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DISTRIBUTION SHEET

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Packaging Design Criteria for the Steel Waste Package

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200
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Abstract: This packaging design criteria provides the criteria for the design, fabrication, safety evaluation, and use of the steel waste package (SWP) to transport remote-handled waste and special-case waste from the 324 facility to Central Waste Complex (CWC) for interim storage.

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FIGURE

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LIST OF TERMS

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
Btu/ft^2	British thermal units per square foot
cal/cm^2	calories per square centimeter
Ci	curie
CWC	Central Waste Complex
DOT	U.S. Department of Transportation
dpm/cm^2	disintegrations per minute per square centimeter
ft	foot
HRCQ	highway route controlled quantity
in.	inch
kg	kilogram
kPa	kilopascal
m	meter
MPa	megapascal
mrem/h	millirem per hour
$\mu Ci/cm^2$	microcuries per square centimeter
NTC	normal transfer conditions
ppm	parts per million
psia	pounds per square inch, absolute
SARP	safety analysis report for packaging
SWDB	Steel Waste Disposal Box
SWP	Steel Waste Package

PACKAGING DESIGN CRITERIA FOR THE STEEL WASTE PACKAGE

1.0 INTRODUCTION

1.1 BACKGROUND

The Steel Waste Package (SWP) has been used to transport radioactive solid waste from the 324 Facility to the Central Waste Complex (CWC) using the configuration shown in Figure 1-1 as authorized per PNL-MA-651, *Safety Analysis Report for the Steel Waste Package* (PNL 1988d), and WHC-SD-TP-DA-004, *Addendum to the Safety Analysis Report for the Steel Waste Packaging* (Crow 1996). To expedite future waste transfers, there is a need to modify the package.

The SWP consists of a Rectangular Grout Container, Rectangular Overpack Disposal Container, 22-Ton Steel Waste Disposal Box (SWDB), SWDB Overpack, and 22-Ton SWDB Impact Limiter.

