogen deflagration is a package limit.
[3]The ARF and RF shown are from RADIDOSE for the accident scenario. The payload materials are assumed to consist of surface contaminated combustible or noncombustible materials or powder, whichever is more conservative for the accident scenario.
[4]Breathing rate for reference man during light activity.
[5]Average distance to receptor for 100, 200 E, and 200 W Areas is 10,000 m. Distance to receptor in 300 Area is 1400 m.
[6]Based on χ/Q' values from RADIDOSE Version 3.
[7]MOI; ^{239}Pu, absorption Type M, 1 µm mean diameter, DCF = 5.0 E-5 Sv/Bq (5.0 E+6 rem/A_2, 1.85 E+8 rem/Ci, or 1.147 E+7 rem/g).
[8]Frequency calculations based on
56 trips per year at 8 km (5 mi) per trip for Cases 1, 2, 3, and 4, 100 trips per year at 32 km (20 mi) per trip for Cases 7, 8, 9, and 10. Frequencies for Cases 5, 6, 11, and 12 assigned.
[9]Credited controls: (a) maximum speed limited to 56 km/h (35 mi/h), (b) sandbags or nonrad (dunnage) containers in front row of array, high DE-Ci containers in rear, (c) containers vented prior to shipment, (d) chemically reactive contents not present.

ARF = airborne release fraction.
DCF = dose conversion factor.
DE-Ci = dose-equivalent curie.
DR = damage tario.
EU = extremely unlikely.
LPF = leak path factor.
M = mitigated.
MAR = material at risk.
MOI = Maximum Exposed Offsite Individual.
RF = respirable fraction.
UM = unmitigated.

Table 2b. Risk-Based Package Accident Summary (Dose Consequences) for Co-located Worker at 100 m (328 ft).

Case	Area	Scenario	Accident condition	MAR[1,2] (DE-Ci)	MAR[1] (g)	MAR[1] (A_2)	DR	ARF[3]	RF[3]	LPF	BR[4] (m^3/s)	Distance (m) to receptor	χ/Q' (s/m^3)[5]	DCF[6] (rem/Ci)	Dose (rem)	Accident frequency (yr^{-1})[7]	Risk class	Credited controls[8]
1	100/200	Collision	UM	353	5,680	13,070	1.0	1.00 E-3	0.10	1.0	3.3 E-4	100	6.1 E-2	1.184E+8	85	EU	III	None
2	100/200	Collision	M	353	5,680	13,070	0.1	1.00 E-3	0.10	1.0	3.3 E-4	100	6.10 E-2	1.184E+8	8.5	EU	IV	(a), (b)
3	100/200	Fire (0.5 MW)	UM	1130	18200	41800	1.0	5.00 E-4	1.00	1.0	3.3 E-4	100	5.97 E-4	1.184E+8	13	EU	IV	None
4	100/200	Fire (0.5 MW)	M	1130	18200	41800	1.0	5.00 E-4	1.00	1.0	3.3 E-4	100	5.97E-4	1.184E+8	13	EU	IV	None
5	100/200	Hydrogen deflagration	UM	239	3850	8850	1.0	1.00 E-3	1.00	1.0	3.3 E-4	100	1.54 E-3	1.184E+8	14	Anticipated	III	None
6	100/200	Hydrogen deflagration	M	239	3850	8850	1.0	1.00 E-3	1.00	1.0	3.3 E-4	100	1.54 E-3	1.184E+8	14	EU	IV	(c), (d)
7	300	Collision	UM	158	2540	5850	1.0	1.00E-3	0.10	1.0	3.3 E-4	100	3.40 E-2	1.184E+8	21	Unlikely	III	None
8	300	Collision	M	158	2540	5850	0.1	1.00 E-3	0.10	1.0	3.3 E-4	100	3.40 E-2	1.184E+8	2.1	Unlikely	III	(a), (b)
9	300	Fire (0.5 MW)	UM	495	7970	18300	1.0	5.00 E-4	1.00	1.0	3.3 E-4	100	7.28 E-4	1.184E+8	7.1	EU	IV	None
10	300	Fire (0.5 MW)	M	495	7970	18300	1.0	5.00 E-4	1.00	1.0	3.3 E-4	100	7.28 E-4	1.184E+8	7.1	EU	IV	None
11	300	Hydrogen deflagration	UM	112	1800	4150	1.0	1.00 E-3	1.00	1.0	3.3 E-4	100	1.58 E-3	1.184E+8	7.0	Anticipated	III	None
12	300	Hydrogen deflagration	M	112	1800	4150	1.0	1.00 E-3	1.00	1.0	3.3 E-4	100	1.58 E-3	1.184E+8	7.0	EU	IV	(c), (d)

[1]MAR based on Table 2a. Specific activity of ^{239}Pu is 6.20 E-2 Ci/g, and 1 A_2 = 2.7 E-2 Ci.
[2]The MARs for collision and fire are conveyance limits while the MAR for hydrogen deflagration is a package limit.
[3]The ARF and RF shown are from RADIDOSE for the accident scenario. The payload materials are assumed to consist of surface contaminated combustible or noncombustible materials or powder, whichever is more conservative for the accident scenario.
[4]Breathing rate for reference man during light activity.
[5]Based on χ/Q' values from RADIDOSE Version 3.
[6]Co-located worker; ^{239}Pu, absorption Type M, 5 µm mean diameter, DCF = 3.2 E-5 Sv/Bq (3.2 E+6 rem/A_2, 1.184 E+8 rem/Ci, or 7.341 E+6 rem/g).
[7]Frequency calculations based on 56 trips per year at 8 km (5 mi) per trip for Cases 1, 2, 3, and 4, 100 trips per year at 32 km (20 mi) per trip for Cases 7, 8, 9, and 10. Frequencies for Cases 5,6, 11, and 12 assigned.
[8]Credited controls: (a) maximum speed limited to 56 km/h (35 mi/h), (b) sandbags or nonrad (dunnage) containers in front row of array, high DE-Ci containers in rear, (c) containers vented prior to shipment, (d) chemically reactive contents not present.

ARF = airborne release fraction.
DCF = dose conversion factor.
DE-Ci = dose-equivalent curie.
DR = damage tario.
EU = extremely unlikely.
LPF = leak path factor.
M = mitigated.
MAR = material at risk.
RF = respirable fraction.
UM = unmitigated.

Calculations in previous safety analysis reports for packaging (HNF-2209, *Safety Analysis Report for Packaging (Onsite) Steel Drum*, Section 7.4) conservatively modeled inertial crush as a drum sandwiched between two hard unyielding plates; one an immobile surface representing the front of the trailer, and the other a 2,268 kg (5,000-lb) plate with an initial velocity of 40 km/h (25 mi/h) representing the column of drums behind the front drum. This is an idealized scenario designed to estimate conservatively the potential damage to that drum. These calculations show substantial failure of the front drum caused by buckling of the drum wall near the drum bottom plate. Evidence of crush failure first begins to show in this conservative model when the 2,268 kg (5,000-lb) plate has an initial speed of 27.8 km/h (17.3 mi/h).

Further calculations in HNF-2209 (Section 7.5) evaluate the response of an array of drums to a collision. This calculation was an analytical model as opposed to the finite-elements model as described above. The coupled, second-order differential equations of motion for an array of three drums crushed against a hard unyielding surface were solved in closed-form modeling the drums as a series of masses, springs, and dashpots. This idealized model is a simplification of the problem compared to the finite elements model described above, which is a dynamic analysis. The three drums were modeled as having an equal mass of 658 kg (1,450 lb), and the initial system velocity was 48 km/h (30 mi/h).

The results of the model indicate that the first drum has a much larger deceleration after striking the unyielding surface than the second or third drums, which are tightly coupled such that they move with nearly the same velocity and the same acceleration. The kinetic energy of the second and third drum is transformed into dissipative energy in the first drum, and because of the large deceleration of the first drum, the first drum absorbs much more energy than the second or third drum. The first drum would likely be ruptured, but the second and third drums most likely would not be ruptured. These results are conservative because they neglect the energy absorbed by the transport vehicle, energy that would not be transferred to the drums. The model considered a stationary unyielding surface, when no surface is truly unyielding. Also, the maximum weight of the drum was modeled, when in practice actual weights vary from nearly empty up to the maximum mass. Although only three drums were considered in the analysis in HNF-2209 (Section 7.5), it was concluded that it would take many more rows of drums before the second row of drums would fail. An uncertainty analysis was conducted to account for the variable mass of the drums in an array, and it was concluded with greater than 95% confidence that none of the drums would fail for an initial system velocity of 48 km/h (30 mi/h), a 70 to 80% confidence that the first drum only would fail for an initial system velocity of 56 km/h (35 mi/h), and a 30 to 40% confidence that the first drum only would fail for an initial system velocity of 64 km/h (40 mi/h).

By limiting the speed of the truck to 56 km/h (35 mi/h), it is concluded that only the first row of drums would fail in a collision. Note that the impact-limiting

function of the front row of drums is effective only where the collision occurs along the longitudinal axis of the trailer. In a jackknife accident, the trailer could overturn, and the drums could impact the ground. However, the shoulder and surrounding ground are yielding, which would mitigate the forces on the package. Furthermore, the percentage of jackknives among all collisions is small, and side-impact collisions by other vehicles are prevented by the road closure.

G.2.5.2.2 Fire. Applied controls are not credited with any reduction in the consequence or frequency of a fire accident.

G.2.5.2.3 Hydrogen. Mitigation of the consequences from a hydrogen deflagration in risk-based packages shall be provided by verifying per the methodology in Attachment A to this Appendix, or equivalent, that void volume hydrogen concentrations remain below the risk-based limits shown in Table 3 during the expected shipping window. Justification for the risk-based hydrogen limits is presented in Attachment A.

Table 3. Hydrogen Concentration Limits for Risk-Based Packages During the Expected Shipping Window.

Package description	Normal-temperature limit (vol%)	Elevated-temperature limit (vol%)*
208 L (55-gal) drums in good condition known to contain 90-mil liners	16.5	14.0
208 L (55-gal) drums in poor condition and/or without 90-mil liners	11.6	9.1
General risk-based packages other than 208 L (55-gal) drums	15.0	12.5
**Applies to packages that (a) have been exposed to solar insolation for longer than 30 minutes immediately prior to handling for transport and/or (b) will be exposed to solar insolation for longer than 30 minutes during transport.		

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ATTACHMENT A – JUSTIFICATION FOR ELEVATED HYDROGEN LIMIT FOR RISK BASED PACKAGES

A.1 Introduction

This paper was developed from a survey of hydrogen deflagration and detonation literature from multiple sources. Its purpose is to provide a technical basis for increasing the hydrogen concentration limit in risk-based packages above the U.S. Nuclear Regulatory Commission (NRC) guidance of 5 vol% as given in NUREG-1609, *Standard Review Plan for Transportation Packages for Radioactive Material*, and in Information Notice 84-72, *Clarification of Conditions for Waste Shipments Subject to Hydrogen Gas Generation* (NRC 1984).

The discussion herein is applicable to risk-based packages only. The 5-vol% hydrogen limit is stated in Chapter 6 of this document. For this paper, "deflagration" refers to a simple burn event without a substantial shock wave, and "detonation" refers to a more energetic explosive event with a significant shock wave that can induce structural damage to the package or its contents. The point at which the hydrogen-oxygen reaction achieves detonation status is termed the deflagration-to-detonation transition (DDT). The DDT for an enclosed hydrogen-air mix occurs over a range of hydrogen concentrations dependent upon ignition source energy, container geometry, and temperature.

A.1.1 Philosophy for Risk-Based Packages

This paper adopts the philosophy that risk mitigation for hydrogen accumulation should focus on preventing detonation rather than deflagration. Deflagration presents a minimal risk to package integrity while detonation provides the true challenge to the containment boundary.

In the case of packages for which a limited degree of risk is to be accepted and which are the focus of this paper, it is the risk of detonation rather than deflagration that needs to be mitigated. As discussed in subsequent sections, explosive detonation of an enriched hydrogen-air mixture results in a supersonic flame front and accompanying large-magnitude pressure pulse. Deflagration, on the other hand, is a relatively weak combustion event that occurs at reduced hydrogen concentrations and produces minimal pressure increases. Deflagration is not accompanied by the supersonic flame front and high-pressure pulse of detonation. In actuality, most, if not all, waste packages could be shown structurally capable of withstanding a deflagration. Conversely, detonation of a hydrogen-rich mixture presents a structural challenge to all but the most robust packages.

A.2 Discussion

A survey of experimental studies pertaining to hydrogen-air deflagration and detonation provides a sizeable and generally consistent database from which a risk-based allowable hydrogen concentration limit can be judiciously derived. Not all of the relevant documents are specific to the waste packaging and transportation segment of the nuclear industry. Several studies were performed in support of the commercial nuclear industry to identify hydrogen deflagration and explosion risks following a loss-of-coolant accident at a nuclear reactor installation.