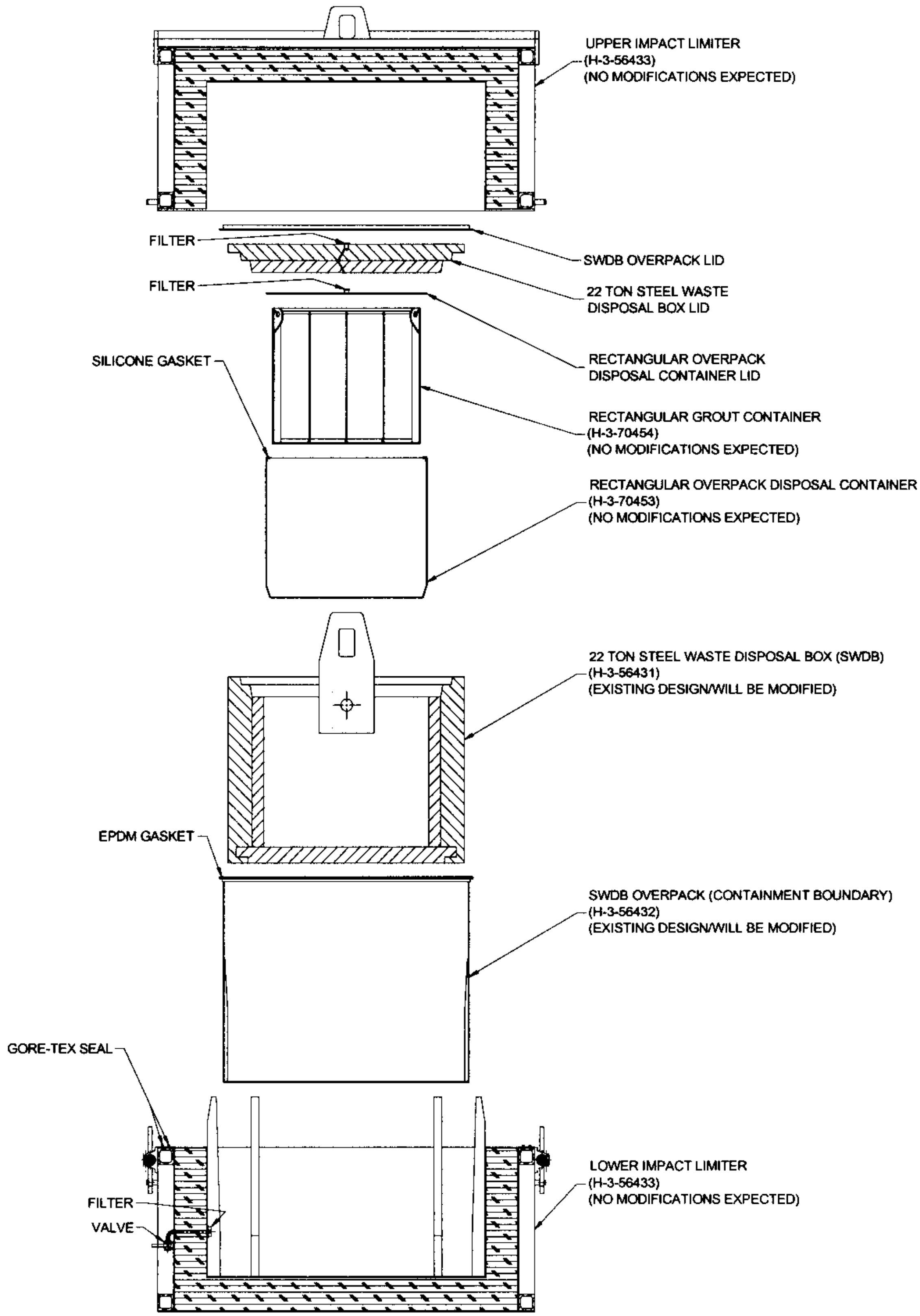
1.2 PURPOSE AND SCOPE

The purpose of this packaging design criteria is to provide criteria for the design, fabrication, safety evaluation, and use of a packaging system to transport remote-handled waste and special-case waste from the 324 Facility to CWC for interim storage. Although CWC is the primary destination, the safety analysis report for packaging (SARP) will authorize transportation to any site within the Hanford Site.

1.3 JUSTIFICATION

At present, there are no packaging systems available, which are economically and technically capable of transporting the waste to CWC within the constraints of the project requirements, based upon Performance Agreement milestones. Modification of the SWP is necessary to meet HNF-PRO-154, *Responsibilities and Procedures for all Hazardous Material Shipments*, requirements for onsite transport. The modifications will expedite handling and shipping operations.

Figure 1-1. Steel Waste Package Components.



2.0 PACKAGE CONTENTS

2.1 PHYSICAL DESCRIPTION

The contents of the SWP consist primarily of contaminated scrap equipment removed from B Cell of the 324 Facility: racks, tanks, pipes, hoses, valves, tank and pipe heel, filters, lead plugs from cell pipe penetrations, and dispersible material. Refer to HNF-2570, *324 Facility Special-Case Waste Assessment in Support of 324 Closure (TPA Milestone M-89-05)* (Hobart 1998), for more details.

2.2 RADIOLOGICAL COMPOSITION

The source term for the SWP is drawn from disposal records of dispersible material removed from the B Cell floor packed in engineered containers in February 1996. It is assumed that the relative amounts of the isotopes in the dispersible material are representative of the relative amounts of the isotopes in the waste to be transported from B Cell. The isotopes present are decayed to obtain equilibrium concentrations of the daughter products. The relative amounts, including the daughter products, are scaled to a 500,000 Ci inventory to obtain the nominal activities. Table 2-1 shows the expected radionuclide inventory. Isotopic ratios may vary; however, the total activity will not exceed 500,000 Ci. Maximum activities of ^{137}Cs and ^{90}Sr will be determined in the SARP and will be dependent upon decay heat limits and shielding requirements.

Table 2-1. Expected Steel Waste Package Radionuclide Inventory. (2 sheets total)

Isotope	Relative amount (%)[1]	Nominal activity (Ci)[2]	A_2 value	Inventory (A_2)
^{60}Co	5.36 E-4	2.68 E+0	1.08 E+1	2.48 E-1
^{90}Sr	1.77 E+1	8.83 E+4	2.70 E+0	3.27 E+4
^{90}Y+	1.77 E+1	8.83 E+4	Daughter	Daughter
^{137}Cs	3.32 E+1	1.66 E+5	1.35 E+1	1.23 E+4
^{137m}Ba+	3.14 E+1	1.57 E+5	Daughter	Daughter
^{154}Eu	2.26 E-2	1.13 E+2	1.35 E+1	8.37 E+0
^{234}U+	2.18 E-7	1.09 E-3	2.70 E-2	4.04 E-2
^{238}Pu	2.53 E-2	1.26 E+2	5.41 E-3	2.33 E+4
^{239}Pu	1.91 E-3	9.54 E+0	5.41 E-3	1.76 E+3
^{240}Pu	1.27 E-3	6.36 E+0	5.41 E-3	1.18 E+3
^{241}Am	3.51 E-2	1.75 E+2	5.41 E-3	3.23 E+4
Total	~ 100	5.00 E+5		1.20 E+5

Table 2-1. Expected Steel Waste Package Radionuclide Inventory. (2 sheets total)

Isotope	Relative amount (%)[1]	Nominal activity (Ci)[2]	A_2 value	Inventory (A_2)

[1]Data on the relative amounts obtained from PNL (1996a and 1996b) Engineered Containers of Dispersibles EC 014-017, 019, 021-025 per discussion with R. Hobart and B. Katayama, 9/11/98.
[2]A total nominal activity of 500,000 Ci is assumed (Mercado 1998).
+Daughter nuclide. Isotopes contributing less than 1 E-3 Ci are not shown.