The following subsections summarize the applicable results of the studies cited in the reference section of this attachment. The study results are then compared and utilized to specify a hydrogen concentration limit greater than 5 vol% that can be justifiably considered to provide risk mitigation for risk-based packages.

A.2.1 Hydrogen Flammability and Detonability Data from Literature

The lower flammability limit (LFL) of hydrogen in air is well documented. The *Handbook of Chemistry and Physics* (CRC 1982); Bureau of Mines Bulletin No. 503, *Limits of Flammability of Gases and Vapors* (Coward and Jones 1952); and Bureau of Mines Bulletin No. 627, *Flammability of Characteristics of Combustible Gases and Vapors* (Zabetakis 1965), are examples of multiple references that give the LFL of hydrogen at 4 vol% in air. The following passage from Zabetakis (1965) regarding deflagration and detonation processes is worth quoting.

> *"Once a flammable mixture is ignited, the resulting flame, if not extinguished, will either attach itself to the ignition source or propagate from it. If it propagates from the source, the propagation rate will be either subsonic (deflagration) or supersonic (detonation) relative to the unburned gas. If it is subsonic, the pressure will equalize at the speed of sound throughout the enclosure in which combustion is taking place so that the pressure drop across the flame (reaction) front will be relatively small. If the rate is supersonic, the rate of pressure equalization will be less than the propagation rate and there will be an appreciable pressure drop across the flame front. Moreover, with most combustible-air mixtures, at ordinary temperatures, the ratio of the peak-to-initial pressure within the enclosure will seldom exceed about 8:1 in the former, but may be more than 40:1 in the latter case. The pressure buildup is especially great when detonation follows a large pressure rise due to deflagration. The distance required for a deflagration to transit to a detonation depends on the flammable mixture, temperature, pressure, the enclosure, and the ignition source. With a sufficiently powerful ignition source, detonation may occur immediately upon ignition, even in the open. However, <u>the ignition energy required to initiate a detonation is usually many orders of magnitude greater than that required to initiate a deflagration.</u>"*
> [Underlining added for emphasis.]

This excerpt provides a clear definition of deflagration (subsonic flame front propagation) versus detonation (supersonic propagation). An approximate quantification of the propagation velocity differences is provided in AIChE Monograph Series No. 10, *Fundamentals of Fire and Explosion* (Stull 1977), which states that the velocity of the detonation front in a given fuel-air mixture is at least 1,000 times greater than the deflagration velocity.

The Zabetakis (1965) excerpt further approximates the relative pressure pulse magnitude created by deflagration versus detonation and qualitatively discusses the relative quantities of ignition energy required to initiate each. Independent test studies in which ignition source strength was investigated show that ignition source strength is a factor in creating detonation, particularly with lean mixtures. As the mixture richens, it becomes more likely for a deflagration event to transition into a detonation.

Controlled laboratory conditions are required to sustain combustion at the LFL. Under the flammability and detonation test conditions of AI-73-29, *Flame and Detonation Initiation and Propagation in Various Hydrogen-Air Mixtures With and Without Water Spray*, a 5-vol% hydrogen-air mix was not ignitable even with a well established flame as the ignition source. Stull (1977) notes that hydrogen-air flame propagation occurs in the upward direction only (i.e., the flame will not propagate downward below the ignition source) between the 4-vol% LFL and about 15 vol%. The 5-vol% hydrogen concentration limit guidance of NRC (1984) and NUREG-1609 is clearly conservative and appropriate for performance-based packages in which flammability is to be absolutely precluded.

Loss Prevention in the Process Industries: Hazard Identification, Assessment, and Control (Lees 1996) gives a lower detonation limit (LDL) of 18.3 vol% for a hydrogen-air mixture in a confined tube. This information is a useful starting point for evaluating hydrogen concentration limits for risk-based packages. A prudent approach for general risk-based packages requires further examination of DDT data from additional studies that address a variety of test configurations. The following sections provide this discussion.

A.2.2 Explosion Testing of Waste Drums

Two testing studies specifically addressed hydrogen deflagration and explosion in 208 L (55-gal) waste drums. In both studies, the drums were in essentially like-new condition and were fitted with lidded 90-mil polyethylene (poly) liners. Hydrogen was injected into the liner void volume to create the desired hydrogen-air mixture. These studies are discussed in turn below.

A.2.2.1 Idaho Falls Drum Testing (RHB-387-83)

Drum explosion testing at Idaho Falls (RHB-387-83, *Gas Generation Studies: Year-End Report, FY '83*) utilized varying hydrogen-air mixtures in sealed drums that were pressurized to 69 kPa gage (10 psig) prior to ignition. Two ignition sources were used. These were a "soft spark" consisting of high voltage applied to an automotive-type spark plug and a "hard spark" comprised of a small electrochemical explosive called a squib, similar to a small firecracker. The soft spark deposited approximately 20 mJ of energy in the gas mixture while the hard spark introduced approximately 5 J. The 5 J ignition source was 250 times more energetic than the 20 mJ source.

EG&G Idaho, Inc. (EG&G), tested mixtures containing 6-, 11-, 14-, and 30-vol% hydrogen. All four mixtures were tested using the soft spark ignition source while only the 14- and 30-vol% mixtures were tested with the hard spark source. Regardless of ignition source strength, drum lids remained in place for the 6-, 11-, and 14-vol% mixtures. At 30-vol% hydrogen, drum lids were blown off and burning contents ejected with both the soft and hard spark ignition sources.

By definition, detonation is indicated by the presence of a supersonic flame front. In the absence of flame front velocity measurements, dP/dt and peak pressure data can assist in approximating the approach to detonation, or DDT. Neither of these parameters was measured in the EG&G testing. Therefore, it is not possible to estimate whether which, if any, of the tests approached or surpassed the detonation point. Nonetheless, given that a 30-vol% hydrogen-air mixture contains a stoichiometric 2:1 ratio of hydrogen and oxygen and that the drum lids were blown off at 30-vol% hydrogen, it is safe to assume that detonation occurred in these drums. Conversely, a mixture containing 14-vol% hydrogen is lean and would not be expected to propagate a detonation except at elevated temperature and/or a highly energetic ignition source.

Attempts were also made to ignite drums containing 30-vol% hydrogen with a 3.7 m (12-ft) drop and by puncturing with a sharpened drill bit. Both tests failed to ignite the hydrogen-air mixture.

With respect to packaging, the RHB-387-83 testing indicates the following.

- 208 L (55-gal) drums in good condition and containing 90-mil poly liners can withstand deflagrations at least as high as 14-vol% hydrogen regardless of whether the ignition source is low or high energy. If hydrogen concentration had been increased incrementally rather than jumping from 14 vol% to 30 vol%, the lid ejection point may have been more closely defined.

- Given that drum lids were not blown off at 14-vol% hydrogen and assuming that a detonation would have blown the lids free, it is probable that detonation did not occur at 14-vol% hydrogen.

- A 30-vol% hydrogen-air mixture is definitely not safe for waste drums. It is highly probable that detonation did occur in drums containing 30-vol% hydrogen.

  - Mechanical events impinging on the drum exterior, such as puncture or drop, do not appear likely to result in explosion and breach of containment even for stoichiometric hydrogen-air mixtures. However, the EG&G drums did not contain any loose debris, metallic or otherwise, that could have created internal sparking when jarred. Therefore, this test result has limited applicability to waste drums.

A.2.2.2 Savannah River Drum Testing (WSRC-TR-90-165)

Drum testing was later performed at the Savannah River Site and documented in WSRC-TR-90-165, *Transuranic Drum Hydrogen Explosion Tests (U)*. Unlike RHB-387-83, the drums were under atmospheric pressure at the time of ignition. The drum lids contained NucFil[1] vents that were initially plugged while hydrogen was injected to the desired concentration, then unplugged immediately prior to the explosion test to determine the effectiveness of vents for relieving the pressure pulse of deflagration or detonation. The ignition source was a Nichrome[2] wire heated by electrical current. No data is given on the strength of the ignition source other than to state that the length of the Nichrome wire had to be shortened from 11.3 cm (4.5 in.) to about 7.6 cm (3 in.) in order to generate sufficient heat by electrical resistance.

Upon ignition, WSRD-TR-90-165 documented that drums containing up to 16.5-vol% hydrogen-air bulged, but did not lose their lids. Conversely, ignition of mixtures containing 16.9-vol% hydrogen and above did cause the drum lids to be blown free. The 16.5-vol% maximum hydrogen concentration at which drum lids were retained is approximately consistent with the 14-vol% value from RHB-387-83 despite the fact that the EG&G drums were fully plugged and pressurized to 69 kPa gage (10 psig) at the time of ignition. The small (2 cm [0.75-in.]) low-flow NucFil vents, which are designed to mitigate gradual pressure buildup rather than sudden pressure spikes, appear to have relieved very little of the shock wave pressure.

In addition to explosion testing of drums to identify hydrogen concentrations at which the lids blew off, WSRC-TR-90-165 documented peak pressure and pressure rise data in a test vessel. Mixing in hydrogen-air mixtures was also studied. The outcome of these additional investigations is as follows.

- *Pressure Data.* The rate of pressure increase (dP/dt) and the peak explosion pressure were measured for various mixtures within an instrumented 1.7 L Nixon reactor (pressure vessel) fitted with a Nichrome wire ignition source 6.4 cm (2.5 in.) long. Table A-1 and Figures 1 and 2, compiled from WSRC-TR-90-165, show the Nixon reactor test data. The maximum pressure data and the dP/dt data from the Nixon reactor each closely follow a smooth and predictable curve. Both the maximum pressure and dP/dt increase with hydrogen concentration and peak at around 40-vol% hydrogen, slightly over stoichiometric. Both parameters fall off above this point as the mixture becomes over-rich in hydrogen.

  Table A-1 and Figure 2 show that dP/dt increased by roughly an order of magnitude between 10- and 15-vol% hydrogen. The rapid increase of dP/dt between these two concentrations indicates the likelihood of approaching DDT above 15 vol%. The occurrence of a partially developed supersonic shock wave is likely at concentrations over 16.5-vol% hydrogen because the drum lids were blown free at 16.9 vol%.

[1]NucFil is a registered trademark of Nuclear Filter Technology, Inc., Lakewood, Colorado.
[2] Nichrome is a registered trademark of the Driver-Harris Wire Company, Harrison, New Jersey.

- *Hydrogen Mixing.* Quantities of hydrogen equivalent to 5 and 25 vol% were injected into an instrumented test drum containing air. Samples were drawn at approximately 20-minute intervals from the top, middle, and bottom sections of the test drum and were analyzed using gas chromatography. In both cases, the hydrogen and air were well mixed within a very short time—about 40 minutes for the 5- % hydrogen-air mixture and about 50 minutes for the 25-vol% hydrogen-air mix. Figure 3 contains a plot reproduced from WSRC-TR-90-165 showing these results. A commercial nuclear industry study of hydrogen mixing, performed under the auspices of the Electric Power Research Institute (EPRI) and cited in RHO-RE-SA-8, *Analysis of the Three Mile Island (TMI-2) Hydrogen Burn*, yielded similar results. The EPRI testing utilized a cylindrical test vessel 10.7 m (35 ft) high and 7.6 m (25 ft) in diameter, significantly larger than a waste package. The hydrogen concentration in the test vessel approached uniformity within a fraction of a percent after only a few minutes. Significant long-term hydrogen concentration gradients did not exist.

The WSRC-TR-90-165 hydrogen mixing results, along with the EPRI data cited in RHO-RE-SA-8, indicate that credit should not be taken for hydrogen stratification when performing hydrogen generation and diffusion analyses. Diffusional and natural convective forces overcome buoyant forces in closed vessels to favor uniform hydrogen concentrations, even in vessels of significant volume. This is predictable, given the high diffusive mobility of hydrogen in other gases as evidenced in tabulations of gas diffusion coefficients, such as Table 5.1-1 of *Diffusion Mass Transfer in Fluid Systems* (Cussler 1997).

Table A-1. Nixon Reactor Pressure Data.

vol% hydrogen	Initial pressure (psig)	Maximum pressure (psig)	dP/dt (psi/s)
5	0.77	1.8	0.1
10	1.63	45.3	368.8
15	2.59	78.9	4012
20	3.68	121.5	13039
25	4.9	186.4	30591.7
30	6.3	240	44132.3
35	7.92	253.5	51153.4
40	9.8	260.5	51780
45	12.03	268	49774
50	14.7	252	39994.9
30	6.3	236	46444
30	6.3	240.1	42188
15	2.59	76.8	3755
25	4.9	189.1	34051.1
5	0.77	20.5	229.2
10	1.63	45.3	329.8
20	3.68	119.8	13645
50	14.7	185	22784
47	13.04	263.6	46444
35	7.92	250.8	51102
45	12.03	258.3	47344
40	9.8	251.5	48346
5	0.77	1.5	0.1

Source: WSRC-TR-90-165, 1991, *Transuranic Drum Hydrogen Explosion Tests (U)*, Rev. 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Figure 1. Maximum Nixon Reactor Pressures
From WSRC-TR-90-165.