Mercado, J. E., 1998, *Scoping Thermal and Shielding Evaluation for the 22½-Ton Box*, EBU-RPT-008, Rev. 0, Waste Management Federal Services, Inc., Northwest Operations, Richland, Washington.

PNL, 1996a, *Manifest 96004: Mixed Waste EC-14,15,17, Feed Cans 1-13&15 Shipped 3/6/96*, PNL-324-96-005, Pacific Northwest Laboratories, Richland, Washington.

PNL, 1996b, *Manifest 96006: Dispersible EC-16, 18, 19, 21, 22, 23, 24, and 25: 22.5 Ton Box Shipment 3/1/96*, PNL-324-96-012, Pacific Northwest Laboratories, Richland, Washington.

2.3 FISSILE CLASSIFICATION

Table 2-2 shows the nominal fissile inventory. The package may contain up to 200 g of fissile isotopes.

Table 2-2. Nominal Steel Waste Package Fissile Inventory.

Isotope	Nominal activity (Ci)	Nominal mass (g)
^{238}Pu	1.26 E+2	7.41 E+0
^{239}Pu	9.54 E+0	1.54 E+2
Total	1.36 E+2	1.61 E+2

Because the quantity of fissile material is greater than 15 g per package, this payload is not fissile excepted (49 CFR 173, "Shippers—General Requirements for Shipments and Packagings").

2.4 MIXED WASTE COMPOSITION

Steel from the structural pieces and equipment represents the bulk of the mass. The dispersible debris, tank heels, and sludge are assumed to contain cadmium (0.71 ppm), chromium (1.63 ppm), lead (24.1 ppm), and barium (1.34 ppm) as shown in Hobart (1998). Additionally, there may be some organic material in the form of plastic insulation from extension cords, rubber boots from manipulator arms, or other miscellaneous debris. No other chemical constituents are expected to be present.

2.5 TRANSPORTATION CLASSIFICATION

Based on the radiological inventory, the contents of the SWP are a Type B, fissile, highway route controlled quantity (HRCQ) per 49 CFR 173.403, "Definitions."

3.0 FACILITY OPERATIONS

3.1 ORIGINATING FACILITY—324 FACILITY

Loading of the SWP shall take place at the 324 Facility. Dispersible material may first be loaded into engineered containers (stainless steel pipe 25 cm [10 in.] in diameter by 152 cm [60 in.] long with end caps and a filter). If engineered containers are used, the engineered containers will be loaded into the Rectangular Grout Container (H-3-70454 [PNL 1993a]). If engineered containers are not used, the waste material will be loaded directly into the Rectangular Grout Container. No grout is to be used in either scenario.

The loaded Rectangular Grout Container exterior will be rinsed, as necessary, while still inside B Cell, transferred to the airlock, and loaded into the Rectangular Overpack Disposal Container (H-3-70453 [PNL 1993b]). The Rectangular Overpack Disposal Container will then be closed and loaded into the 22-Ton SWDB (H-3-56431 [PNL 1996c]). Next, the 22-Ton SWDB will be loaded into the 22-Ton SWDB Overpack (H-3-56432 [PNL 1988b]), which must already be placed inside the bottom of the 22-Ton SWDB Impact Limiter (H-3-56433 [PNL 1988a]), which is already secured to the 22-Ton SWDB Trailer (H-3-56435 [PNL 1988c]). Finally, the top of the impact limiter will be secured to the bottom.

Table 3-1 shows the 324 Facility cranes and how they will be used for the SWP.

Table 3-1. 324 Facility Cranes and Usage for the Steel Waste Package.

Crane	Location	Function
9.1 metric ton (10-ton)	B Cell	Move Rectangular Grout Container and contents (e.g., engineered containers, high-level vault filters, tank heels) from B Cell to air lock.
4.5 metric ton (5-ton)	Air lock	• Load Rectangular Grout Container and contents into Rectangular Overpack Disposal Container. • Put lid on Rectangular Overpack Disposal Container. • Load Rectangular Overpack Disposal Container and contents into Steel Waste Disposal Box (SWDB) using Rectangular Disposal Container Spreader Beam (maximum working load 4.5 metric tons [5 tons]). • Put lid on SWDB.
27.2 metric ton (30-ton)	Cask handling area/truck-lock	• Move SWDB and contents from cask handling area to truck-lock. • Load SWDB into SWDB Overpack using 22-Ton Steel Waste Disposal Box Lifting Yoke (maximum working load 27.2 metric tons [30 tons]). • Put lid on SWDB Overpack.

The package shall be secured to the transfer vehicle before leaving the truck-lock. The exterior package contamination limits must be met, as shown in Table 3-2, prior to transportation. Limited modifications of the loading area may be necessary to improve the loading and package-handling capabilities of the 324 Facility. The impact limiter top shall be secured before the package leaves the 324 Facility.

Table 3-2. External Cask Contamination Limits.

Contaminant	Maximum permissible limits	
	$\mu Ci/cm^2$	dpm/cm^2
Beta- and gamma-emitting radionuclides and alpha emitters with half-lives less than 10 days; natural uranium; depleted uranium; natural thorium; uranium-235, uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical concentrates	10^{-5}	22
All other alpha-emitting radionuclides	10^{-6}	2.2

Source: 49 CFR 173, "Shippers—General Requirements for Shipments and Packagings," 173.443, "Contamination control," *Code of Federal Regulations*, as amended.

3.2 DESTINATION FACILITY—CWC

Off-loading of the SWP is expected to take place at CWC in the 200 West Area. First, the upper half of the 22-Ton SWDB Impact Limiter will be removed. Then the SWDB Overpack lid will be removed. Finally, the 22-Ton SWDB will be lifted directly out of the SWDB Overpack for offloading at CWC. The SWDB will be passively vented.

4.0 PACKAGING/TRANSPORT SYSTEM DESIGN

4.1 GENERAL

The packaging shall be approved for use within the boundaries of the Hanford Site. It will be authorized to transfer Type B, HRCQ of fissile remote-handled mixed waste and special-case waste in the form of structural members, various process equipment and related components (including piping and valves). A SARP shall be written to demonstrate the safety of the transfer by package performance and administrative controls. The SARP will include the evaluation of the packaging system to provide containment, shielding, and subcriticality for the payload during normal and accident conditions. The packaging and transportation shall be performed in accordance with HNF-PRO-154. Approval of the SARP provides authorization for onsite transport.

4.2 STEEL WASTE PACKAGE

4.2.1 General Description

The SWP shall be designed as a reusable system capable of being loaded inside the 324 Facility. Waste material will be loaded into engineered containers or a Rectangular Grout Container inside B Cell. These waste-loaded containers will then be moved into the airlock and placed into the Rectangular Overpack Disposal Container and SWDB, which will then be sealed and decontaminated, as necessary, prior to loading into the overpack and impact limiter. The package will be secured to the trailer within the 324 Facility. The package will be top loaded.

The SWDB Overpack is to be redesigned to be the containment boundary and must be leak testable.

Package performance requirements will be verified through analysis or a combination of analytical and test methods for bounding case scenarios within the SARP.

4.2.2 Materials

All materials shall be compatible with or provide adequate resistance to the corrosive effects of materials (liquids, vapors, gases, and solids) that they will be in contact with throughout their life cycle (50 years). The materials shall also be selected to minimize chemical-galvanic reactions between payload components and the packaging. Containment boundary materials are to be American Society for Testing and Materials (ASTM) or American Society of Mechanical Engineers (ASME) compliant and must have a certified material test report. Other materials shall have a certificate of compliance.

Seals must be able to withstand continuous service temperatures ranging from -33 °C to 140 °C (-27 °F to 285 °F) and extreme temperatures up to 146 °C (295 °F) for a 30-minute fire per 10 CFR 71, "Packaging and Transportation of Radioactive Material," 71.73 "Hypothetical accident conditions."

4.2.3 Fabrication Methods

All welds shall be sufficiently smooth to enable easy decontamination. The design shall consider avoiding potential contamination traps to the greatest extent practicable. Decontamination of all external surfaces will be required to meet Table 3-2 limits. Surface areas that may contact radioactive materials shall be designed for ease of decontamination.

The containment boundary, which is the SWDB Overpack, shall be designed and manufactured to the requirements of ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1 (ASME 1995b), except that ASTM standard materials may be used and a code stamp is not required.