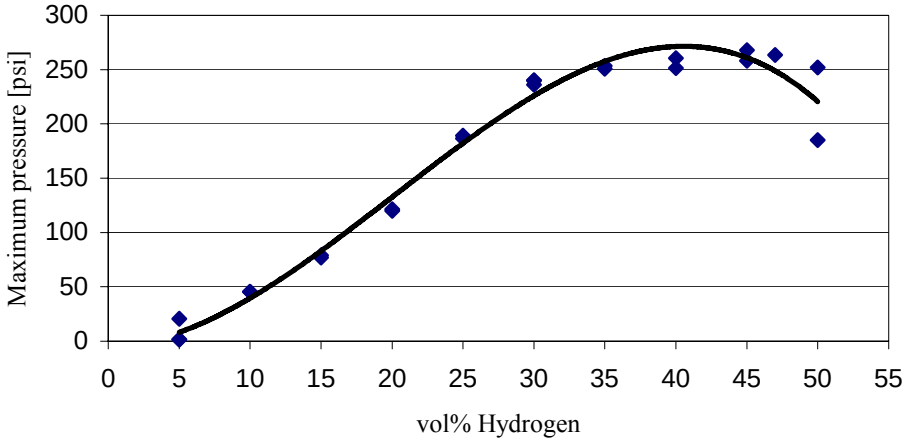


Figure 2. Nixon Reactor Pressure Rise Data
From WSRC-TR-90-165.

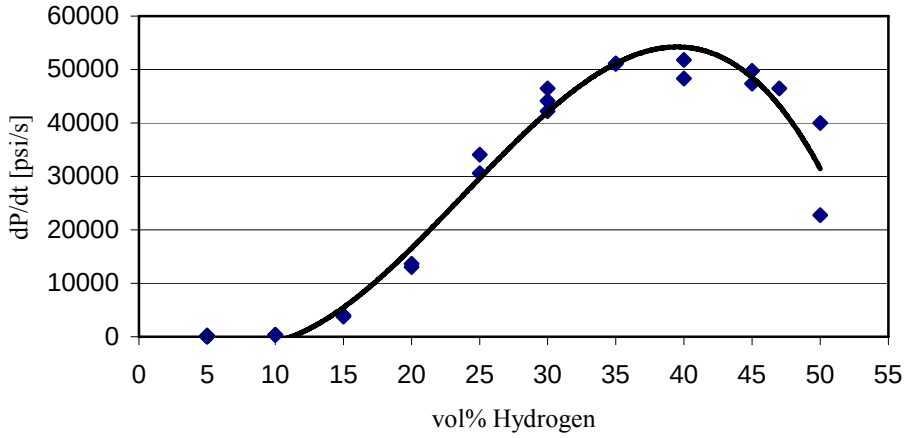
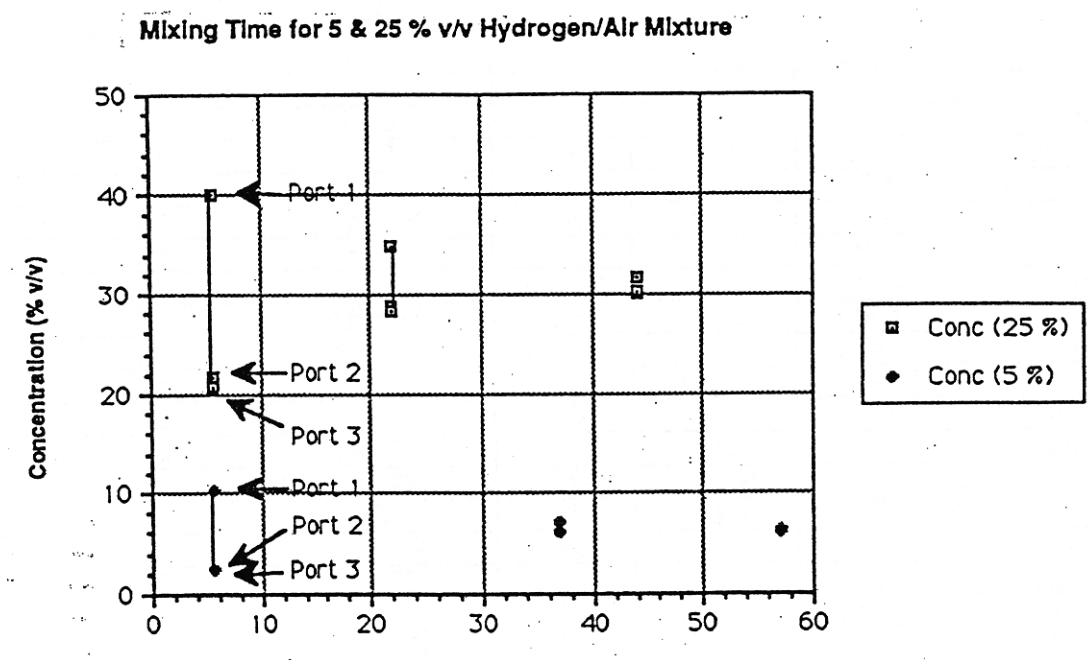


Figure 3. Hydrogen-Air Mixing Time Results From WSRC-TR-90-165.
(Port 1 = top; Port 2 = middle; Port 3 = bottom)



A.2.2.3 Comparison and Summary of Drum Explosion Studies

The drum explosion testing results of RHB-387-83 and WSRC-TR-90-165 are relatively consistent for predicting what range of hydrogen-air mixture concentrations will result in drum lid loss when ignited. RHB-387-83 indicates that the 208 L (55-gal) drum lids remain in place up to at least 14-vol% hydrogen, even with an initial 69 kPa gage (10 psig) internal load on the drum structure. RHB-387-83 did not examine any data points between 14 vol% and 30 vol%; hence, the hydrogen concentration at which the lids would have blown off was not precisely determined. The WSRC-TR-90-165 test results locate the critical hydrogen concentration for lid loss at between 16.5 vol% and 16.9 vol%.

RHB-387-83 and WSRC-TR-90-165 utilized like-new condition drums containing lidded 90-mil poly liners. The liners likely absorbed part of the deflagrative pressure spike and partially mitigated the effect on the steel drums themselves. Therefore, the applicability of these results to legacy drums in less-than-new condition and drums not fitted with liners is limited.

A.2.3 Commercial Nuclear Industry Hydrogen Detonation Studies

Three testing studies of hydrogen flammability and detonation in support of the commercial nuclear industry were reviewed during the compilation of this appendix. Dates of these studies range from 1973 to 1999. They are discussed below in order of publication date. The testing for all three studies was performed in long cylindrical detonation tubes.

A.2.3.1 Flame and Detonation Initiation and Propagation Study (AI-73-29)

AI-73-29 documents testing performed in an instrumented shock (detonation) tube 12.2 m (40 ft) long by 41 cm (16 in.) in diameter. Dry hydrogen-air and hydrogen-air-water spray mixtures were tested to simulate dry and wet containment atmospheres, respectively, following a nuclear reactor loss-of-coolant accident. The findings of the dry atmosphere testing involving hydrogen-air mixtures are applicable to waste packages.

Two ignition sources were used in the "driver end" of the shock tube. The first was a 0.050-in gapped automotive spark plug to which a 60-Hz high voltage was applied. The second was a "well-established" flame produced by igniting a 16-vol% hydrogen-enriched mixture in the driver end of the shock tube. Neither ignition source was quantified in terms of its energy. The enriched mixture was separated from the bulk shock tube atmosphere by a diaphragm designed to rupture when the enriched mixture was ignited by the spark plug, thus providing the well established flame ignition source for the bulk atmosphere in the shock tube.

As noted in Section 2.1, AI-73-29 did not report ignition at 5-vol% hydrogen even with the well established flame as an ignition source. Mixtures of 7-vol% and 9.3-vol% hydrogen were found to be ignitable with the well established flame, but were not ignitable with the spark plug alone. The ignition threshold with the spark plug was 11-vol% hydrogen.

AI-73-29 documented that dry hydrogen-air mixtures up to 16 vol% did not show signs of a detonation wave. The threshold for partial detonation propagation for dry (water-free) mixtures was found to be 18-vol% hydrogen, in good agreement with the 18.3-vol% LDL of hydrogen-air mixtures given in Lees (1996). AI-73-29 determined that the threshold for "well-established detonation propagation" in dry mixtures is 28-vol% hydrogen, nearly stoichiometric for a hydrogen-air mixture.

The findings in AI-73-29 with respect to packaging are as follows.

- A 5-vol% hydrogen-air mixture was not ignitable under the test conditions, even with an aggressive flame source.
- The ignition threshold with a spark source was 11-vol% hydrogen.
- Detonation did not occur at 16-vol% hydrogen, but did occur at 18 vol%. Therefore, the DDT threshold for this study lies between 16- and 18-vol% hydrogen.

A.2.3.2 Hydrogen-Air-Diluent Detonation Study (NUREG/CR-5525)

NUREG/CR-5525, *Deflagration to Detonation Transition Experiments with Hydrogen-Air Mixtures in Shock Tube and Obstacle Array Geometries*, used a heated detonation tube with a length of 13.1 m and a diameter of 0.43 m. The ignition source consisted of up to 110 g of du Pont Detasheet[3] plastic explosive. NUREG/CR-5525 does not quantify the energy of this ignition source, and information on Detasheet is not readily available. However, as a high explosive, it is quite likely the most powerful ignition source utilized by any of the hydrogen detonation studies covered in this document and can be assumed to bound any ignition sources that would be found within waste packages.

The tube was heated so that the temperature dependence of detonation could be studied. At 20 ºC and 1 atm absolute pressure, detonation did not occur in an 11.4- % hydrogen-air mixtures, but did occur at 11.6-vol% hydrogen. The detonable concentration was found to decrease with increasing temperature. At 100 ºC and 1 atm absolute pressure, NUREG/CR-5525 documented success in detonating a lean mixture containing 9.4-vol% hydrogen.

The findings in NUREG/CR-5525 relevant to packaging are as follows.

- Hydrogen-air mixtures up to 11.4-vol% hydrogen will not detonate at ambient temperatures (~20 ºC).
- With a sufficiently energetic ignition source, DDT may occur as low as 11.6-vol% hydrogen at 20 ºC.
- DDT hydrogen concentration drops as temperature increases. At 100 ºC, detonation may occur as low as 9.4-vol% hydrogen given a sufficiently energetic ignition source.

NUREG/CR-5525 is the only study reviewed for this paper that addressed detonation point temperature dependence for hydrogen-air mixtures.

A.2.3.3 DDT Experiments (FZKA 6355)

FZKA 6355, *Deflagration to Detonation Transition Experiments with Hydrogen-Air Mixtures in Shock Tube and Obstacle Array Geometries*, focused on collection of detailed DDT data to support the development of numerical modeling tools for the nuclear power industry. The test apparatus consisted of a shock tube 1.35 m in diameter. The tube was set up for fitment of interchangeable baffles to simulate obstacle arrays. FZKA 6355 measured critical pressure wave Mach numbers at the detonation threshold, the effects of tube obstruction on pressure wave propagation, and shock wave concentration and amplification effects produced by a reflecting cone placed at the end of

[3]Detasheet is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

the detonation tube. The limiting lean hydrogen-air mixture at which detonation successfully propagated was 13.5 vol%.

FZKA 6355 further found that in a closed volume, reflected detonation shock waves can trigger simultaneous secondary detonations in regions remote to the initial localized detonation flame front. This would be relevant to a package whose hydrogen concentration has increased well above the lean detonation threshold, such that the entire package atmosphere is "ripe" for an explosion. An event like this would likely result in a package breach unless the package had been designed to withstand a bounding detonation.

The relevant findings in FZKA 6355 for waste packages are as follows.

- DDT behavior for a given mixture and package is dependent on the size and geometry of the void volume.
- The DDT threshold for this study was found to be approximately 13.5-vol% hydrogen in air.
- Reflected shock waves from a localized detonation can trigger secondary detonations elsewhere in the package void volume, correspondingly increasing the explosive structural load on the package containment boundary.

A.3 Summary and Analysis of Hydrogen Detonation Data

Section 3.1 summarizes the hydrogen detonation data and key points taken from the studies and references discussed in this paper. Section 3.2 contains a brief statistical analysis of the hydrogen detonation data in support of setting hydrogen concentration limits for risk-based packages in Section 4.0, "Conclusions."

A.3.1 Summary of Data

Since the internal configuration of many waste packages is an unknown, it is not possible to completely rule out the incidental occurrence of ideal geometry supporting DDT in a given waste package. The two "ideal" geometries for closed vessel explosions are spherical and cylindrical based on their ability to propagate, reflect, and constructively reinforce a shock wave. Theoretical and empirical correlations exist to describe the physical process of detonation in each of these geometries, including pressure rise and peak pressure (Lees [1996] and Zabetakis [1965]). The testing studies reviewed in the compilation of this paper involve primarily cylindrical geometries. The empty waste drums tested in RHB-387-83 and WSRC-TR-90-165 are low aspect ratio right cylinders; i.e., a small length-to-diameter ratio. The detonation tubes of AI-73-29, NUREG/CR-5525, and FZKA 6355 involved longer horizontal cylinders with greater aspect ratios than drums. The exception was the instrumented Nixon reactor used in WSRC-

TR-90-165 at Savannah River, which consisted of a polyhedron roughly approximating a sphere.

Actual transport packages containing waste will generally have complex internal geometries that are likely to "break up" propagated shock waves rather than to cleanly reflect and reinforce said shock waves. Also, the annular volumes and irregular voids surrounding contained waste material will have greater surface area-to-volume ratios than equivalent spheres or cylinders of the same volume. Thus, a deflagration, once initiated, would face significantly greater quenching by heat loss to its surroundings and be more likely to "fizzle out" before it can propagate or grow into a detonation, assuming that the available hydrogen concentration would support such.

A reasonable estimate of the minimum DDT concentration in waste packages at ambient temperature (~20 ºC), given that waste package void volumes are very unlikely to approach ideal geometry, would be 10-vol% hydrogen. The shock wave from such a detonation would be weak although the shock wave intensity could be expected to increase rapidly with hydrogen concentration as indicated by the 10X increase in pressure rise (dP/dt) between 10-vol% and 15-vol% hydrogen reported in WSRC-TR-90-165 for the Savannah River drum testing.

Table A-2 summarizes the findings cited from the references discussed in Section 2 above. The range of information from the various studies cited herein provides a fairly complete and consistent picture of hydrogen deflagration and detonation behavior. The following bullets summarize the discussion points applicable to risk-based waste packages.

- The LFL of a hydrogen-air mixture given in literature is 4 vol% in air. A hydrogen flame will not propagate in the downward direction below about 15 vol%.

- It is difficult to ignite and sustain a hydrogen deflagration at concentrations of 5 vol% or less. Therefore, the guidance in NRC (1984) and NUREG 1609 is well founded for performance-based packages in which no level of deflagration is tolerable.

- A low-energy spark has a low probability of initiating deflagration in lean hydrogen-air mixtures. Conversely, a high-explosive ignition source produces its own shock wave and can result in detonation of mixtures that are significantly leaner than the 18.3-vol% LDL given in Lees (1996). NUREG/CR-5525 has shown that a combination of elevated temperature (~100 ºC) and energetic ignition source can reduce the detonable concentration to 9.4-vol% hydrogen. Thus, ignition source strength plays a major role in detonability of lean mixtures, and an energetic source increases the probability of detonation. Waste packages are unlikely to contain potentially energetic ignition sources.

  - Waste drum testing conducted at Idaho Falls (RHB-387-83) and at Savannah River (WSRC-TR-90-165) independently confirm that new-condition 208 L (55-gal) drums fitted with lidded 90-mil poly liners can withstand the combustion of mixtures as high as 16.5-vol% hydrogen without loss of drum integrity.

Table A-2. Summary of Hydrogen Detonation Data From Testing Studies.

Reference	Ignition conc.[a] [vol% H_2]	DDT threshold [vol% H_2]	H_2 stratification? [Yes/No]	Comments
RHB-387-83	na	> 14%[b]	na	Drums contained 90-mil poly liners; H_2-air test mixture was inside the liners. No data taken between 14 and 30 vol%. Drum lids were blown off at 30 vol%.
WSRC-TR-90-165	na	16.9% (2)	No	Drums contained 90-mil poly liners; H_2-air mixture was inside the liners. DDT threshold estimated based on 10X increase in dP/dt from 10 to 15 vol% H_2. Hydrogen-air mixing test performed in 208 L (55-gal) drum at 5- and 25-vol% hydrogen.
AI-73-29	7% w/ flame source; 11% w/ spark	18%	na	With well developed flame source, mixture did not ignite at 5%, but did ignite at 7-vol% H_2.
RHO-RE-SA-8	na	na	No	Electric Power Research Institute stratification testing performed in large vessel (10.7 m [35 ft] high x 7.6 m [25 ft] in diameter).
NUREG/CR-5525	na	11.6% @ 20 ºC; 9.4% @ 100 ºC	na	Detonation highly dependent on scale and geometry. Ignition source consisted of a small high-explosive charge.
FZKA 6355	na	13.5%	na	Detonation highly dependent on scale and geometry. Detonation at remote locations in closed volume by propagation of shock wave from initial detonation event; i.e., mixture can detonate in multiple locations.
Lees (1996)	na	18.3%	na	This reference is not a testing study, but is included here because the DDT threshold stated therein was based on testing performed elsewhere.

[a]Ignition concentration is the minimum concentration at which ignition was observed under the specific test conditions; not the same as lower flammability limit.
[b]DDT threshold for drum testing of RHB-387-83 and WSRC-TR-90-165 is indicated by loss of drum lids.

AI-73-29, 1973, *Flame and Detonation Initiation and Propagation in Various Hydrogen-Air Mixtures With and Without Water Spray*, Rev. 0, Atomics International Division, Rockwell International, Canoga Park, California.
FZKA 6355, 1999, *Deflagration to Detonation Transition Experiments with Hydrogen-Air Mixtures in Shock Tube and Obstacle Array Geometries*, Rev. 0, Forschungszentrum Karlsruhe, Institut für Kern- und Eneregietechnik, Karlsruhe, Germany.
NUREG/CR-5525, 1991, *Hydrogen-Air-Diluent Detonation Study for Nuclear Reactor Safety Analyses*, SAND89-2398, Rev. 3, Sandia National Laboratories, Albuquerque, New Mexico.
RHB-387-83, 1983, *Gas Generation Studies: Year-End Report, FY '83*, EG&G Idaho, Inc., Idaho Falls, Idaho.
RHO-RE-SA-8, 1982, *Analysis of the Three Mile Island (TMI-2) Hydrogen Burn*, Rev. 1, Rockwell Hanford Operations, Richland, Washington.
WSRC-TR-90-165, 1991, *Transuranic Drum Hydrogen Explosion Tests (U)*, Rev. 0, Westinghouse Savannah River Company, Aiken, South Carolina.
Lees, F. P., 1996, *Loss Prevention in the Process Industries: Hazard Identification, Assessment, and Control*, 2nd Edition, Butterworth-Heinemann, Boston, Massachusetts.

DDT = deflagration-to-detonation transition. na = not applicable or not tested.

- Detonation strength increases with hydrogen concentration up to about 40 vol%, then decreases as the mixture becomes excessively rich.

- Void volume geometry and scale affect the hydrogen concentration at which DDT occurs. The test studies reviewed herein (AI-73-29, NUREG/CR-5525, and FZKA 6355) address a very limited range of all possible combustion chamber geometries. Their test apparatus was purposefully designed to provide a controlled geometry in order to bound the processes of detonation initiation and propagation and to minimize the number of variables involved. The geometry of the void volume inside a typical waste package will likely be irregular and nonrepresentative of a DDT test chamber and will be less likely to reflect and reinforce the relatively weak shock waves of a fledgling deflagration. Quenching provided by the increased surface area-to-volume ratio that is characteristic of a typical waste container void volume will further inhibit detonation.

- Container temperature affects detonation point. Previous thermal analyses have shown that package temperatures can exceed 100 ºC under bounding Hanford summer conditions with direct solar insolation. Marginal containers, such as legacy drums, exposed to such conditions are at higher risk for a given hydrogen concentration.

A.3.2 Statistical Analysis of Data

Table A-3 shows a simple statistical analysis of hydrogen detonation concentration data from the six relevant sources cited in this paper. The 100 ºC data from NUREG/CR-5525 is not included because it pertains to elevated temperature, and data from the other sources is assumed to pertain to a similar ambient temperature. Although detonation did not occur in the 14-vol% hydrogen mixture of the EG&G study (RHB-387-83), this number is conservatively interpreted as a detonation data point for the purpose of Table A-3. Recall that the next highest concentration tested by EG&G was 30 vol%, which would not be appropriate to include in Table A-3.

The mean, median, and standard deviation of the data in Table A-3 were calculated using the respective statistical functions of Microsoft[4] Excel.[5] The standard deviation of 2.74 vol% is somewhat broad due to the relatively few data points under consideration and the wide range of testing conditions represented by this pool of data. Favorably, the variety of test conditions enhances the applicability of this data set to risk-based packages in general. If all data was collected for the same or a very similar set of test conditions, a tighter grouping would be expected along with a smaller standard deviation.

Note that the mean (15.38 vol%) and median (15.45 vol%) lie close to each other. Also note that the mean plus one standard deviation (15.38 + 2.74) equals 18.12 vol%, which is just below the maximum reported detonation concentration of 18.3 vol% (Lees 1996).

Because only one data point was recorded for an elevated temperature (NUREG/CR-5525), no statistical analysis is possible for detonation at elevated temperature.

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[4]Microsoft is a registered trademark of the Microsoft Corporation, Redmond, Washington.
[5]Excel is a registered trademark of the Microsoft Corporation, Redmond, Washington.

Finally, note that the statistical analysis presented in Table A-3 does not reflect probability of detonation relative to strength of ignition source. The test detonations observed at lower hydrogen concentrations were produced by highly energetic ignition sources that are unlikely to occur in risk-based waste packages considering that this document prohibits chemically reactive materials. Thus, the average detonation concentration of 15.38 vol% is conservative for risk-based packages in terms of qualitative probability.

Table A-3. Statistical Analysis of Hydrogen Detonation Data.

Reference	vol% hydrogen for detonation
RHB-387-83	14
WSRC-TR-90-165	16.9
AI-73-29	18
NUREG/CR-5525	11.6
FZKA 6355	13.5
Lees (1996)	18.3
Mean	15.38
Median	15.45
Standard deviation	2.74

AI-73-29, 1973, *Flame and Detonation Initiation and Propagation in Various Hydrogen-Air Mixtures With and Without Water Spray*, Rev. 0, Atomics International Division, Rockwell International, Canoga Park, California.

FZKA 6355, 1999, *Deflagration to Detonation Transition Experiments with Hydrogen-Air Mixtures in Shock Tube and Obstacle Array Geometries*, Rev. 0, Forschungszentrum Karlsruhe, Institut für Kern- und Eneregietechnik, Karlsruhe, Germany.

NUREG/CR-5525, 1991, *Hydrogen-Air-Diluent Detonation Study for Nuclear Reactor Safety Analyses*, SAND89-2398, Rev. 3, Sandia National Laboratories, Albuquerque, New Mexico.

RHB-387-83, 1983, *Gas Generation Studies: Year-End Report, FY '83*, EG&G Idaho, Inc., Idaho Falls, Idaho.

WSRC-TR-90-165, 1991, *Transuranic Drum Hydrogen Explosion Tests (U)*, Rev. 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Lees, F. P., 1996, *Loss Prevention in the Process Industries: Hazard Identification, Assessment, and Control*, 2nd Edition, Butterworth-Heinemann, Boston, Massachusetts.

A.4 Conclusions and Recommended Hydrogen Limits

This section recommends hydrogen concentration limits for risk-based packages based on the foregoing data presentation and discussion.

A.4.1 Correction for Elevated Temperature

The inverse temperature dependence of detonation concentration versus temperature demonstrated in NUREG/CR-5525 indicates that a two-tiered approach should be adopted when specifying hydrogen concentration limits. In this vein, a base concentration limit is specified for packages that have not been exposed to solar insolation for longer than 30 minutes and is hereafter referred to as the normal-temperature limit. Packages that have been in the sun for longer periods of time immediately prior to handling for transport or that will be exposed to solar insolation for longer than 30 minutes during transport are to be considered to be at elevated temperature and will have a correspondingly reduced hydrogen concentration limit. Given that the detonation concentration determined by NUREG/CR-5525 at 100 ºC was 2.2 vol% lower than at 20 ºC and because this is the only available data point specifically pertinent to elevated temperature, a subtraction of 2.5 vol% will conservatively be taken for all packages at elevated temperature. This will be subsequently referred to as the elevated-temperature limit.

A.4.2 Hydrogen Limits for Structurally Sound 208 L (55-Gal) Drums With 90-mil Liners

RHB-387-83 and WSRC-TR-90-165 specifically tested like-new 208 L (55-gal) drums containing 90-mil poly liners. These drums were empty except for the hydrogen-air mixture, and their void volumes thus represent a favorable cylindrical geometry for propagating a detonation. Given that actual waste drums will have an irregularly shaped void volume in most, if not all, cases, use of the upper bound of 16.5 vol% at which the drum lids remained in place is appropriate for drums at normal temperatures.

Subtracting the 2.5-vol% allowance for elevated temperature discussed in Section 4.1, 208 L (55-gal) drums in good condition and containing 90-mil liners should be limited to 14 vol% when they have been exposed to solar insolation for greater than 30 minutes.