4.2.4 Dimensions and Volume

The Rectangular Grout Container has inside dimensions of approximately 90 cm wide by 171 cm long by 79 cm high (35.5 in. wide by 67.25 in. long by 31 in. high) and an approximate volume of 1.21 m^3 (42.8 ft^3). The SWDB exterior measures approximately 152.4 cm wide by 254 cm long by 157.5 cm high (60 in. wide by 100 in. long by 62 in. high). The impact limiter exterior measures approximately 261 cm wide by 361 cm long by 230 cm high (103 in. wide by 142 in. long by 90 in. high). See the drawings for more details.

4.2.5 Weight of Contents

The total weight of the contents, engineered containers, as necessary, Rectangular Grout Container, and Rectangular Overpack Disposal Container shall be limited to 4,500 kg (10,000 lb) due to crane capacity.

4.2.6 Maximum Gross Weight

The maximum gross weight of the loaded SWP assembly shall be limited to 37.2 metric tons (41 tons). The maximum loaded weight of the SWDB shall be limited to 27.2 metric tons (30 tons) due to crane capacity.

4.2.7 Containment

The package shall consist of multiple release mitigating barriers and is divided into four primary components: (1) inner container(s) for in-cell handling; (2) containment container, which is the SWDB Overpack, to provide the containment boundary; (3) steel shielding cask (SWDB) to provide shielding and outer confinement; (4) and outer container (impact limiter) to provide impact absorption. The SWDB Overpack shall be leak testable and shall be defined as the containment boundary during transport. The containment boundary shall meet the requirements of ANSI N14.5, *American National Standard for Radioactive Materials–Leakage Tests on Packages for Shipment* (ANSI 1997). Because the SWDB Overpack will only be used for shipping, it will not need to be capable of being vented. During storage, the SWDB will be passively ventilated. The other release mitigating barriers shall provide confinement of package contents, meaning these barriers shall mitigate release of any particulate matter.

The containment boundary, which is the SWDB Overpack, shall be designed and manufactured to the requirements of ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1 (ASME 1995b), except that ASTM standard materials may be used and a code stamp is not required.

All other components shall be designed, fabricated, used, and maintained in accordance with international or national standards or design media prepared by Waste Management Federal Services, Inc., Northwest Operations or the seller. As a minimum, all structural materials of construction shall be manufactured to ASTM or other nationally recognized standards.

The containment boundary, which is the SWDB overpack, will be evaluated to the acceptance criteria of ASME *Boiler and Pressure Vessel Code*, Section III, Subsection NE (ASME 1995a), and applied to the intent of U.S. Nuclear Regulatory Commission Regulatory Guide 7.6, *Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels* (NRC 1978a), and Regulatory Guide 7.8, *Load Combinations for the Structural Analysis of Shipping Casks* (NRC 1998b), for both normal and accident conditions as defined in Section 5.0.

4.2.8 Shielding

Source term shielding is provided mainly by the SWDB. Additional shielding is provided by the overpack and impact limiter.

4.2.9 Lifting and Tiedown Attachments

Lifting and tiedown attachments shall meet the technical requirements of 10 CFR 71, "Packaging and Transportation of Radioactive Material," 71.45, "Lifting and tie-down standards for all packages," and ANSI N14.6, *American National Standard for Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More* (ANSI 1993). The lifting attachments for the packaging shall be capable of lifting three times the total suspended weight without generating a combined stress or maximum tensile stress at any point in the load path in excess of the corresponding minimum yield strength of their materials of construction. The lifting attachments shall be compatible with the cranes at the 324 Facility (as shown in Table 3-1) and portable cranes, as applicable, to permit field lifting of the packaging.

4.2.10 Gas Generation and Venting

The SWDB shall be passively vented. During transportation, the SWDB Overpack will not be vented. During a period of time twice the maximum expected shipping time, the concentration of hydrogen gas in the SWP assembly containment shall not exceed 5 percent by volume.

4.3 TRANSPORT SYSTEM

4.3.1 Trailer

The SWP will be transported on a specially modified trailer as specified on H-3-56435 (PNL 1988c).

4.3.2 Tiedowns

The tiedown system for the SWP consists of structural carbon steel angles that are permanently welded to the bed of the trailer to provide lateral and longitudinal bracing. In addition, five turnbuckles on each end of the package provide vertical and additional longitudinal restraint.

Due to the nature of the contents and the design of the package, the package must be restrained to prevent movement and shifting during all normal transfer conditions (NTC) and in response to emergency situations, such as panic stops and emergency evasive maneuvers. Because this is restricted to onsite shipping, it is not required to meet the U.S. Department of Transportation (DOT) requirements. Consequently, the package restraint system shall be capable of withstanding the forces that would result if the loaded vehicle was subjected to each of the following forces (independently) as defined by the Canadian Council of Motor Transport Administrators:

1. 0.8*g* times the weight of the package in a forward direction

2. 0.5*g* times the weight of the package in a rearward direction

3. 0.5*g* times the weight of the package in the lateral direction

4. 0.2*g* times the weight of the package relative to the load in a vertical direction, discounting gravity.

The package shall meet the following NTC and accident condition performance test requirements, which have been modified only for onsite environmental.

5.0 GENERAL REQUIREMENTS

5.1 NTC

By definition, onsite shipment of the SWP is not considered shipment in commerce. Consequently, DOT regulations do not apply. However, U.S. Department of Energy Order 460.1A, *Packaging and Transportation Safety* (DOE 1996), and HNF-PRO-154 require an equivalent degree of safety to that provided by the DOT regulation. The extremes of Hanford Site environmental conditions are defined in WHC-SD-TP-RPT-004, *Environmental Conditions for On-Site Hazardous Materials Packages* (Fadeff 1992), and listed below.

5.1.1 NTC Performance Test Requirements

5.1.1.1 General Standards for All Packages. General standards for all packages are as follows.

- Outside of package shall have a tamper-indicating device.
- Each package shall have a positive closure device.
- Package shall be constructed of materials that have no significant chemical galvanic or other reactions between package and components
- Package accessible surfaces in still air at 46 °C (115 °F) and in the shade shall not exceed 85 °C (185 °F).

5.1.1.2 Hot and Cold Conditions.

5.1.1.2.1 Heat. Evaluate package and payload performance for extreme ambient temperature of 46 °C (115 °F) in still air, with decay heat, and solar insolation for a 12-hour day as shown in Table 5-1.

Table 5-1. Solar Heat Loads.

Form and location of surface	Insolation for 12 hours per day
Flat surface transported horizontally	
Base	None
Other surfaces	647 cal/cm^2 (2,386 Btu/ft^2)
Flat surface not transported horizontally	
Each surface	162 cal/cm^2 (597 Btu/ft^2)
Curved surfaces	324 cal/cm^2 (1,194 Btu/ft^2)

5.1.1.2.2 Cold. Evaluate package and payload performance for extreme ambient temperature of -33 °C (-27 °F) in still air and in the shade.

5.1.1.3 External Pressure.

5.1.1.3.1 Reduced External Pressure. Evaluate for external pressure of 95.21 kPa absolute (13.81 psia).

5.1.1.3.2 Increased External Pressure. Evaluate for external pressure of 102.38 kPa absolute (14.85 psia).

5.1.1.4 Vibration. Evaluate package fatigue performance for vibration normally incident to transport using response parameters given in ANSI N14.23, *Draft American National Standard Design Basis for Resistance to Shock and Vibration of Radioactive Material Packages Greater than One Ton in Truck Transport* (ANSI 1992). Evaluate package fatigue response for a minimum of 1,000 cycles per shipment.

5.1.1.5 Water Spray. Evaluate package performance for a simulated rainfall of 1.5 cm (0.6 in) per hour for at least 1 hour.

5.1.1.6 Free Drop. Evaluate package performance for a free drop of 0.3 m (1 ft). The defined drop surface shall be an essentially hard, unyielding surface in an orientation that results in the most damage to the package.

5.1.1.7 Compression. There is no stacking of this package; consequently, stacking is not evaluated. In addition, package structural integrity is bounded by free-drop condition.

5.1.1.8 Penetration. Evaluate package performance for a vertical steel cylinder with a 3.2 cm diameter hemispherical end and 6 kg of mass, dropping from a height of 1 m onto the package. The cylinder is assumed to strike the package's exposed surface in the region most vulnerable to puncture. The long axis of the cylinder is assumed to be perpendicular to the package surface.

5.1.1.9 Lifting and Tiedown. Evaluate package lifting device performance to the requirements of DOE-RL-92-36, *Hanford Site Hoisting and Rigging Manual* (RL 1998). For tiedown attachments attached to the package, evaluate performance either for (1) failure of the attachment before damage of the package or (2) attachment meets the 10, 2, and 5 requirements of 10 CFR 71.45 (b).

5.1.1.10 Brittle Fracture. As a minimum, evaluate package performance when subjected to an ambient temperature of -33 °C (-27 °F). Evaluate plastic and rubber materials to manufacturer's recommended service limits. If required by material constraints, limit the low-temperature use of the package in the SARP.

5.1.1.11 Containment. The package shall be designed and constructed so that the containment boundary, which is the SWDB Overpack as defined in Section 4.2.7, shall be leaktight as defined by ANSI N14.5 (ANSI 1997). For transportation, the containment boundary shall meet the requirements of ANSI N14.5 (ANSI 1997).

5.1.1.12 Shielding. The maximum surface dose at any accessible surface on the package shall not exceed 1000 mrem/h. The dose rate 2 m (6.5 ft) from the surface shall be limited to 10 mrem/h. The dose in any normally occupied space in the transfer vehicle shall be limited to 2 mrem/h or less.

5.1.1.13 Criticality. The contents shall remain safely subcritical during NTC as described in Section 5.1. The package design shall also ensure that during NTC, as described in Section 5.1, three packages stacked together in any arrangement with close full reflection on all sides of the stack by water will remain subcritical.

5.2 ACCIDENT CONDITIONS

The SWP shall be evaluated under the following hypothetical accident conditions.

- **Free Drop**: this is a free drop of the specimen through a distance of 9 m (30 ft) onto a 20 cm (8-in.-thick) concrete surface with a concrete strength of 28,000 kPa (4,000 psi), Grade 60, No. 7 rebar spaced 30.5 cm (12 in.) apart with 5 cm (2-in.) cover, each way, each face, and a soil modulus of elasticity of 190 MPa (28,000 psi). The package shall impact in an orientation expected to cause maximum damage.

- **Puncture**: this is 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 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 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.

- **Thermal**: this is exposure of the whole specimen for not less than 30 minutes to a heat flux not less than that of a radiation environment of 800 °C (1,475 °F) with an emissivity coefficient of at least 0.9. For purposes of calculation, the surface absorptivity must be either that value which the package may be expected to possess if exposed to a fire or 0.8, whichever is greater. In addition, when significant, convective heat input must be included on the basis of still, ambient air at 800 °C (1,475 °F). Artificial cooling must 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. The effects of solar radiation may be neglected prior to, during, and following the test.

Immersion of the SWP (10 CFR 71.73 [c], [4], and [5]) shall not be considered because the package will not be transported near large bodies of water.

5.2.1 Containment

The package shall be designed and constructed so that the containment boundary, which is the SWDB Overpack as defined in Section 4.2.7, shall be leaktight as defined by ANSI N14.5 (ANSI 1997). For transportation, the containment boundary shall meet the requirements of ANSI N14.5 (ANSI 1997).

5.2.2 Shielding

Subsequent to all accident events, as described in Section 5.2, the dose 1 m (3.3 ft) from the surface of the packaging system shall not exceed 1 rem/h.

5.2.3 Criticality

Subsequent to all accident events, as described in Section 5.2, the packaging system shall be evaluated for one package to remain safely subcritical.

5.3 AS LOW AS REASONABLY ACHIEVABLE (ALARA)

The design features of the package shall be consistent with the requirements of HNF-PRO-1618, *ALARA Management Commitment and Policy.* Exposure of personnel to radiological and other hazardous materials associated with the loading, closure, tiedown, transfer, and off-loading of the package shall be minimized. Cost benefit analyses should be performed, as needed, to determine the best balance between exposure and economical design.

The contamination limits, as directed by 49 CFR 173.443 (see Table 3-1), will be met prior to transport of the packaging.

5.4 QUALITY ASSURANCE

The quality assurance program requirements for such activities as design, procurement, fabrication, inspection, testing, component handling, and documentation of the SWP and its components shall be in accordance with WMNW-QAPP-001, *Quality Assurance Program Plan for Project Hanford Management Contract Work* (WMNW 1999). Construction of containment boundary components shall meet the appropriate additional and supplemental requirements of ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications* (ASME 1994).

5.5 MAINTENANCE

Maintenance, as required and specified in the SARP, shall be performed on the packaging to ensure packaging integrity is maintained. Ease and minimization of maintenance shall be considered in the design of the packaging. Vendor-supplied spare parts and maintenance data, if applicable, shall be provided for equipment specified in the design. Special tools required to operate the packaging system and/or replace/repair components shall also be provided as part of the project.

5.6 SARP

A SARP will be prepared based upon the above design criteria that will provide the safety analysis necessary to demonstrate that the packaging meets or exceeds all Hanford Site packaging safety acceptance criteria as required by HNF-PRO-154. Operational (loading and off-loading), maintenance, acceptance, and quality assurance criteria will be included in the SARP for development of facility procedures, ensuring that operation, transport, and storage of the package meet the requirements of this packaging design criteria.

6.0 REFERENCES

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

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

HNF-PRO-154, *Responsibilities and Procedures for All Hazardous Material Shipments*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-1618, *ALARA Management Commitment and Policy*, Fluor Daniel Hanford, Inc., Richland, Washington.

ANSI, 1997, *American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment*, ANSI N14.5, American National Standards Institute, New York, New York.

ANSI, 1993, *American National Standard for Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More*, ANSI N14.6, American National Standards Institute, New York, New York.

ANSI, 1992, *Draft American National Standard Design Basis for Resistance to Shock and Vibration of Radioactive Material Packages Greater than One Ton in Truck Transport*, ANSI N14.23, American National Standards Institute, New York, New York.

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

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

ASME, 1994, *Quality Assurance Requirements for Nuclear Facility Applications*, ASME NQA-1-1994 Edition, American Society of Mechanical Engineers, New York, New York.

Crow, S. R., 1996, *Addendum to the Safety Analysis Report for the Steel Waste Packaging*, WHC-SD-TP-DA-004, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

DOE, 1996, *Packaging and Transportation Safety*, DOE Order 460.1A, U.S. Department of Energy, Washington, D.C.

Fadeff, J. G., 1992, *Environmental Conditions for On-Site Hazardous Materials Packages*, WHC-SD-TP-RPT-004, Rev. 0,Westinghouse Hanford Company, Richland, Washington.

Hobart, R. L., 1998, *324 Facility Special-Case Waste Assessment in Support of 324 Closure (TPA Milestone M-89-05)*, HNF-2570, Rev. 1, prepared by B&W Hanford Company for Fluor Daniel Hanford, Inc., Richland, Washington.

Mercado, J. E., 1998, *Scoping Thermal and Shielding Evaluation for the 22½-Ton Box*, EBU-RPT-008, Rev. 0, Waste Management Federal Services, Inc., Northwest Operations, Richland, Washington.

NRC, 1978a, *Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels*, Regulatory Guide 7.6, U.S. Nuclear Regulatory Commission, Washington, D.C.

NRC, 1978b, *Load Combinations for the Structural Analysis of Shipping Casks*, Regulatory Guide 7.8, U.S. Nuclear Regulatory Commission, Washington, D.C.

PNL, 1996a, *Manifest 96004: Mixed Waste EC-14,15,17, Feed Cans 1-13&15 Shipped 3/6/96*, PNL-324-96-005, Pacific Northwest Laboratories, Richland, Washington.

PNL, 1996b, *Manifest 96006: Dispersible EC-16, 18, 19, 21, 22, 23, 24, and 25: 22.5 Ton Box Shipment 3/1/96*, PNL-324-96-012, Pacific Northwest Laboratories, Richland, Washington.

PNL, 1996c, *22 Ton Steel Waste Disposal Box Assembly/Details*, H-3-56431, Rev. 1 (4 sheets), Pacific Northwest Laboratory, Richland, Washington.

PNL, 1993a, *Rectangular Grout Container Weldment/Sling Assembly*, H-3-70454, Rev. 1 (2 sheets), Pacific Northwest Laboratory, Richland, Washington.

PNL, *Rectangular Overpack Disposal Container/Weldment/Details*, H-3-70453, Pacific Northwest Laboratory, Richland, Washington.
1992, Sheet 1, Rev. 0
1993b, Sheets 2 and 3, Rev. 1

PNL, 1996a, *Manifest 96004: Mixed Waste ED-14,15,17, Feed Cans 1-13&15 Shipped 3/6/96*, PNL-324-96005, Pacific Northwest Laboratories, Richland, Washington.

PNL, 1996b, *Manifest 96006: Dispersible EC-16, 18, 19, 21, 22, 23, 24, and 25: 22 Ton Box Shipment 3/1/96*

PNL, 1988a, *22 Ton Steel Waste Disposal Box Impact Limiter Assembly/Detail*, H-3-56433, Rev. 0 (9 sheets), Pacific Northwest Laboratory, Richland, Washington.

PNL, 1988b, *22 Ton Steel Waste Disposal Box Overpack Assembly/Details*, H-3-56432, Rev. 0 (3 sheets), Pacific Northwest Laboratory, Richland, Washington.

PNL, 1988c, *22 Ton Steel Waste Disposal Box Trailer Modification*, H-3-56435, Rev. 0 (6 sheets), Pacific Northwest Laboratory, Richland, Washington.

PNL, 1988d, *Safety Analysis Report for the Steel Waste Package*, PNL-MA-651, Rev. 1,Pacific Northwest Laboratories, Richland, Washington.

RL, 1998, *Hanford Site Hoisting and Rigging Manual*, DOE-RL-92-36, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WMNW, 1999, *Quality Assurance Program Plan for Project Hanford Management Contract Work*, WMNW-QAPP-001, Waste Management Federal Services, Inc., Northwest Operations, Richland, Washington.