A.4.3 Hydrogen Limits for 208 L (55-Gal) Drums in Poor Condition and/or Without Liners

The structural analysis in HNF-2209, *Safety Analysis Report for Packaging (Onsite) Steel Drum*, allows up to 0.76 cm (0.30 in.) of corrosion loss for 208 L (55-gal) drums in poor condition. A drum with this level of wall thinning will be considerably more fragile than its like-new counterpart, and the lid clamping device can be expected to have aged as well. Similarly, drums without liners will not have the energy-absorbing advantage of the 90-mil poly liner. For drums in this category, use of the lowest deflagration concentration from Table A-3 above is appropriate. Thus, 208 L (55-gal) drums in poor condition and/or having no internal liners should have a normal-temperature limit of 11.6-vol% hydrogen.

At elevated temperature, i.e., when exposed to direct sunlight for longer that one-half hour, drums in visibly marginal condition should be limited to 9.1 vol% to adequately mitigate the risk of hydrogen detonation. Note that this is slightly less than the NUREG/CR-5525 finding of detonation at 9.4-vol% hydrogen at elevated temperature.

A.4.4 Hydrogen Limits for General Packages Other Than 208 L (55-gal) Drums

For all other packages, including 322 L (85-gal) drums, a normal-temperature hydrogen limit of 15 vol% is recommended for conservatism. This is slightly below the average from Table A-3 and is recommended on the basis that no containers other that 208 L (55-gal) drums with liners have been specifically tested for resistance to hydrogen deflagration. The DDT thresholds reported in NUREG/CR-5525 and FZKA 6355 are both less than 15 vol%, but they also made use of highly energetic ignition sources as well as idealized test chamber geometries. The RHB-387-83 value of 14 vol% is also less, but this is not a DDT threshold; rather, it is the highest concentration at which detonation was not observed and, as such, does not indicate the actual level at which the EG&G drum lids would have been blown off.

Subtracting 2.5 vol% for elevated temperatures, general packages other than 208 L (55-gal) drums should be limited to 12.5 vol% if subjected to solar insolation for greater than 30 minutes.

A.4.5 Summary of Hydrogen Limit Recommendations

Table A-4 summarizes the recommended hydrogen concentration limits for risk-based packages as discussed above.

Table A-4. Recommended Hydrogen Limits for Risk-Based Packages.

Package description	Normal-temperature limit (vol%)	Elevated-temperature* limit (vol%)
208 L (55-gal) drums in good condition known to contain 90-mil liners	16.5	14.0
208 L (55-gal) drums in poor condition and/or without 90-mil liners	11.6	9.1
General risk-based packages other than 208 L (55-gal) drums	15.0	12.5

*Applies to packages that (a) have been exposed to solar insolation for longer than 30 minutes immediately prior to handling for transport and/or (b) will be exposed to solar insolation for longer than 30 minutes during transport.

A.5 References

AI-73-29, 1973, *Flame and Detonation Initiation and Propagation in Various Hydrogen-Air Mixtures With and Without Water Spray*, Rev. 0, Atomics International Division, Rockwell International, Canoga Park, California.

FZKA 6355, 1999, *Deflagration to Detonation Transition Experiments with Hydrogen-Air Mixtures in Shock Tube and Obstacle Array Geometries*, Rev. 0, Forschungszentrum Karlsruhe, Institut für Kern- und Eneregietechnik, Karlsruhe, Germany.

HNF-2209, 2004, *Safety Analysis Report for Packaging (Onsite) Steel Drum*, Rev. 1-A, Fluor Hanford, Inc., Richland, Washington.

NUREG-1609, 1999, *Standard Review Plan for Transportation Packages for Radioactive Material*, Spent Fuel Project Office, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG/CR-5525, 1991, *Hydrogen-Air-Diluent Detonation Study for Nuclear Reactor Safety Analyses*, SAND89-2398, Rev. 3, Sandia National Laboratories, Albuquerque, New Mexico.

RHB-387-83, 1983, *Gas Generation Studies: Year-End Report, FY '83*, EG&G Idaho, Inc., Idaho Falls, Idaho.

RHO-RE-SA-8, 1982, *Analysis of the Three Mile Island (TMI-2) Hydrogen Burn*, Rev. 1, Rockwell Hanford Operations, Richland, Washington.

WSRC-TR-90-165, 1991, *Transuranic Drum Hydrogen Explosion Tests (U)*, Rev. 0, Westinghouse Savannah River Company, Aiken, South Carolina.

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CRC, 1982, *Handbook of Chemistry and Physics*, 63rd Edition, CRC Press, Inc., Boca Raton, Florida.

Lees, F. P., 1996, *Loss Prevention in the Process Industries: Hazard Identification, Assessment, and Control*, 2nd Edition, Butterworth-Heinemann, Boston, Massachusetts.

NRC, 1984, *Clarification of Conditions for Waste Shipments Subject to Hydrogen Gas Generation*, Information Notice 84-72, U.S. Nuclear Regulatory Commission, Washington, D.C.

Stull, D. R., 1977, *Fundamentals of Fire and Explosion*, AIChE Monograph Series No. 10, Volume 73, American Institute of Chemical Engineers, New York, New York.

Zabetakis, M. G., 1965, *Flammability Characteristics of Combustible Gases and Vapors*, Bulletin 627, U.S. Bureau of Mines, Washington, D.C.

APPENDIX H

EXAMPLE CHECKLISTS

APPENDIX H – EXAMPLE CHECKLISTS

H.1 PURPOSE

This appendix contains examples of checklist used at the Hanford Site. The examples may be used as a starting point for developing checklists to be used when conducting onsite shipments. Additional examples of checklists may be found on the Hanford Internet at http://www2.rl.gov/rapidweb/phmc/transpack/index.cfm?PageNum=42.

The following example checklists are provided in this appendix.

- Hazardous Material/Waste Checklist - Highway Milkrun Shipments (1 page)
- Checklist for Radioactive Material By Highway (2 pages)
- Radioactive Mixed Waste Checklist (2 pages)
- Non-radioactive Hazardous Waste Checklist, Truck Freight (1162 Bldg. Review) (2 pages)
-

1 - Hazardous Material/Waste Checklist

Shipper:_____

1 over 1:_____

Shipment #:
Charge Code:

HAZARDOUS MATERIAL/WASTE CHECKLIST - HIGHWAY MILKRUN SHIPMENTS

PACKAGE (NOT SUBJECT TO ONE OVER ONE REVIEW)	YES	NO	N/A
1. No breaches in Containment			
2. No Excessive Paint chips or surface tears			
3. Closed Securely per manufacturer's instructions or procedures			
4. No rust or creases or bulges			
5. Correct package for the material shipped			
6. Overall construction satisfactory (See Reverse)			
7. If shipment shipped under an exemption check the following:			
8. Do you have a current copy of the exemption on file?			
9. Check expiration date on exemption. Is it current?			
10. Is exemption valid for the product being shipped in the package?			
11. A copy of exemption must accompany the shipment			
MARKING & LABELING (NOT SUBJECT TO ONE OVER ONE REVIEW)			
12. Shipper			
13. Receiver			
14. Word "Waste" marked in association with PSN (if required)			
15. Letters "RQ" marked in association with PSN (if required)			
16. Proper Shipping Name			
17. Identification Number			
18. N.O.S. constituents in parentheses			
19. Poison constituents in parentheses			
20. Hazardous substance in parentheses			
21. Primary label			
22. Subsidiary Label without Hazard Class			
23. Container Specification Marking			
24. Exemption Number on package			
25. Max. permissable gross wgt. of container (verify manufacturer's embossed marking)			
26. Gross weight, compare weight(s) to SWITS			
27. Orientation Arrows (combination packages of liquid)			

Rev. 2 01/18/00

2 - Checklist For Radioactive Material By Highway

Date:
RSR #:

Shipper:_____
1 over 1:_____

CHECKLIST FOR RADIOACTIVE MATERIAL BY HIGHWAY			
1. Charge code for billing			
2. Charge code for labor			
	Yes	No	N/A
3. RSR			
4. Other characterization documentation			
CHARACTERIZATION (SUBJECT TO ONE OVER ONE REVIEW)			
5. Is the material greater than 70 Bq per gram			
6. Does the material conform to any exceptions			
7. Is it specifically listed Uranium or Thorium			
8. Is it a RCRA waste			
9. Is it special form with certificate			
10. Material is fissile or fissile excepted			
11. If being shipped as "Empty", inernal smears done			
12. Is a RCRA waste (Note: cannot be shipped by air)			
13. Meets definition of other hazard class			
14. Radiation and contamination levels conform to PSN			
15. Class 7 calculations reviewed/attached			
16. CoC reviewed			
17. SARP reviewed if required			
18. Exemptions reviewed if applicable and current			
19. Full name and address of shipper			
20. Full name and address of receiver that is authorized with license on file			
21. Number of pages shown			
22. Word "Waste" if RCRA waste			
23. RQ in association with PSN			
22. Proper Shipping Name			
24. Uranium or Thorium specifically listed PSN (note: the words, "Radioactive Material" must be written in association with PSN. Be shown in conjunction with PSN)			
25. Emergency Response Guide number			
26. Emergency Response Phone number			
27. Hazard class and UN number			
28. Subsidiary hazard and packing group (optional)			
29. Physical and chemical form			
30. LSA or SCO group			
31. Number of packages, type, activity in Bq and T.I. for each package			
32. Name or symbol for radionuclides			
33. CoC number			
34. Note if the package is an overpack			
35. Category of label shown and correct for dose rates (Radioactive I, II, III)			
36. Exclusive Use Shipment			
37. Fissile excepted/Fissile material controlled shipment			
38. Package identification marks shown and copy of certificate included			

Date:
RSR #:

Shipper:_____
1 over 1:_____

CHECKLIST FOR RADIOACTIVE MATERIAL BY HIGHWAY			
SHIPPING PAPERS (SUBJECT TO ONE OVER ONE REVIEW)	**YES**	**NO**	**N/A**
39. Emergency contact number listed and guide number provided			
40. TID seal number listed			
41. Radiation survey completed and signed by HPT			
42. Signature of shipper			
43. One over one review completed			
PACKAGING (NOT SUBJECT TO ONE OVER ONE REVIEW)			
44. Packaging is correct for the material classification with manufacturer certification			
45. Packaging is in unimpaired condition			
46. Package closed per manufacturer instructions or appropriate procedure			
47. Exemption for package, is current, and covers the RAD material in			
MARKING & LABELING (NOT SUBJECT TO ONE OVER ONE REVIEW)			
48. Name and address of Shipper and Consignee/Receiver			
49. "Waste" and/or "RQ" marked in association with PSN.			
50. Proper Shipping Name			
51. ID #			
52. Excepted package statement in or on package or with shipping papers			
53. Primary and subsidiary labels applied near PSN. Two each on package			
54. Tamper seal affixed to package			
55. Orientation arrows (combination packages of liquids)			
56. "Type A" or "Type B" with trefoil marking on package			
57. Max. permissable gross wgt. of container (verify manufacturer's embossed marking)			
58. Gross Weight			
DRIVER & VEHICLE (NOT SUBJECT TO ONE OVER ONE REVIEW)			
59. Carrier Print: _____			
60. Vehicle number Print: _____			
61. Vehicle inspection date within 1 year of shipment Print: _____			
62. Vehicle tires meet tread requirements			
63. Hazardous material certificate of registration current			
64. Latest emergency response guidebook in vehicle			
65. Driver name Print: _____			
66. CDL with correct endorsements Expiration Date:			
67. DOT medical card Expiration Date:			
68. Load properly braced, shored and secured			
69. Vehicle placarded as required (Yellow-III/HRCQ/LSA Exclusive Use)			
70. All hazardous materials segregated as per Segregation Table			
70. POC and ONC notification made (provide shipping papers & applicable attachment)			

Rev. 3 05/24/00 T0005032.4

3 - Radioactive Mixed Waste Checklist

Shipper:_____

1 over 1:_____

RADIOACTIVE MIXED WASTE CHECKLIST			
UNIFORM HAZARDOUS WASTE MANIFEST (SUBJECT TO ONE OVER ONE REVIEW)	YES	NO	N/A
1. The consignee is authorized to receive the material			
2. Generator's US EPA ID #			
3. Manifest #			
4. Generator's name and address			
5. Transporter (1) Company name & EPA ID #			
6. Transporter (2) Company name & EPA ID #			
7. Designated facility name and site address			
8. Designated facility EPA ID #			
9. Transporter's phone numbers			
10. Designated facility phone number			
11. "RQ" or "X" in HM column (as required)			
12. Proper Shipping Name shown (*If Excepted Qty RAM **SEE SECTION BELOW)** - PSN/Hazard Class/ID #/PG (if subsidiary hazard) - RQ if hazardous substance			
13. The words "Radioactive Material" unless in proper shipping name (172.203(d)(1))			
14. Name or symbol of radionuclides			
15. Description of physical & chemical form, or special form			
16. The group for LSA-I-II-III and SCO-I-II			
17. The activity in Bq			
18. Type of radioactive material label (i.e., White I, Yellow II/III) identified?			
19. Transport index (TI) listed for each package			
20. If fissile shipment, the weight in grams or kilograms of fissile isotopes			
21. Fissile Controlled warning			
22. "Fissile Excepted"			
23. Is activity within limits for Type A: Type B:			
24. If Type B, is Certificate of Compliance number noted? Has CoC been checked for compliance with quantity or other restrictions and current?			
25. "Highway Route Controlled Quantity" in association with Basic Description?			
26. Subsidiary hazard listed (class/division)			
27. If HRCQ, Route Plan attached?			
28. Number of packages			
29. Type of packages			
30. Weight in Kg			
31. Waste codes listed			
32. Is emergency contact number noted?			
33. Seal number noted?			
34. Carrier possesses most current ERG guide			
35. Placarding noted			
36. "Exclusive Use Shipment", paperwork attached?			
37. Page # on manifest			
38. Generator signed and dated manifest			
39. Transporter (1) signed and dated manifest			
40. Transporter (2) signed and dated manifest			

Shipper:_____

1 over 1:_____

RADIOACTIVE MIXED WASTE CHECKLIST			
SOURCE DOCUMENT REVIEW (SUBJECT TO ONE OVER ONE REVIEW)	**YES**	**NO**	**N/A**
41. If a waste shipment review HWM, SWITS, 310 Report			
42. If not a Waste Review Bill of Lading, HMSR			
43. Does number and type of package match source documents?			
PACKAGING/MARKING/LOADING (NOT SUBJECT TO ONE OVER ONE REVIEW)			
44. Hazardous waste sticker with manifest #, PSN, Hazard Class, ID #, PG (if subsidiary hazard), waste codes, and RQ (if hazardous substance)			
45. Gross Weight (≥ 50 Kgs or 110 lbs)			
46. Gross Weight, compare weight(s) to SWITS			
47. Max. permissable gross wgt. of container (verify manufacturer's embossed marking)			
48. Type A or B noted, if applicable - Manufacturer or shipper certification			
49. Hazardous and subsidiary risk labels applied - 2 labels filled out correctly - Category of RAM label applied [ ] None [ ] White I [ ] Yellow II [ ] Yellow III			
50. Package free of damage & surveyed by HPT			
51. Certificate of Compliance number attached if Type B - Serial number - Radiation symbol			
52. Seal(s) attached			
53. Check external cask temperature (max. 122°F for LTL, 180° F for Ex Use)			
54. Vehicle given visual inspection			
55. Package secured in or on vehicle			
56. Vehicle placarded as required or orange panels or PCB marking			
57. If HRCQ or TL quantities of radioactive, has carrier had a Motor Carrier Evaluation?			
*** RADIOACTIVE EXCEPTED QTY (SUBJECT TO ONE OVER ONE REVIEW)**			
58. Use Non-Radioactive Hazardous Waste Checklist. "Limited quantity radioactive material" must appear on the shipping paper (or manifest) in association with the basic description			
DRIVER & VEHICLE (NOT SUBJECT TO ONE OVER ONE REVIEW)			
59. Carrier			
60. Vehicle Number			
61. Vehicle inspection date within 1 year of shipment			
62. Vehicle Tires meet Tread requirements			
63. Hazardous Material Certificate of Registration current			
64. Current Emergency Response Guidebook in vehicle			
65. Driver Name			
66. Current Commercial Driver License with proper endorsements and Physical Card			
67. Load properly braced, shored and secured			
68. Vehicle placarded as required or orange panels or PCB marking			
69. All Hazardous materials segregated as per Segregation Table			
70. POC and ONC notification made			

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4 - Non-Radioactive Hazardous Waste Checklist

Shipper:_____

1 over 1:_____

NON-RADIOACTIVE HAZARDOUS WASTE CHECKLIST TRUCK FREIGHT (1162 BLDG. REVIEW)			
UNIFORM HAZARDOUS WASTE MANIFEST (SUBJECT TO ONE OVER ONE REVIEW)	YES	NO	N/A
1. Generator's EPA ID #			
2. Manifest #			
3. Generator's name and address			
4. Transporter (1) Company name & EPA ID #			
5. Transporter (2) Company name & EPA ID #			
6. Designated facility name and site address			
7. Designated facility EPA ID #			
8. Transporter's phone numbers			
9. Designated facility phone number			
10. "RQ" or "X" in HM Column (as required)			
11. The word "Waste" for Federal Waste Codes			
12. Proper Shipping Name			
13. Hazard class or division number			
14. Identification Number			
15. Packing Group			
16. N.O.S. entries			
17. The word "Poison" (if required) (6.1 PG I or II) [as in 172.203(K) and (M)]			
18. Poison constituents (2.3, 6.1, PG I or II			
19. Hazardous substances			
20. Additional requirements in 172.203 (Poison Inhalation and Hazard Zone are shown)			
21. Exemption number (copy of exemption on file and with shipment, if required)			
22. Limited quantity			
23. Empty packages may be worded, "Residue last contained..."			
24. Number of packages			
25. Type of package (DM, CF, etc.)			
26. Weight listed (in kg or other vol.)			
27. Waste codes listed (when required)			
28. Emergency contact phone # (box (J) on manifest) including area code			
29. Does carrier posses most current ERG guide			
30. Vehicle placarded as required or orange panels or PCB marking			
31. Page numbers shown on manifest			
32. Generator signed and dated manifest			
33. Transporter (1) signed and dated manifest			
34. Transporter (2) signed and dated manifest			
SOURCE DOCUMENT REVIEW (SUBJECT TO ONE OVER ONE REVIEW)			
35. If a waste shipment review HWM, SWITS, 310 Report			
36. If not a Waste Review Bill of Lading, HMSR			
37. Does number and type of package match source documents?			

Shipper:_____

1 over 1:_____

NON-RADIOACTIVE HAZARDOUS WASTE CHECKLIST TRUCK FREIGHT (1162 BLDG. REVIEW)			
PACKAGING (NOT SUBJECT TO ONE OVER ONE REVIEW)	**YES**	**NO**	**N/A**
38. Authorized in Column 8 of 172.101 or 173.12			
39. No Damage			
40. If shipment shipped under an exemption check the following:			
41. Do you have a current copy of the exemption on file?			
42. Check expiration date on exemption			
43. Is exemption valid for the product being shipped in the package?			
44. A copy of exemption must accompany the shipment			
MARKING (NOT SUBJECT TO ONE OVER ONE REVIEW)			
45. Hazardous Waste Sticker with manifest #, PSN, ID # and waste codes (when required)			
46. Marked Inhalation Hazard (when required)			
47. Exemption packages marked with DOT-E #			
48. Address of shipper			
49. Combination packages of liquid marked with orientation arrows			
50. Labpack list attached to container (when required)			
51. Max. permissable gross wgt. of container (verify manufacturer's embossed makring)			
52. Gross weight, compare weight(s) to SWITS			
LABELING (NOT SUBJECT TO ONE OVER ONE REVIEW)			
53. Packages labeled with primary and secondary labels without number (as required)			
LOADING (NOT SUBJECT TO ONE OVER ONE REVIEW)			
54. Containers surveyed by 1100 Area HPT and PTR form signed off by 1100 Area HPT			
55. Segregation of hazardous materials (complies with segregation table 49 CFR 177.848)			
56. Vehicle is placarded (if required)			
57. Driver trained per DOT requirements (CDL with proper endorsements and medical card)			
58. Vehicle meets all requirements of the Federal Motor Carrier Safety Regulations (annual inspection current)			
59. Package secured in or on the vehicle			
60. If hazardous waste, has the carrier had a Motor Carrier Evaluation?(Possess EPA ID #)			
61. Has bulk container been tested within the required time limits and the container approved and properly tested			
DRIVER & VEHICLE (NOT SUBJECT TO ONE OVER ONE REVIEW)			
62. Carrier			
63. Vehicle Number			
64. Vehicle inspection date within 1 year of shipment			
65. Vehicle Tires meet Tread requirements			
66. Hazardous Material Certificate of Registration current			
67. Latest Emergency Response Guidebook in vehicle			
68. Driver Name			
69. Current Commercial Driver License with proper endorsements and Physical Card			
70. Load properly braced, shored and secured			
71. Vehicle placarded as required			
72. All Hazardous materials segregated as per segregation table			
73. POC and ONC notification made			

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APPENDIX I

SPECIAL PACKAGING AUTHORIZATIONS

APPENDIX I - SPECIAL PACKAGING AUTHORIZATIONS

I.1 SPECIAL PACKAGING AUTHORIZATION DEFINITIONS AND USAGE

TSD-evaluated Special Packaging Authorization (SPA) is a specific class of DOE pre-approved packages / packaging systems where the hazard and transportation safety analysis have been conducted and the results included in the TSD as the authorization basis document. SPAs are intended to eliminate the need and cost of conducting multiple One Time Requests for Shipment (OTRSs) for either similar shipments of low activity /high volume payloads, or high activity, high volume payloads where a Type B package is either unavailable or would be cost prohibitive to produce (e.g. SPAs are risk based). A SPA consists of specific payload(s) and authorized packages / packaging systems, and required Administrative and Engineered Controls. Changes to the SPA are not subject to evaluation and contractor approval under the USQ_T program.

To use a SPA, the shipper conducts an evaluation to ensure that his payload meets SPA requirements for use. If the payload meets the SPA criteria, the shipper then selects from the available authorized packages and controls. DOE- Field Office approval of each bounded shipment under a SPA is not required. Compliance to the SPA is documented by the appropriate TSD Evaluation Worksheet for each SPA. The SPA is intended to give the shipper greater flexibility in package and control selection. As the authorized SPAs are an integral part of the TSD, their payloads and configurations are promulgated by DOE-RL as part of the TSD. Use of the SPA does not relieve the shipper from the responsibility of meeting the requirements of the TSD.

The following SPAs are currently authorized:

Demolition Debris (DD)
Contaminated Equipment (CE)
Retrieval Packages (R)

Additional SPAs covering payloads such as Vitrification Plant Glass Logs may be developed and added to the TSD in the future if needed.

The basic general concept of these SPAs is that the payload to be shipped is contained in multiple packages or confinement layers sufficient to meet normal conditions of transport without failure. Additional layers of confinement are then added to the package to reduce the risk of releases under accident conditions that may be encountered onsite. The TSD defines containment and confinement as follows:

Confinement system means the assembly of components of the packaging intended to retain the Class 7 (radioactive) material intact during transport.

Containment system means the assembly of components of the packaging intended to prevent the leakage of all Class 7 (radioactive) material (including gases and liquids) during transport within the leakage rate limits specified in the TSD.

Each SPA is based on DOE approved safety analyses that establish the boundaries and limits of applicability. Shippers must ensure that the payloads shipped under a SPA meet the established requirements and limits. Completed checklists are to be retained and stored with the other shipping papers. The contractor may include additional information items and procedural requirement on the checklists used, as long as all the information required by this Appendix is also provided.

I.2 DD SPA – (DEMOLITION DEBRIS SPA)

The DD SPA is a packaging system consisting of a roll-off Industrial packaging Type 1 (IP-1) container and either another IP container or multiple layers of plastic liners sealed to prevent leakage of the contents. The system serves as an IP-2 equivalent packaging system. Open-top roll-off IP-1 containers are used extensively on the Hanford Site for the transport of Type A waste quantities of building debris from environmental remediation sites to final disposal facilities. Waste being transported under this SPA will meet the definition of Low Specific Activity-II (LSA-II) material per 49 CFR 173.403, "Definitions." Use of IP-1 containers to transport LSA-II material does not comply with U.S. Department of Transportation (DOT) regulations because Table 9 of 49 CFR 173.427, "Transport requirements for low specific activity (LSA) Class 7 (radioactive) materials and surface contaminated objects (SCO)" requires an IP-2 container for LSA-II material and these containers do not meet all of the IP-2 packaging requirements per 49 CFR 173.411, "Industrial Packagings." Therefore, the use of open-top roll-off containers for LSA-II material constitutes a risk based packaging as defined by DOE/RL-2001-36, *Hanford Sitewide Transportation Safety Document*. Changes to the DD SPA are not subject to evaluation and contractor approval under the USQ_T program.

Demolition debris consists of concrete with rebar, structural steel, and general building debris. Each DD SPA IP-1 roll-off container will be loaded with up to 5.6 m^3 (200 ft^3) or 9,072 kg (20,000 lb) of debris. Each load of debris is limited to 0.86 dose-equivalent curies (DE-Ci) of radioactive material. As shown in Appendix A to the 200 Area Building Debris OTRS, the worst-case classification of the payload is LSA-II.

DD SPA reusable roll-off IP-1 containers are open-top steel containers that meet the requirements for IP-1 packages under 49 CFR 173. The package will also be designed to meet the acceptance requirements at the receiving facility.

The use of the DD SPA for waste streams that are not the direct result of Decontamination and Decommissioning activities is not authorized. Use of this DD SPA is limited to debris from structures that have been decontaminated to the extent practicable prior to demolition.

Demolition Debris Special Packaging Authorization (SPA)
Table 1: Demolition Debris SPA Entry Bounding Requirements

Area	Bounding Value	Remarks
Structural	Meets the General Design Requirements of 49 CFR 173.410 and Type A (49CFR173.412)).	IP-1 containers constructed in accordance with 49 CFR 173.411 are satisfactory provided that the following elements from 49 CFR 173.412 for a Type A container are met. (a) 2. The packaging must incorporates a feature easily visible from the outside, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in closed transport vehicles in exclusive use, the cargo compartment, instead of the individual packages, may be sealed. (b) Confinement and shielding is maintained during transportation and storage over a temperature range of –33 ^{o}C (-27 ^{o}F) to 46 ^{o}C (115 ^{o}F). 2. The packaging must include a confinement system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. If the confinement system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package. 3. For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis. (e) Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield. 4. Failure of any tie-down attachment that is a structural part of the packaging, under normal conditions, must not impair the ability of the package to meet other requirements specified in the TSD.
Thermal	Meets the General Design Requirements of 49 CFR 173.410 and Type A (49CFR173.412)).	Containment and shielding is maintained during transportation and storage over a temperature range of –33 °C (–27 °F) and 46 °C (115 °F).
Shielding	Meets 49 CFR 173 requirements.	
Containment	Meets 49 CFR 173 requirements.	
Criticality	Payloads must be Fissile Excepted	
Gas Generation	Hydrogen gas concentration does not exceed 5% by volume in the sealed package over a period of	If venting is required and the shipment cannot be completed within the established shipping window, provisions shall be made before loading the package for venting and purging to reestablish a new shipping window before the original shipping window expires.

Demolition Debris Special Packaging Authorization (SPA)
Table 1: Demolition Debris SPA Entry Bounding Requirements

Area	Bounding Value	Remarks
	time twice that of the expected shipment time under normal operating conditions.	
(Maximum Payload Volume/Weight	A maximum of 5.625 m^3 (198.6 ft^3) and 9,072 kg (20,000 lb) of payload is allowed per container.	
Total Payload	0.86 DE-Ci	
Fissile Payload	Meets the requirements of 49 CFR 173.453	
Waste Heat	0.3 Watts	
Tie Down	Meets the requirements of 49 CFR 393, Subpart I	
Other Payload Restrictions / Prohibited Materials	No explosive materials No Free Liquids No spray-on Polyurea Foam liners No chemically inter-reactive components.	

Go to Tables 2 & 3

Demolition Debris Special Packaging Authorization (SPA) TABLE 2: SPA Authorized Packages & Administrative Controls Note: For Payloads of less than 1 A_2 the TSD allows shipments that meet DOT requirements		
0 DE-Ci < Payload < 0.50 DE-Ci Authorized Packages	0.50 DE-Ci < Payload < 0.86 DE-Ci Authorized Packages	**Payload> 0.86 DE-Ci**
1. Type B package 2. Type A package (or equivalent) + 1 confinement boundary 3. Open-top roll-off IP-1 containers with TARP+ 1 confinement boundary (may be another IP container or two plastic liners sealed in accordance with the DD SPA.	1. Type B package 2. Type A package (or equivalent) + 1 confinement boundary. 3. Open-top roll-off IP-1 containers with TARP+ 2 confinement boundaries (may be two IP containers or an IP container and two plastic liners sealed in accordance with the DD SPA.	Use of DD SPA not authorized.

Demolition Debris SPA: Authorized Packaging Configurations/ Administrative Controls

TABLE 3: Demolition Debris SPA Administrative Controls

0 DE-Ci < Payload < 0.5 DE-Ci	0.5 DE-Ci < Payload < 0.86 DE-Ci	Remarks
Maximum speed limited to 56 km/h (35 mi/h)	Maximum speed limited to 56 km/h (35 mi/h)	
Containers vented prior to shipment	Containers vented prior to shipment	
Chemically reactive contents not present	Chemically reactive contents not present	
Only one container is allowed per conveyance	Only one container is allowed per conveyance	
Roll-off container loading and transport may only occur at ambient temperatures of 38 °C (100 °F) or less.	Roll-off container loading and transport may only occur at ambient temperatures of 38 °C (100 °F) or less.	
Each roll-off container must be transported to the ERDF within 30 days of loading	Each roll-off container must be transported to the ERDF within 30 days of loading	
The DD will be loaded into the container in the following sequence:	The DD will be loaded into the container in the following sequence:	
1. Two liners are placed in the roll-off container. The liners are constructed of flame-resistant, black low-density polyethylene (LDPE) with a minimum thickness of 0.15 mm (6 mil), pre-formed with sealed interior corner seams. The liners are sized to fit inside the container and to allow overlapping closure and sealing of the maximum load after the liner is filled. The liner is sized such that when placed inside the empty container, the outside of the container is protected from spillage during loading operations.	1. Two liners are placed in the roll-off container. The liners are constructed of flame-resistant, black low-density polyethylene (LDPE) with a minimum thickness of 0.15 mm (6 mil), pre-formed with sealed interior corner seams. The liners are sized to fit inside the container and to allow overlapping closure and sealing of the maximum load after the liner is filled. The liner is sized such that when placed inside the empty container, the outside of the container is protected from spillage during loading operations.	
2. Six inches of clean soil is placed in the bottom of the liner.	2. Six inches of clean soil is placed in the bottom of the liner.	
3. The demolition debris is placed on top of the clean soil. Any exposed rebar is cut flush with the concrete, as required by acceptance criteria for the ERDF.	3. The demolition debris is placed on top of the clean soil. Any exposed rebar is cut flush with the concrete, as required by acceptance criteria for the ERDF.	
4. Six inches of clean soil is placed on top of the demolition debris.	4. Six inches of clean soil is placed on top of the demolition debris.	
5. Fixant is applied to the demolition debris.	5. Fixant is applied to the demolition debris.	
6. The liners are folded over the top of the payload and the seam sealed with a heat gun. If necessary, an extension rod is attached to the heat gun to reach the seam.	6. The liners are folded over the top of the payload and the seam sealed with a heat gun. If necessary, an extension rod is attached to the heat gun to reach the seam.	
A tarp is placed over the top of the roll-off container and secured such that it will remain in place under conditions experienced during normal transport. A schematic showing a cross-sectional view of the loaded container is shown in Figure 1	A tarp is placed over the top of the roll-off container and secured such that it will remain in place under conditions experienced during normal transport. A schematic	

of the 200 BD OTRS. The loaded container gross weight shall not exceed 18,099 kg (40,000 lb).

showing a cross-sectional view of the loaded container is shown in Figure 1 of the 200 BD OTRS. The loaded container gross weight shall not exceed 18,099 kg (40,000 lb).

Demolition Debris SPA: Authorized Packaging Configurations/ Administrative Controls

TABLE 3: Demolition Debris SPA Administrative Controls

The following controls and restrictions apply to the transport of demolition debris in open-top roll-off containers.

1. Payload is limited demolition debris consisting of concrete with rebar, structural steel, and general Demolition debris. The payload must be classified as LSA-II, or lower.

   - The container must be loaded as described in Section 3.0 of the 200 BD OTRS.

2. Fixatives will be used for demolition operations to control airborne radiological contamination. EarthBond[1], TerraBond[2], and Road Oyl[3] are the fixatives currently allowed by acceptance criteria for the ERDF. Based on a review of the compatibility of these fixatives with polyethylene, some of these fixatives contain ingredients that may degrade polyethylene at elevated temperatures over extended periods of time. To ensure that the fixatives do not degrade the roll-off container liners, the following restrictions are placed on container loading and transport: Substitute Fixatives other than those mentioned above are allowed provided that they do not result in generation of additional hazardous waste, do not react with other package contents and do not cause liner degradation within the temperature and time constraints. Permission to use Substitute Fixants will be obtained from DOE-RL, SED prior to loading of packages.

The following controls and restrictions apply to the transport of demolition debris in open-top roll-off containers.

1. Payload is limited demolition debris consisting of concrete with rebar, structural steel, and general Demolition debris. The payload must be classified as LSA-II, or lower.

   - The container must be loaded as described in Section 3.0 of the 200 BD OTRS.

2. Fixatives will be used for demolition operations to control airborne radiological contamination. EarthBond[4], TerraBond[5], and Road Oyl[6] are the fixatives currently allowed by acceptance criteria for the ERDF. Based on a review of the compatibility of these fixatives with polyethylene, some of these fixatives contain ingredients that may degrade polyethylene at elevated temperatures over extended periods of time. To ensure that the fixatives do not degrade the roll-off container liners, the following restrictions are placed on container loading and transport: Substitute Fixatives other than those mentioned above are allowed provided that they do not result in generation of additional hazardous waste, do not react with other package contents and do not cause liner degradation within the temperature and time constraints. Permission to use Substitute Fixants will be obtained from DOE-RL, SED prior to loading of packages.

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[1] EarthBond is a registered trademark of Roberts Consolidated Industries, Inc., Boca Raton, Florida.
[2] TerraBond is a registered trademark of Coastal Fluid Technologies, Inc., Lafayette, Louisiana.
[3] Road Oyl is a registered trademark of the Road Products Corporation, Knoxville, Tennessee.
[4] EarthBond is a registered trademark of Roberts Consolidated Industries, Inc., Boca Raton, Florida.
[5] TerraBond is a registered trademark of Coastal Fluid Technologies, Inc., Lafayette, Louisiana.
[6] Road Oyl is a registered trademark of the Road Products Corporation, Knoxville, Tennessee.

Demolition Debris SPA (DD SPA)Shipment Evaluation Checklist

Package or Shipment Number:

Required Packaging System Configuration

Enter Total payload DE-Ci inventory

Payload	Minimum Required Package
If total Payload is between 0 and 0.5 DE-Ci:	A minimum of a Type A package (or authorized equivalent) and + 1 confinement boundary.
If total Payload is between 0.5 and 0.86 DE-Ci:	A minimum of Two (2) Type A packages (or authorized equivalent) and + 1 confinement boundary.

Required Package Configuration

☐ A minimum of a Type A package (or authorized equivalent) and + 1 confinement boundary.

☐ A minimum of Two (2) Type A packages (or authorized equivalent) and + 1 confinement boundary.

Package Evaluation

Description of packaging system being used: (include description of packages used to meet containment / confinement requirements, Package Certification Data including material of construction, who and how certified.

Package Requirements	Yes	No	Remarks
Package meets DD SPA Structural Requirements	☐	☐	
Package meets DD SPA Thermal Requirements	☐	☐	
Package meets DD SPA Shielding Requirements	☐	☐	
Package meets DD SPA Containment Requirements	☐	☐	
Package meets DD SPA Tie Down / Load Restraint Requirements	☐	☐	

Copies of Package Tie Down / Restraint Plans will be provided to DOE Traffic Manager at least one week prior to shipping The DOE traffic manager will issue stop work if tie-down is unacceptable.

Payload Evaluation

Area	Limits	Yes	No	Remarks
Total Payload	<0.86 DE-Ci	☐	☐	
Fissile Payload	Fissile excepted	☐	☐	
Criticality	Fissile excepted	☐	☐	
Waste Heat	<0.3 Watts	☐	☐	
Gas Generation	< 5 Volume pct Flammable Gases	☐	☐	
	Flammable Gas Limit applies to time duration of loading and transportation activities until received at receipt facility. Inner package may be vented using HEPA filter.			
Prohibited Materials		☐	☐	

Administrative Controls

☐ Speed Restriction (35 MPH for Type B or equivalent package, 10 MPH for Type A or equivalent Package).

☐ Road Closure

Signed Organization Date:

I.3 CE SPA – (CONTAMINATED EQUIPMENT PACKAGES SPA)

The use of the Contaminated Equipment Packages Special Packaging Authorization (CE-SPA) is limited to packages meeting the requirements for Contaminated Equipment waste packages used to package and transport waste forms generated as a result of operation, demolition, repair and/or maintenance of DOE operated facility systems and components used to manage and contain nuclear materials or wastes. Contaminated Equipment Packages that do not meet, at a minimum, Type A (or equivalent) requirements will be, at a minimum, over packed. The shipper will be responsible for evaluating (and documenting) the shipping configuration for compliance to the SPA requirements. Changes to the CE-SPA are not subject to evaluation and contractor approval under the USQ_T program.

Specifically, a confinement boundary may be another Type A package (or equivalent, or higher), or multiple layers of flexible material at least 10 mils thick that has been placed around the package in a manner that the placement of the seams does not reduce the strength of the two layers and provides containment of the payload during transport. The flexible material must be sealed in such a manner that it allows maintenance of the containment boundary during handling and transportation activities. When flexible materials are used, the effects of softening and other types of loss of physical properties throughout the anticipated range of transportation environments (e.g. temperature, wind, and weather conditions) will have to be considered.

Contaminated Equipment Packages Special Packaging Authorization (CE SPA)
Table 1: CE SPA Entry Bounding Requirements

Area	Bounding Value	Remarks
Structural	Meets the General Design Requirements of 49 CFR 173.410 and Type A (49CFR173.412)).	IP-2 container constructed in accordance with 49 CFR 173.411 is satisfactory provided that the following elements 49 CFR 173.412 for a Type A container are met. (a) The outside of the packaging must incorporate a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in closed transport vehicles in exclusive use, the cargo compartment, instead of the individual packages, may be sealed. (b) Confinement and shielding is maintained during transportation and storage over a temperature range of –33 °C (–27 °F) and 46 °C (115 °F). (c) The packaging must include a confinement system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. If the confinement system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package. (d) For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis. (e) Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield. (f) Failure of any tie-down attachment that is a structural part of the packaging, under normal, must not impair the ability of the package to meet other requirements specified in the TSD.
Thermal	Meets the General Design Requirements of 49 CFR 173.410 and Type A (49CFR173.412)).	Temperature of the accessible external surfaces of the loaded package will not exceed 85 °C (185 °F) in an exclusive-use shipment. Containment and shielding is maintained during transportation and storage over a temperature range of –33 °C (–27 °F) and 46 °C (115 °F).
Shielding	Meets 49 CFR 173 requirements.	
Containment	Meets 49 CFR 173 requirements.	
Criticality	K_{eff} <0.95,	

Contaminated Equipment Packages Special Packaging Authorization (CE SPA)

Table 1: CE SPA Entry Bounding Requirements

Area	Bounding Value	Remarks
Gas Generation	Hydrogen gas concentration does not exceed 5% by volume in the sealed package over a period of time twice that of the expected shipment time under normal operating conditions.	If venting is required and the shipment cannot be completed within the established shipping window, provisions shall be made before loading the package for venting and purging to reestablish a new shipping window before the original shipping window expires.
Total Payload	<100 DE-Ci	
Fissile Payload	<325 FGEs	
Waste Heat	<50 Watts	
Tie Down	Meets the requirements of 49 CFR 393, Subpart I	
Other Payload Restrictions / Prohibited Materials	No explosive materials No Free Liquids No pressurized gas containers No spray-on Polyurea Foam liners No chemically inter-reactive components.	Items suspected of containing residual liquids shall be packaged with an approved absorbent capable of retaining at least two times the potential liquid volume.

Go to Tables 2 & 3

Contaminated Equipment Packages SPA: Authorized Packaging Configurations/ Administrative Controls

TABLE 2: CE SPA Authorized Packages & Administrative Controls

Note: For Payloads of less than 1 A_2 the TSD allows shipments that meet DOT requirements

0 DE-Ci < Payload < 50 DE-Ci		50 DE-Ci < Payload < 100 DE-Ci		
Authorized Packages	Preventive Administrative Controls (minimum of 2)	Authorized Packages	Preventive Administrative Controls (minimum of 2)	**Payload> 100 DE-Ci**
1. Type B package 2. Type A packages + 1 confinement boundary	Speed Restriction Route controls, or Rolling road closure Rail: Crossing Closure	1. Type B package 2. 2 Type A packages + 1 confinement boundary	Speed Restriction Route controls, and Rolling road closure Rail: Crossing Closure	Use of SPA not authorized.

Contaminated Equipment Packages SPA: Authorized Packaging Configurations/ Administrative Controls

TABLE 3: CE SPA Administrative Controls

0 DE-Ci < Payload < 50 DE-Ci	50 DE-Ci < Payload < 100 DE-Ci	Remarks
Speed Restriction Road transport: 35 mph for Type B package, 10 mph for Type A package, Rail: do not exceed 10 mph	Speed Restriction Road transport: 35 mph for Type B package, 10 mph for Type A package, Rail: do not exceed 10 mph	
Highway, Route control, rolling road closure Rail, Crossing Closure	Highway, Route control, rolling road closure Rail, Crossing Closure	Highway: Routes shall be planned and utilized to reduce interaction with other traffic, intersections closed for transition of shipment., Road closure to eliminate other traffic Rail: Highway crossing shall be closed for transition of shipment.
Contaminated Equipment (CE) to be decontaminated to the extent practicable prior to packaging	CE to be decontaminated to the extent practicable prior to packaging	
CE to be properly restrained within the packaging to prevent damage to confinement boundaries	CE to be properly restrained within the packaging to prevent damage to confinement boundaries	
No shipments during inclement weather, slick or icy conditions, or limited visibility	No shipments during inclement weather, slick or icy conditions, or limited visibility	
No shipment when temperatures are or are projected to be below maximum NDT of components relied on for confinement	No shipment when temperatures are or are projected to be below maximum NDT of components relied on for confinement	

Contaminated Equipment Packages SPA (CE SPA)Shipment Evaluation Checklist

Package or Shipment Number:

Required Packaging System Configuration

Enter Total payload DE-Ci inventory

Payload	Minimum Required Package
If total Payload is between 0 and 50 DE-Ci:	A minimum of a Type A package (or authorized equivalent) and + 1 confinement boundary.
If total Payload is between 50 and 100 DE-Ci:	A minimum of Two (2) Type A packages (or authorized equivalent) and + 1 confinement boundary.

Required Package Configuration

☐ A minimum of a Type A package (or authorized equivalent) and + 1 confinement boundary.

☐ A minimum of Two (2) Type A packages (or authorized equivalent) and + 1 confinement boundary.

Package Evaluation

Description of packaging system being used and method of transport: (include description of packages used to meet containment / confinement requirements, Package Certification Data including material of construction, who and how certified.

Package Requirements	Yes	No	Remarks
Package meets CE SPA Structural Requirements	☐	☐	
Package meets CE SPA Thermal Requirements	☐	☐	
Package meets CE SPA Shielding Requirements	☐	☐	
Package meets CE SPA Containment Requirements	☐	☐	
Package meets CE SPA Tie Down / Load Restraint Requirements	☐	☐	

Copies of Package Tie Down / Restraint Plans will be provided to DOE Traffic Manager at least one week prior to shipping The DOE traffic manager will issue stop work if tie-down or restraint is unacceptable.

Payload Evaluation

Area	Limits	Yes	No	Remarks
Total Payload	<100 DE-Ci	☐	☐	
Fissile Payload	<325 FGEs	☐	☐	
Criticality	K_{eff} <0.95	☐	☐	
Waste Heat	<50 Watts	☐	☐	
Gas Generation	< 5 Volume pct Flammable Gases	☐	☐	
	Flammable Gas Limit applies to time duration of loading and transportation activities until received at receipt facility. Inner package may be vented using HEPA filter.			
Prohibited Materials		☐	☐	

Administrative Controls

☐ Speed Restriction (35 MPH road for Type B or equivalent package, 10 MPH for Type A or equivalent Package: 10 MPH rail).

☐ Road Closure

Signed Organization Date:

I.4 R SPA - (RETRIEVAL PACKAGES SPA)

The use of the Retrieval Packages Special Packaging Authorization (R SPA) is limited to packages meeting the requirements for retrieved waste packages. Retrieval packages that do not meet, at a minimum, Type A (or equivalent) requirements will be, at a minimum, over packed. It is important to keep in mind that this SPA is a risk based packaging approach that allows shipment of payloads normally requiring a certified Type B package and a DOE Field Officer Manager approved transportation safety document (PSSD or equivalent). The shipper will be given flexibility in selecting the packaging components to meet the Type A package and confinement requirements and administrative controls. The shipper will be responsible for evaluating (and documenting) the shipping configuration for compliance to the SPA requirements. Changes to the R SPA are not subject to evaluation and contractor approval under the USQ_T program.

The basis for this SPA includes requiring multiple confinement layers. Specifically, a confinement boundary may be another Type A package (or equivalent, or higher), or multiple layers of flexible material at least 10 mils thick that has been placed around the package in a manner that the placement of the seams does not reduce the strength of the two layers. The flexible material must be sealed in such a manner that it allows maintenance of the confinement boundary during handling and transportation activities. When flexible materials are used, the effects of softening and other types of loss of physical properties throughout the anticipated range of transportation environments (e.g. temperature, wind, and weather conditions) will have to be considered.

Retrieval Packages Special Packaging Authorization (R SPA)
Table 1: R SPA Entry Bounding Requirements

Area	Bounding Value	Remarks
Structural	Meets the General Design Requirements of 49 CFR 173.410 and Type A (49CFR173.412)).	IP-2 container constructed in accordance with 49 CFR 173.411 is satisfactory provided that the following elements 49 CFR 173.412 for a Type A container are met. (a) The outside of the packaging must incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in closed transport vehicles in exclusive use, the cargo compartment, instead of the individual packages, may be sealed. (b) Confinement and shielding is maintained during transportation and storage over a temperature range of –33 °C (–27 °F) and 46 °C (115 °F). (c) The packaging must include a confinement system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. If the confinement system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package. (d) For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis. (e) Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield. (f) Failure of any tie-down attachment that is a structural part of the packaging, under normal, must not impair the ability of the package to meet other requirements specified in the TSD.
Thermal	Meets the General Design Requirements of 49 CFR 173.410 and Type A (49CFR173.412)).	Temperature of the accessible external surfaces of the loaded package will not exceed 85 °C (185 °F) in an exclusive-use shipment. Containment and shielding is maintained during transportation and storage in a temperature range of –33 °C (–27 °F) and 46 °C (115 °F).
Shielding	Meets 49 CFR 173 requirements.	
Containment	Meets 49 CFR 173 requirements.	
Criticality	K_{eff} <0.95,	

Retrieval Packages Special Packaging Authorization (R SPA)

Table 1: R SPA Entry Bounding Requirements

Area	Bounding Value	Remarks
Gas Generation	Hydrogen gas concentration does not exceed 5% by volume in the sealed package over a period of time twice that of the expected shipment time under normal operating conditions.	If venting is required and the shipment cannot be completed within the established shipping window, provisions shall be made before loading the package for venting and purging to reestablish a new shipping window before the original shipping window expires.
Total Payload	<100 DE-Ci	
Fissile Payload	<325 FGEs	
Waste Heat	<50 Watts	
Tie Down	Meets the requirements of 49 CFR 393, Subpart I	
Other Payload Restrictions / Prohibited Materials	No explosive materials No Free Liquids No spray-on Polyurea Foam liners No chemically inter-reactive components.	

Go to Tables 2 & 3

Retrieval Packages SPA: Authorized Packaging Configurations/ Administrative Controls
TABLE 2: R SPA Authorized Packages & Administrative Controls
Note: For Payloads of less than 1 A_2 the TSD allows shipments that meet DOT requirements

0 DE-Ci < Payload < 50 DE-Ci		50 DE-Ci < Payload < 100 DE-Ci		
Authorized Packages	Preventive Administrative Controls (minimum of 2)	Authorized Packages	Preventive Administrative Controls (minimum of 2)	**Payload> 100 DE-Ci**
1. Type B package 2. Type A packages + 1 confinement boundary	Speed Restriction Road Closure	1. Type B package 2. 2 Type A containers + 1 confinement boundary	Speed Restriction Road Closure	Use of SPA not authorized.

Retrieval Packages SPA: Authorized Packaging Configurations/ Administrative Controls
TABLE 3: R SPA Administrative Controls

0 DE-Ci < Payload < 50 DE-Ci	50 DE-Ci < Payload < 100 DE-Ci	Remarks

Retrieval Packages SPA (R SPA)Shipment Evaluation Checklist

Package or Shipment Number:

Required Packaging System Configuration

Enter Total number of payload DE-Ci

Payload	Minimum Required Package
If total Payload is between 0 and 50 DE-Ci:	A minimum of a Type A package (or authorized equivalent) and + 1 confinement boundary.
If total Payload is between 50 and 100 DE-Ci:	A minimum of Two (2) Type A packages (or authorized equivalent) and + 1 confinement boundary.

Required Package Configuration

☐ A minimum of a Type A package (or authorized equivalent) and + 1 confinement boundary.	A minimum of Two (2) Type A packages (or authorized equivalent) and + 1 confinement boundary.

Package Evaluation

Description of packaging system being used: (include description of packages used to meet containment / confinement requirements, Package Certification Data including material of construction, who and how certified.

Package Requirements	Yes	No	Remarks
Package meets R SPA Structural Requirements	☐	☐	
Package meets R SPA Thermal Requirements	☐	☐	
Package meets R SPA Shielding Requirements	☐	☐	
Package meets R SPA Containment Requirements	☐	☐	
Package meets R SPA Tie Down / Load Restraint Requirements	☐	☐	

Copies of Package Tie Down / Restraint Plans will be provided to DOE Traffic Manager at least one week prior to shipping The DOE traffic manager will issue stop work if tie-down or restraint is unacceptable.

Payload Evaluation

Area	Limits	Yes	No	Remarks
Total Payload	<100 DE-Ci	☐	☐	
Fissile Payload	<325 FGEs	☐	☐	
Criticality	K_{eff} <0.95	☐	☐	
Waste Heat	<50 Watts	☐	☐	
Gas Generation	< 5 Volume pct Flammable Gases	☐	☐	
	Flammable Gas Limit applies to time duration of loading and transportation activities until received at receipt facility. Inner package may be vented using HEPA filter.			
Prohibited Materials		☐	☐	

Administrative Controls

☐ Speed Restriction (35 MPH for Type B or equivalent package, 10 MPH for Type A or equivalent Package).

☐ Road Closure

Signed Organization Date: