ENGINEERING CHANGE NOTICE

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Proj.
ECN

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14a. Justification (mark one)			
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14b. Justification Details The revision to the Offsite Transportation Hazards Assessment is required to ensure that the consequences of transportation accident scenarios are documented, including the additional packages described in this revision.
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1. ECN (use no. from pg. 1)

640854

16. Design Verification Required

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☒ No

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ENGINEERING

CONSTRUCTION

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Additional ☐ \$
Savings ☐ \$

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19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐
Functional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐
Operating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
Conceptual Design Report	☐	Installation Procedure	☐	Component Index	☐
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
Environmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐		☐
Environmental Permit	☐	Inventory Adjustment Request	☐		☐

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

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Document Number/Revision

Document Number Revision

21. Approvals

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Design Authority		Design Agent	
Cog. Eng. M. E. Burnside	7-23-97	PE	
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QA		Safety	
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Other		Other	
J. H. O'Brien	7/23/97		
R. E. Broz	7/24/97		
J. M. Hammons	7/24/97		
		DEPARTMENT OF ENERGY	
		Signature or a Control Number that tracks the Approval Signature	
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Offsite Transportation Hazards Assessment

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Richland, WA 99352

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HAZARDS ASSESSMENT FOR EMERGENCY
PREPAREDNESS FOR OFFSITE
TRANSPORTATION HAZARDS ASSESSMENT

July 22, 1997

WASTE MANAGEMENT FEDERAL SERVICES, INC.,
NORTHWEST OPERATIONS

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OFFSITE TRANSPORTATION HAZARDS ASSESSMENT

1.0 INTRODUCTION

This report documents the emergency preparedness Hazards Assessment for the offsite transportation of hazardous material from the Hanford Site. The assessment is required by the U.S. Department of Energy (DOE) Order 151.1. Offsite transportation accidents are categorized using the DOE system to assist communication within the DOE and assure that appropriate assistance is provided to the people in charge at the scene. The assistance will initially include information about the load and the potential hazards. Local authorities will use the information to protect the public following a transportation accident.

This Hazards Assessment will focus on the material being transported from the Hanford Site. Shipments coming to Hanford are the responsibility of the shipper and the carrier and, therefore, are not included in this Hazards Assessment, unless the DOE elects to be the shipper of record.

2.0 HANFORD BACKGROUND INFORMATION

The Hanford Site and facilities are described in various Environmental Impact Statements, Environmental Assessments, and Safety Analysis reports. The description below is taken mainly from the Hanford Site National Environmental Policy Act (NEPA) Characterization document (Cushing 1992) and the environmental impact statement for the disposal of defense wastes (DOE 1987).

2.1 HANFORD HISTORY AND CURRENT MISSION

Nine plutonium production reactors (100 Area) were built on the bank of the Columbia River from 1943 to 1963. They operated for periods of time ranging from fourteen years to twenty-four years. All of them are currently shutdown with the fuel removed and the cooling systems drained. Companion fuel fabrication plants (300 Area), chemical processing plants (the 200 Areas), and waste management facilities (the 200 Areas) were constructed and operated. Irradiated uranium discharged from the reactors was processed to recover uranium and plutonium. This processing resulted in the accumulation of a wide variety of radioactive and chemical wastes.

For more than 20 years, Hanford Site facilities were dedicated primarily to the production of plutonium for national defense and management of the resulting wastes. In later years, programs at the Hanford Site were diversified to include research and development for advanced reactors, renewable energy technologies, waste disposal technologies, and cleanup of contamination from past practices.

The DOE has established a new mission for Hanford including:

Waste Management of stored defense wastes and the handling, storage, and disposal of radioactive, hazardous, mixed, or sanitary wastes from current operations.

Environmental Restoration of approximately 1,100 inactive radioactive, hazardous, and mixed waste sites and about 100 surplus facilities.

Research and Development in energy, health, safety, environmental sciences, molecular sciences, environmental restoration, waste management, and national security.

Technology Development of new environmental restoration and waste management technologies, including site characterization and assessment methods; waste minimization, treatment, and remediation technology; and education outreach programs.

2.2 LOCATION

The DOE's Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State (Figure 2.1).

3.0 IDENTIFICATION AND SCREENING OF HAZARDS

Potentially hazardous materials are transported regularly to and from the Hanford Site. Approximately 350 radioactive material shipments are received and 500 radioactive material shipments are made annually.

Typically, materials from the following U.S. Department of Transportation (DOT) hazard classes are transported:

- 2.1 Flammable gases
- 2.2 Non-flammable compressed gases such as carbon dioxide
- 2.3 Poisonous gases such as chlorine
- 3 Flammable and combustible liquids such as gasoline
- 4.1 Flammable solids, including those that react violently with water such as sodium metal and sodium-potassium mixtures.
- 5.1 Oxidizers
- 5.2 Organic peroxides
- 6.1 Poisonous materials
- 6.2 Infectious substances (mainly Hanford Environmental Health Foundation and Pacific Northwest National Laboratory)
- 7 Radioactive materials
- 8 Corrosive materials.
- 9 Miscellaneous hazardous materials
- ORM-D Other Regulated Material (ORM-D).

Figure 2.1. Hanford Site Map.

The following DOT categories of radioactive material (Class 7) are transported: limited quantity, low specific activity, Type A, Type B, Fissile, and Highway Route Controlled quantities. The material comprises liquid and solid wastes, fuel, activated material, and contaminated soil and rubble. These materials may have secondary hazards such as corrosivity or flammability associated with them.

Non-radioactive hazardous materials are packaged in accordance with DOT regulations. Typical packaging systems include metal and plastic drums, boxes, gas cylinders, and tanker trucks. Some materials are contained in combination packaging comprising an outer and an inner container.

Radioactive materials are transported in packagings approved by the DOT. Typical packaging systems for solid radioactive materials include drums, plywood boxes, and certified transport casks.

Many non-routine shipments and small quantity shipments occur every year. Examples include small shipments of medical isotopes for treatment and research and waste products being sent to a recycling or disposal facility. Specific shipments and anticipated shipping campaigns are analyzed individually in the appendices of this document. The remainder of the shipments are covered by general guidance for radioactive and hazardous chemical transportation emergency categorization.

4.0 HAZARD CHARACTERIZATION

There is a wide variety of hazardous materials shipped from the Hanford Site. In some cases, a shipment is a one-time event. In other cases, several shipments of the same type occur. For example, a campaign to ship slightly contaminated nitric acid to England involved several shipments.

The contents of each shipment are summarized on the shipping papers. The appendices to this document describe and analyze selected containers and shipments. These descriptions were placed in appendices to facilitate document revision as additional transportation events are analyzed.

In accordance with DOE Order 151.1, Chapter V, Section 2D, the categorization of all events or accidents involving any of the selected containers or shipments documented in the attached appendices are categorized as an Offsite Transportation Operational Emergency. Worst case situations or scenarios that constitute a threat to the shipment are also discussed.

5.0 EVENT SCENARIOS

Transportation event scenarios generally involve vehicle accidents. Two cases are usually considered: (1) an accident without fire and (2) an accident with a fire. The potential consequences are almost always worse with a fire. There are other events that could damage a shipping container. An improperly secured load could fall from a vehicle during transport. An improperly

assembled package could leak during transport. Sabotage to the transport vehicle could cause an accident or a fire. A civil disturbance or bomb threat could cause the driver to abandon the load leaving the safety uncertain. Due to a mistake in loading, the contents of a package could be chemically unstable or a nuclear criticality could occur during transport. The load could be threatened by a natural disaster such as a hurricane or flood. Civil disturbance, malevolent events, and natural disasters are considered in this section. The appendices include transportation accident scenarios for each container or shipment considered.

Type B containers for the shipment of large quantities of radioactive material must meet a series of criteria that were designed to guarantee that the container would not breach in most accidents. The words "maximum credible accident relevant to the mode of transport" were used in International Atomic Energy Agency (IAEA) documents on the subject. However, in specifying the criteria, it quickly became evident that really crash proof containers are immovable objects and, therefore, some probability of failure must be recognized.

For example, the 30 ft (9 m) drop test specified in the regulations simulates a direct impact at 30 mph, or a glancing impact at 45° at 45 mph. Although highway speeds are higher, it was reasoned that in the majority of accidents some form of slowing down takes place. Also, crushing of the vehicle in a head-on collision attenuates the load to the package. The criteria for fire resistance is another example of applying judgement and reasoning when specifying a criteria. Fires that follow an accident are usually started by the vehicle fuel after which other combustible materials being transported become involved. A 30 minute fire criteria was adopted since most transport fires burn out or are extinguished in less time. However, more severe transport fires do occur. On December 16, 1991 a truck carrying unirradiated nuclear fuel was involved in an accident on U.S. Interstate 91 near Springfield, Massachusetts. The subsequent fire lasted almost three hours (NUREG-1458). According to a study sponsored by the U.S. Nuclear Regulatory Commission (NRC) (Fisher 1987), approximately 99.4% of all truck accidents on U.S. highways would be less severe than the tests to which Type B shipping containers are subjected. Therefore, there is only a slight possibility that an accident could release material from a fully qualified, properly loaded and properly closed Type B container.

The following sections describe natural disasters and malevolent events that are categorized as Offsite Transportation Operational Emergencies. These sections should be used for events of this type unless a specific analysis is provided for a particular load in the appendices. The categorization for vehicle accidents is described for each load in the appendices.

As previously stated, per DOE Order 151.1, all offsite shipment scenarios shall be categorized as an Offsite Transportation Operational Emergency regardless of severity.

5.1 NATURAL DISASTERS

A hazardous materials shipment could be threatened by a natural event such as a hurricane, tornado, flood, earthquake or forest fire. In some cases, the truck driver may have to leave the load in an uncontrolled location to escape the danger or seek shelter. An Offsite Transportation Operational Emergency should be declared if a load that has the potential to create an emergency condition is threatened by a natural event or must be left unattended with the safety uncertain in an uncontrolled area. The purpose of the declaration is to notify people within the DOE that a hazardous materials shipment is at increased risk.

5.2 SABOTAGE

Sabotage as used here is deliberate damage to the load or transport vehicle in order to cause a threat to the safety of the driver or the integrity of the container. Confirmed physical damage is classified as an Offsite Transportation Operational Emergency since the safety has been degraded and there could be additional damage that has not yet been discovered.

5.3 CIVIL DISTURBANCE

A riot or other civil disturbance may cause a serious threat to the safety of the driver and the shipment and may force the driver to leave the load in an uncontrolled location. This situation is classified as an Offsite Transportation Operational Emergency since the safety has been degraded.

5.4 BOMB THREAT

The presence of an explosive device is a serious threat to the safety of personnel and a potential threat to the integrity of the container. An Offsite Transportation Operational Emergency should be declared if, in the judgement of the driver or his management, a credible threat exists. This is also true for the detonation of an explosive device or a large explosion that threatens high hazard loads.

5.5 EMERGENCY CLASSIFICATION FOR SHIPMENTS OF RADIOACTIVE MATERIAL

The appendices analyze specific shipments. Other shipments will occur that comply with applicable regulations which have not been specifically analyzed from an emergency preparedness perspective. The paragraphs below provide guidelines on categorizing accidents involving radiological shipments that have not been specifically analyzed.

5.5.1 Review of Transportation Quantity Categories

A system of quantity categories is used in the regulation of radioactive material transportation. Each package is classified into one of five categories: Limited Quantity, Low Specific Activity, Type A quantity, Type B

quantity or Highway Route Controlled Quantity. The quantity category determines the type of container required to ship the material and the applicability of other (DOT) requirements. The basic principle is that stronger packaging is required for material that poses a higher risk.

The quantity categories are tied to A_1/A_2 values listed in the Code of Federal Regulations (49 CFR 173.435). The values are the number of curies for each listed isotope that determine a Type A quantity. The A_1 value applies if the material is in "special form" whereas the A_2 value applies if the material is in "normal form". The A_1 (Special form) curie values are higher since the material is either a single solid piece or is contained in a sealed capsule that has been shown to pass a series of tests that demonstrate that the material will probably not be released in an accident. Table 5.1 summarizes the quantity categories in terms of the A_1/A_2 values.

There are few packaging requirements for Limited Quantity and Low Specific Activity materials. Radioactive material in Type A quantities must be transported in packages that are designed to withstand normal handling mishaps. Type B quantities of radioactive material, including Highway Route Controlled Quantities, must be transported in containers that are expected to maintain containment, shielding and nuclear criticality control in most accidents.

Table 5.1. Quantity Categories for Radioactive Material Shipment.

Category	Quantity
Limited Quantity	Solids: $10^{-3} A_1(A_2)$; liquids (other than Tritiated water): $10^{-4} A_2$ *
Low Specific Activity	Unirradiated uranium and material in which the radioactivity is uniformly distributed and in low concentration (see 49 CFR 173.403)
Type A	$\leq A_1(A_2)$
Type B	$> A_1(A_2)$
Highway Route Controlled Quantity	> 3000 times $A_1(A_2)$ or 27,000 Ci whichever is least

* The A_1 value applies if the material is special form. Table 5.1 is not a complete definition of the quantity classification system. For example, additional definitions apply for tritium. See 49 CFR 173.403 for the complete definition of these categories. See 49 CFR 173.421 for the activity limits prescribed for radioactive materials categorized as limited quantity.

Since the quantity classification system and package requirements are based on the $A_1(A_2)$ values, it is instructive to review the basis for the values. Type A package contents limits are determined for individual radionuclides using the "Q" system.

Under the Q system, a series of exposure routes are considered, each of which might lead to radiation exposure to persons in the vicinity of a Type A package involved in a transport accident. The dosimetric routes lead to five contents limit values Q_A , Q_B , Q_C , Q_D and Q_E , for external photon dose, external beta dose, inhalation dose, skin and ingestion dose due to contamination transfer and submersion dose respectively. Contents limits for special form alpha and neutron emitters and tritium are considered separately. The A_1 value for special form materials is the lesser of the two values Q_A and Q_B , while the A_2 value for non-special form radioactive materials is the least of A_1 and the remaining Q values. Several assumptions used in the derivation of individual Q values are described below, but all dose evaluations are based upon the following:

- The effective or committed effective dose equivalent to a person exposed in the vicinity of a transport package following an accident should not exceed 50 mSv (5 rem).
- The dose or committed dose equivalent received by individual organs, including the skin, of a person involved in the accident would not exceed 0.5 Sv (50 rem), or in the special case of the lens of the eye 0.15 Sv (15 rem).
- A person is unlikely to remain at 1 m from the damaged package for more than 30 minutes.

The key assumptions in evaluating the external photon dose are that all shielding of the packages is lost in the accident, the dose rate is evaluated at 1 m from the package and the exposed individual is assumed to remain in the vicinity for 30 minutes. The key assumptions in evaluating the beta dose is that all shielding of the packages is lost but there is a residual shielding factor associated with the package debris. The evaluation of the internal dose from inhalation assumes that only normal form material escapes to the air. The net intake factor is assumed to be 10^{-6} of the package contents. This could correspond to a release fraction of 10^{-3} of the package contents coupled with a dispersion/intake factor of 10^{-3} or some other combination of release fraction and dispersion/uptake factors. The skin contamination and ingestion doses assumes that 1% of the package contents are spread uniformly over an area of 1 m²; handling of the debris is assumed to result in contamination of the hands to 10% of this level. It is further assumed that the exposed person recognizes the possibility of contamination and washes the hands within a period of five hours. The ingestion dose is based on the assumption that a person ingest all the contamination from 10 cm² of skin over a 24 hour period.

The submersion dose due to gaseous isotopes assumes a rapid 100% release of the package contents into a store room or cargo handling bay of specified dimensions and ventilation rate.

The Low Specific Activity category was originally created for the transportation of radioactive ores, slag or residues from processing that were carried in bulk or in sacks or other packaging. The specific activities of this material is so low that a significant intake would likely not occur. The limits for Low Specific Activity material were established based on a model where it was assumed that it is most unlikely that a person would remain in a dusty atmosphere long enough to inhale more than 10 mg of material. Under

these conditions, if the specific activity of the material is such that the mass intake is equivalent to the activity intake assumed to occur for a person involved in an accident with a Type A package, then this material should not present a greater hazard during transport than the quantities of radioactivity transported in Type A packages. For the purpose of this Hazards Assessment, Low Specific Activity material will be assumed to pose the same potential consequences as Type A material.

5.5.2 Emergency Classification

There is not a direct correspondence between the assumptions and dose criteria used to derive the A_1/A_2 values and the criteria used in the DOE emergency classification system. Some of the assumed exposure pathways and receptor distances are not appropriate for emergency classification. For example, the ingestion pathway from touching contamination and then eating is not considered in assessing the appropriate DOE emergency classification. The dose criteria are also different. The A_1/A_2 values are based on a five rem criteria whereas the DOE emergency classification system is based on the EPA protective action guideline of one rem. Another difference is that the A_1/A_2 values were derived based on an accident involving a single container but there may be many containers on a truck. There also could be a mixed load on a truck where some of the packages are limited quantity but others are Type A. Even with these differences, some conservative relationships between the DOT quantity categories for radioactive material and the DOE emergency classification levels can be established.

Limited quantity packages contain activity levels at least a thousand times smaller than Type A packages. Therefore, the potential radiation dose from an accident would be approximately a thousands times smaller or 5 mrem per package using the DOT evaluation method. The DOT method is conservative since it includes additional dose pathways not considered in the DOE classification system. It is reasonable to conclude that even with multiple packages involved in an accident, limited quantity material cannot reach a DOE Emergency categorization level based on dose received during an accident. There may be another consideration, however. An accident involving radioactive material may cause a great deal of concern and disruption of normal activities at the scene regardless of the activity level or potential dose. For example, the first responders may decide to evacuate people before contacting Hanford for information about the load. An Offsite Transportation Operational Emergency should be declared if radioactive material from Hanford is involved in an accident and people have been evacuated, a major road is blocked because of the concern about radiation, or some other substantial disruption or concern is reported by local officials.

Accidents involving Type A quantities have the potential to reach a Offsite Transportation Operational Emergency status. The potential dose to someone at the accident scene is 5 rem from a single package using the DOT evaluation method. This exceeds the one rem criteria for an Offsite Transportation Operational Emergency. For example, consider an accident involving twenty packages containing Type A quantities of Eu-152 (10 Ci in each package). Using a release fraction of 1% which corresponds to an upper bound fire release, a dose of 1.3 rem is calculated at a distance of 100 m. This exceeds the criteria for an Offsite Transportation Operational Emergency.

An Offsite Transportation Operational Emergency is recommended if a shipment of Type A quantity package(s) is threatened by an accident, natural disaster or malevolent event, or a fire is involved or judged to be likely.

Type B and highway route controlled quantities are transported in shipping casks that are designed to withstand accidents. Because of the difficulty of quickly verifying cask integrity, these shipments meet an Offsite Transportation Operational Emergency if the cask is threatened by an accident, natural disaster, or malevolent event. An Offsite Transportation Operational Emergency should be declared if the cask is involved in a fire or if a release has occurred or is judged to be likely. Radiation levels greater than 10 mR/hr at distances greater than 2 m from the cask indicate a possible cask breach. Shipping casks for Type B and highway route controlled quantities may contain thousands of curies with the potential for a serious radiological problem in the unlikely event of a major release.

5.6 HAZARDOUS CHEMICAL SHIPMENTS

Hanford typically does not ship large volumes of chemicals. The majority of chemical shipments will be small volumes of waste or surplus products. The Department of Transportation has provided a North American Emergency Response Guidebook which is available free to fire departments, police and other first response agencies. The guidebook is available across the country and widely used by these agencies. The sections below describe a system for declaring an Offsite Transportation Operational Emergency using the information in the guidebook for material that has not been specifically analyzed from an emergency preparedness perspective.

5.6.1 Identify the Material

The first step in responding to a transportation accident and requests for information is to identify the material involved. The shipping papers provide the best way to identify the material and the quantities. Shipping papers are available in the cab of the motor vehicle. A duplicate copy is available at Hanford. The second choice is to identify the materials from the placards on the transport vehicle or the package markings. The placards will identify the type of hazard, the hazard class or division and a four digit identification number. The four digit number may be on the placard or on an orange panel next to the placard. As a general principle, an Offsite Transportation Operational Emergency should be declared if any load from Hanford that requires placards is involved in an accident or other threatening situation. The following sections describe situations requiring an Offsite Transportation Operational Emergency status.

5.6.2 Inhalation Hazard Chemicals

The 1996 edition of the North American Emergency Response Guidebook identifies 514 entries for chemicals that are an inhalation hazard in the event of a spill or release. The guidebook provides an "isolation distance" and "protect" distances for small and large spills. Two protection distances are listed. One is recommended for a release during the day and the other for a release at night. Two distances are listed since the atmosphere is usually

more stable at night resulting in less atmospheric mixing and a higher downwind concentration. An Offsite Transportation Operational Emergency should be declared if an inhalation hazard chemical is released and the protection distance listed in the guidebook for the applicable time of day is less than the distance to populated areas or exceeds the distance to populated areas. An Offsite Transportation Operational Emergency declaration is appropriate if the material is identified as an inhalation hazard but the protection distance is less than the distance to populated areas.

5.6.3 Other Chemicals

An Offsite Transportation Operational Emergency classification should be declared if an explosive material identified by DOT Division numbers 1.1 through 1.6 is involved in an accident and a large explosion has occurred in populated areas or the load is threatened by a fire and populated areas are located within a mile. These materials have the potential to throw fragments one mile or more in the event of an explosion. Presently, shipments from Hanford of explosive material is not anticipated. If the chemical is not an explosive and not listed as an inhalation hazard but the shipment still requires warning placards by DOT regulations, the accident or threatening situation should be considered as an Offsite Transportation Operational Emergency.

6.0 EVENT CONSEQUENCES

6.1 CALCULATION MODELS

Consequences of the events and conditions identified in the appendices were estimated using several computational models. The Emergency Prediction Information (EPI) computer code was used to calculate the downwind concentrations from chemical releases. The Hanford Unified Dose Utility (HUDU) (Scherpelz 1991) program was used for the radiological dose calculations. These programs are typical of those used by Emergency Response organizations to assess the consequences of accidents.

The EPI program was developed by Homan Associates, Inc. for use in hazardous material emergency planning and response. The program is sold commercially and has five source models:

- Continuous Release
- Term Release
- Area Continuous
- Area Term
- Liquid Spill

The liquid spill option calculates the source term from a pool. The area continuous and area term options are also spills but the user must supply the source term. The EPI program uses both the plume and puff Gaussian dispersion models depending upon the duration of the release. The program

user's manual documents the features of the program. The specific options and parameters used to calculate the consequences of the postulated releases are documented in the appendices.

EPI does not accurately model heavy gases but can be used to predict the downwind concentration after the cloud has mixed with air. More complex heavy gas models are required close to the source of a large release. The general rule-of-thumb is that heavy gas models must be used for concentrations above 50,000 ppm (5%). The concentrations of interest in this document are far below this value and therefore EPI is used to obtain the results.

The HUDU program was developed for use in the Hanford emergency centers to provide a rapid initial assessment of radiological emergency situations. The code uses a straight-line Gaussian atmospheric dispersion model to estimate the transport of radionuclides released from an accident site. It calculates internal doses due to inhalation and external doses due to exposure to the plume.

6.2 RECEPTOR LOCATIONS

Consequences at several receptor locations were calculated as described below.

Emergency Responder Receptor

An Offsite Transportation Operational Emergency is appropriate if the only likely exposures to hazardous materials in excess of a Protective Action Guides (PAG) would be to personnel who might be engaged in the accident recovery, cleanup and investigation, whereby they could come in direct contact with the vehicle and its load. This definition cannot be used directly when comparing computer calculations with PAG since the calculational tools used to estimate the airborne concentrations of hazardous materials releases are not valid at such close distances. The strategy that has been adopted for calculations is to use 100 m as the receptor location but to base the categorization on a criteria less than the PAGs. The vehicle and immediate vicinity is initially used to categorize an Offsite Transportation Operational Emergency.

An Offsite Transportation Operational Emergency categorization is appropriate if protective action criteria will likely be exceeded near the accident but not outside the exclusion zone that would be established by the on-scene commander. An Offsite Transportation Operational Emergency categorization is appropriate if protective action guides are likely to be exceeded outside the exclusion zone. The emergency response guidebook uses the term "isolation zone" to describe the area (including upwind) around the incident in which persons may be exposed to life threatening concentrations. The DOT terminology will be used in the remainder of this document and will be assumed to be the area established by the on scene commander to exclude (isolate) non-responders from the incident.

The on-scene commander will likely be a local fire or law enforcement official. The isolation zone size will be established based on factors such as the location of intersections, advice from the shipper, guidelines remembered from training classes and guidelines in available reference materials.

The DOT has published an Emergency Response Guidebook for use by first responders to a transportation incident. Most police and fire departments consult this guidebook for advice on handling hazardous materials transportation accidents. The guidebook lists "initial isolation zone" and "protective action zone" distances for chemicals that are a potential acute inhalation hazard. The on-scene commander would establish a control zone for a spill of these chemicals at least as large as the initial isolation distance. These distances vary from 500 ft to 1500 ft depending upon which chemical was spilled and the size of the spill.

For the purpose of this hazards assessment, an event will be considered to have the potential to create an Offsite Transportation Operational Emergency if calculated airborne concentrations exceed PAGs at a distance of 100 m (330 ft) from the point of the release with adverse meteorology conditions. Adverse meteorology conditions are a wind speed of 1 m/second (2.2 mph) and "F" class atmospheric stability. The DOE event classification may be modified for an actual event based on the proximity of the threatened population. For example, a spill on a highway in a sparsely populated region may not have the potential to harm anyone other than the people involved in the accident, whereas the same spill on a road passing through a large city could threaten many people.

6.3 CRITERIA FOR EMERGENCY CATEGORIZATION

Listed below are the dose and concentration criteria used to determine categorization for the release scenarios.

Per DOE Order 151.1, all offsite shipment scenarios shall be categorized as an Offsite Transportation Operational Emergency regardless of severity.

6.3.1 Radiological

- A projected dose equivalent of 100 mrem at 100 m from the release to standard man, where the projected dose equivalent is the sum of the Effective Dose Equivalent (EDE) from exposure to external sources and the Committed Effective Dose Equivalent (CEDE) from inhalation during the early phase of a release.
- A projected dose equivalent of 1 rem at 100 m from the point of release to standard man, where the projected dose equivalent is the sum of the EDE from exposure to external sources and the CEDE from inhalation during the early phase of a release.
- A projected dose equivalent of 1 rem at the exclusion zone boundary to standard man, where the projected dose equivalent is the sum of the EDE from exposure to external sources and the CEDE from inhalation during the early phase of a release. The isolation zone boundary will be

assumed to be 200 m in this analysis to determine if a postulated accident has the potential to create an emergency equivalent in classification to a General Emergency. Categorization for an actual event will be based on the distance to threatened populations.

6.3.2 Hazardous Material

- A peak concentration in air that equals or exceeds the Emergency Response Planning Guideline-1 (ERPG) value, or equivalent, at 100 m from the release.
- A peak concentration in air that equals or exceeds the ERPG-2 value, or equivalent, at 100 m from the point of the release.
- A peak concentration in air that equals or exceeds the ERPG-2 value, or equivalent, at the exclusion zone boundary. The exclusion zone boundary will be assumed to be 200 m in this analysis to determine if the postulated accident has the potential to create an emergency equivalent in classification to a General Emergency. Categorization for an actual event will be based on the distance to threatened populations.

7.0 REFERENCES

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- DOE, 1987, *Environmental Impact Statement, Disposal of Hanford High-Level and Transuranic and Tank Wastes*, Hanford Site, Richland Washington, DOE/EIS-0113, U.S. Department of Energy, Washington, D.C.
- DOT, 1996, *1996 North American Emergency Response Guidebook*, U.S. Department of Transportation, Washington, D.C.
- Fisher, L. F. et al., 1987, *Shipping Container Response to Severe Highway and Railway Accident Conditions*, NUREG/CR-4829, U.S. Nuclear Regulatory Commission, Washington, D.C.
- Scherpelz, R.I., 1991, *HUDU - The Hanford Unified Dose Utility Computer Code*, PNL-7636, Pacific Northwest Laboratory, Richland Washington.
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APPENDIX A CHLORINE CONTAINER TRANSPORTATION

1.0 CHLORINE TRANSPORTATION

The potable water treatment systems in the 200 East, 200 West and 300 Areas currently use 2000 lb chlorine containers. The 100K and 100N water treatment systems have been converted to the use of 150 lb cylinders.

The supplier and carrier are responsible for the full containers on their way to Hanford. However, Hanford as the shipper, is responsible for the empty containers on the way back to be refilled. The "empty" containers are shipped with a poison gas placard because they may contain chlorine gas.

2.0 CHLORINE CONTAINER DESCRIPTION

One ton chlorine containers are used at the 200 Area and 300 Area water treatment plants. The smaller 150 lb cylinders used at the 100N and 100K treatment plants.

2.1 TON CHLORINE CONTAINERS

Ton chlorine containers have a chlorine capacity of 1920 lb and weigh approximately 3800 lb when full. They are welded tanks about 30 in. in diameter and 80 in. long. The heads are convex inward and forge welded to the barrel. The sides are crimped inward at each end to form chimes which provide a grip for lifting beams. Each container is equipped with two identical valves near the center of one end. Each valve connects with an internal education pipe.

The containers are equipped with six fusible metal plugs, three in each end, spaced 120° apart. The fusible metal is designed to yield or melt between 158 °F and 165 °F to relieve pressure and prevent rupture of the container in case of fire or other exposure to high temperature. Should a plug melt, an opening approximately 1/3 in. in diameter would be created to relieve pressure.

The chlorine systems operate at a vacuum. Therefore, almost all of the gas in the ton containers is exhausted before switching to a new tank. The vendor stated that the ton containers are typically returned with less than 4 lb of residual gas. There could be special circumstances where a nearly full container is returned. For example, if the discharge valve is damaged the container may be returned to the vendor for repair.

2.2 150 LB CYLINDERS

The 150 lb (68 kg) cylinders look like a typical gas cylinder. They are about 27 cm (10 3/4 in.) in diameter and 1.4 m (56 in.) high with a single valve at the top. The valve is protected with a screw-on cap when the valve is not in use. The cylinder may weigh as much as 132 kg (290 lb) when full. The cylinders are equipped with a pressure relief device consisting of a fusible metal plug in the valve body. The metal is designed to yield or melt between 70 °C and 74 °C (158 °F and 165 °F). The cylinders are moved within the facility with a hand truck. The cylinders are not designed to be lifted by the valve protective housing.

The water treatment systems operate on a vacuum. The cylinders typically contain less than a pound of chlorine when switched out. Under unusual circumstances, a cylinder with a substantial amount of chlorine could be returned to the vendor.

3.0 PROPERTIES

Chlorine is one of the most reactive and widely used chemical elements. Neither the gas nor the liquid is explosive or flammable. However, both react chemically with many substances. Chlorine is a gas at standard atmospheric pressure and temperature but is shipped and stored in pressurized containers as a liquid.

In low concentrations, gaseous chlorine is almost colorless. In higher concentration it has a yellowish-green color that can be readily seen. The gas has a characteristic odor and is about two and one-half times as heavy as air. Thus if it escapes from a container or system, it will tend to seek the lowest level in the building or area in which the leak occurs. Chlorine gas is nonflammable, but can support combustion, and may react explosively with organics, metals, and moisture. Chlorine gas (or liquid) leaks can get worse initially since the chlorine reacts with moisture in the air to form hydrochloric acid. The acid then corrodes the metal in the storage container causing an increase in the size of the leak.

However, a leak in a chlorine storage container may also seal itself. As the gas (or liquid) escapes, additional chlorine will evaporate in the container. The rapid evaporation may cool the liquid and container sufficiently to form an ice plug in the opening.

Liquid chlorine is amber in color and is about one and one-half times as heavy as water. At standard atmospheric pressure, it boils at about -29 °F and freezes at about -150 °F.

The bleach-like odor is apparent at about 0.2 part per million parts in air (ppm). At approximately 1 ppm, annoying symptoms manifest; nose and throat irritation, and eye lachrimation. Because of these properties, severe industrial exposures seldom occur. People usually leave the area because of the irritation before a severe exposure occurs. At 30 ppm, chlorine causes coughing. At 1000 ppm, chlorine is fatal in a very short time. Chlorine is primarily an irritant of the nose, windpipe, and lungs. It reacts with

moisture to liberate oxygen and form hydrochloric acid. The acid may cause tissue inflammation or burns. At lower airborne concentrations, the effects of chlorine exposure are generally reversible.

4.0 CHLORINE RELEASE SCENARIOS

Transportation related failure modes are the same for ton containers and the smaller cylinders.

4.1 FAILURE OF PRIMARY BARRIER

The container (cylinder) barriers are the tank walls, valves, and fusible plugs. These barriers could fail by any of several modes:

- a. The tank could be dropped while being unloaded from the transport truck. A fall could damage a valve or puncture the tank. The leak rate would depend on the opening size and the pressure in the container.
- b. The tank could be punctured by debris in an accident or be struck by another vehicle or an object while the truck is parked.
- c. An improperly secured load could result in a container falling from a moving truck.
- d. A transport vehicle accident could damage the container. Accidents can vary from minor with no damage to the load to severe impacts and rollovers followed by a fire. The truck could fall from a bridge or overpass or roll down a steep bank beside the road. The postulated worst case transportation accident is a severe impact that ruptures one or more containers.
- e. An act of sabotage or malevolent event could release chlorine. An explosive or projectile could breach a tank. Sabotage to the transport vehicle could cause an accident and/or a fire.
- f. A fire causing melting of one or more fusible plugs. Each ton container has six fusible metal plugs, three in each end, spaced 120° apart. The 150 lb cylinders have a single plug in the valve assembly. The fusible metal is designed to yield or melt between 158 °F and 165 °F (70°C and 74°C) to relieve pressure and prevent rupture of the tank in case of fire or other exposure to high temperature. The leak rate would depend upon the number of plugs that melted and whether they are venting liquid or gaseous chlorine.

4.2 RANGE OF POSSIBLE RELEASES

Both the ton containers and the cylinders are typically shipped back to the vendor with less than 4 lb of residual chlorine in each container. This amount may cause airborne concentrations above the Protective Action Guidelines but only for people standing near the damaged container(s). This situation would be an Offsite Transportation Operational Emergency.

Three cases will be considered below for the unlikely event that a cylinder or ton container is returned to the vendor before it is emptied. The first is a relatively small gas leak of 15 lb per hour. This could occur from a valve leak or a small hole in the container. The second case is a sudden release from a full 150 lb cylinder. The last case is a sudden release from a full ton container.

5.0 CHLORINE RELEASE CONSEQUENCES

The Emergency Prediction Information continuous release option was used to model the small (15 lb/h) chlorine release. The instantaneous release option was used to model the large chlorine releases. The postulated conditions were "F" class stability, 1 m/s wind speed and a ground level standard terrain release. The results are shown in Table A.5.1.

Table A.5.1. Chlorine Release Results.

Leak Size	100 m	200 m	Distance to ERPG-3
15 lb/h	30 ppm	7.5 ppm	.15 km (500 ft)
150 lb Cylinder	over 500,000 ppm	110,000 ppm	3.5 km (2.2 mi)
Ton Container	over 500,000 ppm	>500,000 ppm	8 km (5 mi)

The Emergency Response Planning Guidelines-1,2,3 values are 1 ppm, 3 ppm, and 20 ppm, respectively. These results indicate that a small leak or large leak from a full cylinder or ton container would be an Offsite Transportation Operational Emergency.

The U.S. Department of Transportation (DOT) has provided a North American Emergency Response Guidebook (DOT 1996) for first responders during the initial phase of a hazardous materials incident. Chlorine is listed as an inhalation hazard with a small spill initial isolation distance of 200 ft and protection distances of 0.2 mi for a day time spill and 0.5 mi for a night time spill. A release from a 150 lb cylinder is classed as a small spill by the DOT. The isolation distance is 600 ft for a large spill and the protection distances are 0.5 mi (daytime) and 1.9 mi (nighttime). A release from a ton container is a large spill.

The DOT guidebook is widely used by emergency response organizations. The recommendations in the guidebook are consistent with the emergency classifications suggested above for full cylinders or containers. They are very conservative for empty containers being returned for refilling.

6.0 ADVICE TO FIRST RESPONDERS

The Hanford shipper is responsible for providing shipper-related emergency information and must maintain a 24 hour emergency telephone number for technical advice and detailed information regarding the shipments. The attachment provides a brief general summary of the load and the potential hazards.

7.0 REFERENCES

DOT, 1996, *1996 North American Emergency Response Guidebook*, U.S. Department of Transportation, Washington, D.C.

**ATTACHMENT
CHLORINE CONTAINER SUMMARY**

Identification of Hazardous Material

The chlorine containers from Hanford are being returned to the vendor for refilling. They may contain a few pounds of chlorine liquid and gas. In very unusual circumstances, a container with a significant amount of chlorine may be returned to the vendor. The shipping papers will indicate if residual or significant amounts of chlorine are in the containers.

Potential Concerns in the Event of an Accident

Chlorine is an inhalation hazard that causes severe health effects in high concentrations. The hazard from residual amounts in empty containers is limited to a few feet from the release. Larger amounts can cause health effects several miles downwind (see DOT response guide).

DOT Response Guide

Follow DOT Emergency Response Guide 124 (1996 edition) until it can be verified by shipping papers or other means that only empty containers are involved in the accident.

APPENDIX B CESIUM CAPSULE TRANSPORTATION

1.0 INTRODUCTION

Cesium capsules will be shipped from the Waste Encapsulation and Storage Facility (WESF) located in the 200E Area of the Hanford site to offsite locations. The capsules will be transported in the Beneficial Uses Shipping System (BUSS) cask with sixteen capsules per shipment. The shipment is classified as a Highway Route Controlled Quantity shipment with approximately 720,000 Ci of cesium in each shipment. The BUSS cask is a U.S. Department of Energy (DOE) and U.S. Nuclear Regulatory Commission certified Type B shipping container. During previous shipping campaigns, extensive briefings and training for State and local police, fire departments and emergency response organizations were conducted.

2.0 BUSS CASK DESCRIPTION

The major components of the BUSS cask system (Figure B.2.1) include the cask body and lid, basket, impact limiters, personnel barrier, and skid. The maximum gross weight of the system is approximately 33,000 lb (15,300 kg).

The BUSS cask body is a one-piece, cylindrical forging with envelope dimension of 54.25 in. (137.8 cm) OD and 49 in. (124.5 cm) high. Eleven circumferential fins are situated about the axial midplane of the cask body. The fins are an integral, nonwelded part of the container walls. The cask body has a cylindrical cavity with dimensions of 20.25 in. (51.44 cm) diameter and 23.0 in. (58.4 cm) high. Besides the opening for the lid, there are two other penetrations into the interior of the cask body: a 1.25 in. (3.18 cm) diameter inlet port near the lid end of the container and a diametrically opposite identical drain port at the bottom of the cask cavity. Both ports are fitted with a thermal cover (shield), bolted port cover and recessed seal. The walls and closed end of the cask body are a minimum of 13 in. (33 cm) thick.

The cask lid is a one-piece forging. The lid is bolted to the cask body by using 12 corrosion resistant steel 1 1/2 in. (3.81 cm) diameter bolts. Two diametrically opposite 0.125 in. (0.318 cm) diameter holes penetrate the flange of the lid to enable leak checking the lid seal.

The cask body and lid are both fabricated from ASTM A473, Type 304 stainless steel. The cask lid and port seals consist of concentric double seals, one of copper and the other elastomeric. In each case the metallic seal is located in-board to the elastomeric seal relative to the cask interior.

Figure B.2.1. Principal Structural Members of the BUSS Cask.

The BUSS cask is provided with an impact limiter at each end. The limiters are shells fabricated from a 0.120 in. (0.305 cm) to 0.250 in. (0.635 cm) thick Type 304 stainless steel sheet and filled with moderate-density polyurethane foam. The foam thickness is about 18 in. (45.7 cm) on the sides and 17 in. (68.6 cm) on the ends of the container. On the surfaces of the limiters next to the cask are rings with 0.5 in. (1.27 cm) holes that maintain clearance between the cask and the limiters and enable air to circulate around the ends of the container. The limiters are held in place on the cask with four turnbuckles.

The BUSS cask personnel barrier is designed to prevent burns since the surface of the cask can be over 100 °F (38 °C). The cask heat load is approximately 4 kw with a full load of sixteen Cs capsules. The barrier is attached to the transport trailer frame between the impact limiters and defines the accessible surface of the container about 18 in. (45.7 cm) above the actual cask surface.

The BUSS cask is transported on a cask skid attached to a dedicated trailer system. The skid is designed to allow the assembled cask system to be tied to the transport vehicle.

3.0 CASK PAYLOAD

Sixteen CsCl capsules can be transported in the BUSS cask.

4.0 PROPERTIES

The capsules are a radioactive cesium chloride salt that is doubly encapsulated in closed-end stainless steel metal cylinders. The outer capsule container is approximately 2 5/8 in. (6.7 cm) in diameter and 20 3/4 in. (52 cm) long (Figure B.4.1). The average activity of each capsule is about 45,000 Ci of Cs-137. Table B.4.1 summarizes the capsule dimensions and contents.

The cesium capsules passed all Special Form tests and were qualified as Special Form in 1975. The tests verified that the capsules will retain their contents if subjected to the following conditions:

1. Free drop - A free drop through a distance of 30 ft onto a flat essentially unyielding horizontal surface.
2. Percussion - Impact of the flat circular end of a 1 in. diameter steel rod weighing 3 lb, dropped through a distance of 40 in.

Figure B.4.1. Cutaway Sketch of a Typical WESF Capsule.

3. Heating - Heating in air to a temperature of 1475°F and remaining at that temperature for a period of 10 minutes.
4. Immersion - Immersion for 24 hours in water at room temperature.

The regulations were subsequently amended to require additional leak tests after each special form test and an increased temperature for the immersion test. The cesium capsules were shown to meet these additional requirements although they were exempt from these requirements by a grandfather clause in the revised regulation.

A cesium capsule failure was detected in June, 1988 at a commercial irradiation facility, Radiation Sterilizers Inc. (RSI), in Decatur, Georgia.

A subsequent investigation concluded that all WESF cesium capsules met Special Form requirements when fabricated. However, a total of 12 cesium capsules in the field have been found to leak or swell due to thermal cycling at the facility. Eleven of these were identified at the RSI facility and one from the Westerville, Ohio facility.

The BUSS Cask Certificate of Compliance is being amended to allow shipment of the cesium capsules as "Normal Form," to ensure safety and compliance to U.S. Department of Transportation (DOT) regulations in the event that the payload (capsules) does not meet Special Form requirements.

Table B.4.1. Physical Data and Curie Loading of a Cesium Chloride WESF Capsule.

<u>Capsule Property</u> Material	<u>Inner Capsule</u> 316L Stainless Steel	<u>Outer Capsule</u> 316L Stainless Steel
Inner Diameter, in. (cm)	1.978 (5.024)	2.353 (5.977)
Outer Diameter, in. (cm)	2.250 (5.715)	2.625 (6.668)
Total Length, in. (cm)	19.725 (50.10)	20.775 (52.77)
Cesium Chloride		
Quantity, lb (kg)	5.9 (2.7)	
CsCl Chemical purity, wt%	90 to 95	
Cs-137 Isotopic Content, %	30.2	
Density, g/cm ³	2.6	
Maximum Nominal Capsule Activity, Ci of Cs-137	70,000	
Maximum Thermal Power, W	33	
Melting Point,* °F (°C)	1195 (646)	

* Dependent on purity

5.0 ACCIDENT SCENARIOS

The BUSS cask is a certified Type B package and therefore is designed to withstand accident conditions. Furthermore, the capsules themselves are double encapsulated and capable of withstanding many accidents. The probability of a release in a transportation accident is very small. However, to establish the maximum potential consequences of an accident, a severe accident is postulated that breaches the cask and several capsules.

The following conditions could lead to a release.

5.1 FAILURE OF PRIMARY BARRIER

The primary barrier is the BUSS cask. The following conditions may compromise the integrity of the cask.

- a. The cask could be damaged by a fire. This condition could exist by itself or be in conjunction with mechanical damage caused by an accident. The cask is designed to protect the contents from excessive temperature in a fire that lasts for 30 minutes. Therefore, it would take an abnormally long or hot fire to compromise the cask integrity.
- b. Puncturing by external impact. The cask body is made of 13 in. (33 cm) thick stainless steel. Penetration is unlikely in almost all accidents.
- c. Free Drop. The BUSS cask was analyzed for the effects of a thirty foot drop. This test simulates several accident conditions: a drop from a crane during loading, a fall from a bridge or overpass in an accident or, an impact at approximately 30 mph with a solid object. The BUSS cask passed the test and therefore is expected to survive most accidents.
- d. Transport vehicle accident. For the purpose of determining the maximum emergency classification equivalence, a severe accident that exceeds the design criteria for the cask is postulated.
- e. An act of sabotage or malevolent event resulting in breach of the BUSS cask. The cask is so massive that a large external explosive would be required to create a release. The truck could be hijacked but it would be difficult to open the cask and disperse the contents since the impact limiters are heavy, the cask surface is hot and the radiation levels are high if the capsules are taken out of the cask. Sabotage to the transport vehicle could cause an accident.

5.2 EFFECTS OF OTHER BARRIERS

The capsules themselves provide a substantial barrier to the release of radioactive cesium to the air. The capsules are double encapsulated (although not considered special form for these shipments). They would probably survive being ejected from the cask. The capsules, however, could be crushed by a heavy object such as the cask itself or be breached by an extended period of high temperature.

5.3 RANGE OF POSSIBLE RELEASES

Most likely there will be no release from the BUSS cask in a transportation accident because the cask is designed to withstand severe accident conditions. Less than 1% of accidents (Fisher 1987) are severe enough to exceed the design criteria for the cask. The environmental assessment for the return of the capsules (DOE 1994) divided the spectrum of accidents into six severity categories. They ranged from minor accidents (Severity Category 1) to a 150 mph crash followed by a fire that lasted for more than three hours (Severity Category 6). There was no release for the first three severity categories since these events were within the cask design specifications. The worst case severity (Category 6) has a release fraction of $2.0 \text{ E-}03$.

6.0 BUSS CASK VEHICLE ACCIDENT

This scenario postulates a Severity Category 6 accident. The cask is breached and the capsules are pressure ruptured by heating in the subsequent fire. The overall release fraction is $2.0 \text{ E-}03$ with a respirable fraction of 1.0 (DOE 1994).

The source term is derived by multiplying the activity in each capsule by the number of capsules and the release fraction.

$$\text{Source (Ci of } ^{137}\text{Cs, } ^{137}\text{Ba)} = (45,000 \text{ Ci per capsule})(16 \text{ capsules})(2 \text{ E-}3)$$

$$\text{Source} = 1440 \text{ Ci}$$

The 50 year committed dose values calculated with the Hanford Unified Dose Utility program are shown in Table B.6.1. The assumed conditions were a ground level release with a 1.0 m/s wind speed, "F" class atmospheric stability and a 60 m mixing layer depth. In most cases, actual meteorological conditions would result in faster dispersion and lower dose values.

Table B.6.1. BUSS Cask Accident Dose Results.

Distance		Dose (rem)
Km	Miles	
0.1	.06	420
0.2	.12	130
1.6	1.0	4.0
3.2	2.0	1.5
4.5	2.8	1.0
4.8	3.0	0.85
8.0	5.0	0.45

A Severity Class 6 accident has the potential to reach an Offsite Transportation Operational Emergency. There could be an extreme hazard near the accident. Only a few minutes exposure near a single unshielded capsule could be lethal.

7.0 EMERGENCY CLASSIFICATION

The BUSS cask is designed to withstand many accidents. It may be difficult, however, to quickly verify cask integrity. An Offsite Transportation Operational Emergency should be declared if a loaded cask is damaged in an accident or threatened by a natural disaster, civil disturbance, or malevolent event. The categorization should be declared if there is a fire lasting longer than the 30 minute design criteria for the cask or if a release has occurred or is judged to be likely. Radiation levels greater than 10 mR/h at distances greater than 2 m from the cask indicate a possible cask breach.

8.0 ADVICE TO FIRST RESPONDERS

Waste Management Federal Services, Inc., Northwest Operations is responsible for providing shipper-related emergency information and must ensure that a 24-hour emergency telephone number for technical advice and detailed information regarding the shipments is maintained. It is likely, however, that the first responders will have some knowledge of the cask and the hazards since briefings have been conducted along the transportation corridor. The drivers are also trained and prepared to inform first responders about the load and to give assistance at the event scene. The transporter utilized will have an emergency response organization and capabilities for emergency response and recovery actions at the scene. An Emergency Response Plan and Cesium Cask Recovery Guide has been prepared. The

plan suggests that DOT Emergency Response Guide number 163 (DOT 1996) be followed until more specific advice is provided based on conditions at the scene. The attachment provides a brief general summary of the load and the potential hazards.

9.0 REFERENCES

- DOE, 1994, *Environmental Assessment - Return of Isotope Capsules to the Waste Encapsulation and Storage Facility*, DOE/EA-0942, U.S. Department of Energy, Washington, D.C.
- Fisher, L. F. et al., 1987, *Shipping Container Response to Severe Highway and Railway Accident Conditions*, NUREG/CR-4829, U.S. Nuclear Regulatory Commission, Washington, D.C.
- DOT, 1996, *1996 North American Emergency Response Guidebook*, U.S. Department of Transportation, Washington, D.C.

**ATTACHMENT
BUSS CASK SUMMARY**

Identification of Hazardous Material

The cask contains up to 16 cesium capsules. Each capsules has a Cs-137 activity of 45,000 Ci for a total cask load of 720,000 Ci. The decay product Ba-137m is in equilibrium.

Potential Concerns in the Event of an Accident

The BUSS cask is a U.S. Department of Energy certified Type B package. The cask is designed to withstand accidents including a fire. A cask breach is not expected for almost all accidents. Damage to the impact limiters or separation of the impact limiters from the cask does not necessarily indicate a breach of the cask. In the unlikely event of a breach, life threatening levels of radiation may be present near the accident. The surface of the cask is hot to the touch and may cause thermal burns.

DOT Response Guide

Follow DOT Emergency Response Guide 163 (1996 edition) pending advice from the carrier, the carrier emergency response contractor, Federal or State officials based on the conditions at the scene of the accident.

APPENDIX C

T-3 SPENT FUEL SHIPPING CASK

1.0 INTRODUCTION

The T-3 cask is used to transport irradiated fuel pins, assemblies, and components to other U.S. Department of Energy (DOE) sites. The near term anticipated use is to ship fuel pins that were irradiated in the Fast Flux Test Facility (FFTF) from the Hanford Site to the Idaho National Engineering Laboratory. The T-3 cask is certified by both the DOE and U.S. Nuclear Regulatory Commission (NRC) for spent fuel shipments.

2.0 CASK DESCRIPTION

The major components of the T-3 cask system (Figure C.2.1) include the containment vessel and lid, lead shielding, outer shell, and impact limiters. The overall dimensions are 541.5 cm (17 ft 9 in.) in length and 132.1 cm (4 ft 4 in.) in diameter. The cask without the impact limiters measures 450.1 cm (177.2 in.) in length and 67.16 cm (26.44 in.) in diameter. The maximum gross weight of the cask and contents is approximately 17,706 kg (39,000 lb).

The inner shell (containment vessel) is a standard seamless stainless steel schedule 40 pipe having an outside diameter of 21.9 cm (8.625 in.) with a nominal wall thickness of 0.82 cm (0.322 in.). The outer cask shell is comprised of a 2.54 cm (1 in.) thick stainless steel shell overlaid with a 10 gauge stainless steel cover. The annular space between the inner and outer shells is filled with lead having a thickness of approximately 20.3 cm (8 in.).

The containment vessel is sealed at the bottom end with a 30.05 cm (11.83 in.) thick stainless steel plug with two Viton O-ring seals. The top end of the containment vessel is sealed with a 29.53 cm (11.625 in.) thick stainless steel plug with two Viton O-ring seals. The bottom plug is retained by a bolted closure plate. The top plug is secured in place with hex flange screws.

No drain or vents penetrate directly into the containment vessel. A drain/vent line opens directly into the area between the two O-ring seals at each end of the cask. The lines are sealed during shipment.

Impact limiters are placed on the top and bottom of the cask during shipment. The impact limiters are cylindrical shells filled with rigid polyurethane foam.

Figure C.2.1. Schematic of the T-3 Cask.

3.0 CASK PAYLOAD

The T-3 cask is authorized to transport irradiated, (a) mixed oxide fuel pins and assemblies, (b) reactor fuel comprised of U-235 and/or Pu-239 oxides, carbides, nitrides, or metallic alloys, and (c) structural components. The minimum cooling time of each assembly and rod must be 90 days and the cask may contain 1,400 thermal watts.

4.0 PROPERTIES

The T-3 cask is authorized to carry a variety of loads from complete irradiated FFTF fuel assemblies to irradiated reactor structural components such as control assemblies. Complete fuel assemblies are potentially the most hazardous loads anticipated in the near future.

FFTF fuel assemblies are hexagonal shaped components, 12 cm (4.715 in.) across outside load pad flats and 3.66 m (12 ft) long. The assembly contains a bundle of fuel pins arranged in a hexagonal lattice. The standard FFTF fuel assembly had 217 pins, 0.58 cm (0.23 in.) outer diameter, and contained mixed oxide fuel pellets. The metal fuel test assemblies have 169 pins, 0.69 cm (0.27 in.) OD, with uranium-plutonium-zirconium metal alloy fuel. There is a small amount of sodium in the metal fuel test pins to improve the heat transfer to the cladding. Both types of fuel pins were approximately 2.39 m (94 in.) long but the region that contained fuel was only 91.4 cm (36 in.) long. These dimensions are before irradiation. The pins swell, grow in length and twist with irradiation. Fuel assemblies may contain up to 200 g of residual sodium that is solidified in various cracks and crevices.

The inventory of fission products and remaining fuel in each assembly depends upon the initial loading, the irradiation location in the reactor and the length of irradiation. A total assembly may contain over 200,000 Ci of activity.

5.0 ACCIDENT SCENARIOS

The T-3 cask is a DOE and NRC certified Type B container and is designed to withstand accident conditions. The probability of a release in a transportation accident is very small. If the cask is breached, most likely any release would be from a closure seal leak or a small split in the wall. However, to establish the maximum potential consequences of an accident, a severe accident is postulated that breaches the cask and releases a fraction of the entire contents.

The following conditions could lead to a release.

5.1 FAILURE OF PRIMARY BARRIER

The following conditions may compromise the integrity of the cask.

- a. The cask could be damaged by a fire. This condition could exist by itself or be in conjunction with mechanical damage caused by an accident. The cask is designed to protect the contents from excessive temperature in a fire that lasts for 30 minutes. Therefore, it would take an abnormally long or hot fire to compromise the cask integrity.
- b. Puncturing by external impact. The cask walls include a 1 in. (2.54 cm) thick stainless steel wall around a 8 in. (20.3 cm) lead shield with a 0.322 in. (0.82 cm) stainless steel inner wall. Penetration is unlikely in almost all accidents.
- c. Free Drop. The T-3 cask was analyzed for the effects of a thirty foot drop. This test simulates several accident conditions: a drop from a crane during loading, a fall from a bridge or overpass in an accident or, an impact at approximately 30 mph with a solid object. The cask passed the test and, therefore, is expected to survive most accidents.
- d. Transport vehicle accident. For the purpose of determining the maximum emergency classification, a severe accident that exceeds the design criteria for the cask is postulated.
- e. An act of sabotage or malevolent event resulting in breach of the cask. The cask is so massive that a large external explosive would be required to create a release. The truck could be hijacked but it would be difficult to quickly open the cask and disperse the contents. Sabotage to the transport vehicle could cause an accident.

5.2 EFFECTS OF OTHER BARRIERS

The fuel cladding provides a barrier to the release of fuel particles and fission products. If the entire fuel assembly is shipped, the duct wall and assembly structure provide some mechanical protection for the pins. The release fractions specified below are assumed to be the fraction released from the fuel through a cask breach to the atmosphere.

5.3 RANGE OF POSSIBLE RELEASES

Most likely there will be no release from the T-3 cask in a transportation accident since the cask is designed to withstand severe accident conditions. Less than 1% of accidents (Fisher 1987) are severe enough to exceed the design criteria for the cask. A Radiological Transportation Risk Assessment (Green 1995) has been written for the T-3 cask transportation of metal fuel. The risk assessment divided the spectrum of

accidents into six Severity Categories. They ranged from minor accidents (Severity Category 1) to a severe accident followed by a fire (Severity Category 6). There was no release for the first severity category since this event was within the design specifications for the cask. The worst case (Severity Category 6) was assigned release fractions that varied from 0.63 for noble gases to 1.0×10^{-7} for spent fuel particles.

6.0 T-3 CASK VEHICLE ACCIDENT

This scenario postulates a Severity Category 6 accident. The cask is breached and a fraction of the contents released to the air in respirable form. Different release fractions and respirable fractions are assigned for each physical-chemical group, Table C.6.1. These values are based on the metal fuel T-3 cask transportation risk assessment (Green 1995). However, the Severity Category 6 values in Table C.6.1 for halogens, cesium, ruthenium and particulates are a factor of ten higher than the values used in the risk assessment document to account for the considerable uncertainty in the values and to ensure that the beyond design bases worst case accident is conservatively classified.

The source term is derived by multiplying the inventory in the cask by the product of the release and respirable fractions. The cask may be used to transport entire fuel assemblies or pin containers with various numbers of pins. The worst case inventory is an entire 169 pin fuel assembly. The inventory values were calculated using the ORIGEN2 computer program assuming that a fuel assembly generating 7.4 MW of power is irradiated for 1133 days (200 MWD/kg) followed by 850 days of decay. The activity for the various isotopes is listed in Table 1 (page 33) in the transportation risk assessment document. Only a few of the isotopes are important dose contributors in a release. Table C.6.2 summarizes the source term for the isotopes that contribute a significant dose in the unlikely event of a Severity Category 6 release.

The dose was calculated with the Hanford Unified Dose Utility (HUDU) program (Scherpelez 1991). The assumed conditions were a ground level release with "F" atmospheric stability, 1.0 m/s (2.2 mph) wind speed and a 60 m mixing layer depth. The calculated dose is 1.4 rem at 100 m and 420 mrem at 200 m. These results place this event as an Offsite Transportation Operational Emergency. An actual release from a loaded T-3 cask would be classified as an Offsite Transportation Operational Emergency.

Table C.6.1. Release and Respirable Fractions.

Severity Category	1	2	3	4	5	6
Release Fraction						
Noble Gas	0	0.0099	0.033	0.39	0.33	0.63
Halogens	0	1.1 E-07	3.5 E-07	6 E-06	3.5 E-06	6 E-04
Vol. Sol.	0	3 E-08	1 E-07	1 E-06	1 E-06	1 E-04
Particles	0	3 E-10	1 E-09	1 E-08	1 E-08	1 E-06
Ruthenium	0	4.1 E-09	1.4 E-08	2.4 E-07	1.4 E-07	2.4 E-05
Respirable Fraction						
Noble Gas	1	1	1	1	1	1
Halogens	1	1	1	1	1	1
Vol. Sol.	0.05	0.05	0.05	0.05	1	1
Particles	0.05	0.05	0.05	0.05	0.05	0.05
Ruthenium	0.05	0.05	0.05	0.05	0.05	0.05

Table C.6.2. Respirable Activity Released to the Air.

Isotope	Source Term (Ci)
⁸⁵ Kr	1,625
¹⁰⁶ Ru	1.54 E-02
¹³⁴ Cs	1.14
¹³⁷ Cs	2.45
²³⁸ Pu	2.14 E-05
²³⁹ Pu	5.70 E-06

7.0 EMERGENCY CLASSIFICATION

The T-3 cask is designed to withstand many accidents. It may be difficult, however, to quickly verify cask integrity. An Offsite Transportation Operational Emergency should be declared if a loaded cask is damaged in an accident or threatened by a natural disaster, civil disturbance, or malevolent event. The categorization should be declared if there is a fire lasting longer than the 30 minute design criteria for the cask or if a release has occurred or is judged to be likely. Radiation levels greater than 10 mR/h at distances greater than 2 m from the cask indicate a possible cask breach.

8.0 ADVICE TO FIRST RESPONDERS

Waste Management Federal Services, Inc., Northwest Operations is responsible for providing shipper-related emergency information and for ensuring that a 24-hour emergency telephone number for technical advice and detailed information regarding the shipments. The attachment provides a brief general summary of the load and the potential hazards.

9.0 REFERENCES

- Fischer, L. F. et al., 1987; *Shipping Container Response to Severe Highway and Railway Accident Conditions*, NUREG/CR-4829, U.S. Nuclear Regulatory Commission, Washington, D.C.
- Green, J.R., 1995, *Radiological Transportation Risk Assessment of the Shipment of Sodium-Bonded Fuel from the Fast Flux Test Facility to the Idaho National Engineering Laboratory*, WNC-SD-TP-RPT-013, Rev.1
- Napier, B. A., R. A. Peloquin, D. L. Strenge, and J. V. Ramsdell, 1988, *GENII - The Hanford Environmental Radiation Dosimetry Software System*, Vol. 1-3. PNL-6584, Pacific Northwest Laboratory, Richland, Washington.
- Scherpelz, R.I., 1991, *HUDD - The Hanford Unified Dose Utility Computer Code*, PNL-7636, Pacific Northwest Laboratory, Richland Washington.

**ATTACHMENT
T-3 CASK SUMMARY**

Identification of Hazardous Material

Spent nuclear fuel that was irradiated in the Fast Flux Test Facility at the Hanford Site. The cask may contain individual fuel pins or a complete assembly. Nuclear criticality is not a concern even if the cask is submerged in water or water is used to fight a fire.

Potential Concerns in the Event of an Accident

The T-3 cask is a U.S. Department of Energy certified Type B package. The cask is designed to withstand accidents including a fire. A cask breach is not expected for almost all accidents. Damage to the impact limiters or separation of the impact limiters from the cask does not necessarily indicate a breach of the cask. In the unlikely event of a breach, life threatening levels of radiation may be present near the accident.

DOT Response Guide

Follow DOT Emergency Response Guide 165 (1996 edition) pending specific advice from Federal or State officials based on the conditions at the scene of the accident.

APPENDIX D BULK OIL TRANSPORTATION

1.0 INTRODUCTION

Bulk oil (gasoline, diesel fuel, oil) is a fire hazard and an environmental pollution concern. U.S. Department of Transportation (DOT), U.S. Environmental Protection Agency (EPA), and State regulations specify spill reporting and cleanup responsibility. The sections below summarize the bulk oil products transported offsite and the contractual arrangements for complying with the various regulations.

2.0 DESCRIPTION OF OFFSITE TRANSPORTATION OF PETROLEUM PRODUCTS

Table D.2.1 summarizes recent bulk oil shipments transported from the Hanford site as waste or recyclable oil. This information was compiled based on review of bulk oil shipment documentation and discussion with primary users of oil in bulk quantities.

**Table D.2.1. Description of Bulk Waste Oil Transported Offsite (Outbound)
from January 1994 to February 1995.**

Date	Package	Amount (Kg)	Gallons (Nominal Density = .85)	Description
1-11-94	Tanker	2355	529	off- specification oil
1-24-94	Tanker	16564	3713	PCB mineral oil
2-25-94	Tanker	1591	357	used oil
3-11-94	Tanker	10882	2440	used oil
4-15-94	Tanker	1534	344	used oil
4-18-94	Tanker	16943	3798	PCB mineral oil, < 500 ppm
4-27-94	Tanker	2857	641	off- specification oil
5-17-94	Tanker	3536	793	specification oil
5-31-94	Tanker	1564	351	specification oil

Date	Package	Amount (Kg)	Gallons (Nominal Density = .85)	Description
6-28-94	Tanker	3645	817	specification oil
7-11-94	Tanker	5982	1341	specification oil
7-18-94	Tanker	14155	3173	RQ, diesel fuel
8-25-94	Tanker	3136	703	specification oil
8-30-94	Tanker	15755	3532	PCB mineral oil, 50-499 ppm
9-13-94	Tanker	4255	954	specification oil
9-28-94	Tanker	1164	261	off- specification oil
10-17-94	Tanker	2588	581	off- specification oil
11-4-94	Tanker	4136	928	specification oil
11-28-94	Tanker	3582	803	specification oil
11-30-94	Tanker	16281	3650	PCB oil, 50-499 ppm
1-5-95	Tanker	5818	1305	specification oil
1-30-95	Tanker	246	56	water/diesel (non-regulated)
2-14-95	Tanker	3282	735	bulk oil
2-21-95	DM	1929.32	432	bulk oil
2-24-95	Tanker	5091	1142	specification oil
9-14-95	DM	68.1	15.3	bulk oil
1-17-96	Tanker	15,637	3504	bulk oil
9-05-96	DM	65.95	14.8	bulk oil
2-14-97	Tanker	8725	2000	bulk oil

The amounts are small when compared with the thousands of gallons typically carried in trucks, rail cars and barges. Several of the shipments did, however, exceed the 3500 gal threshold specified in 49 CFR 130. This DOT regulation requires the carrier to have a written plan for spill response and notification. Four of the shipments in the table above were contaminated with polychlorinated biphenyls (PCB). This material is a known carcinogen and is considered to be a hazardous substance in concentrations above 500 ppm. PCBs spills will be classified using the general guidance in the main body of this document.

3.0 SPILL NOTIFICATION AND CLEANUP

Bulk oil spills are an environmental pollution concern. The transporter is responsible by contract and regulations for spill notifications and cleanup. Spills of these materials are not classified emergencies in the U.S. Department of Energy (DOE) emergency system. They may, however, be reportable within the DOE occurrence notification system. Refer to WHC-CM-1-5 for guidance on occurrence reporting. Refer to WHC-CM-2-14 for the hazardous waste shipping requirements.

4.0 EMERGENCY CLASSIFICATION FOR A FIRE

Oil, gasoline and diesel fuel are well known fire hazards. The DOT Emergency Response Guide 128 suggests a 1/2 mi isolation distance in all directions if a tank, rail car or tank truck is involved in a fire. High temperatures can occur up to a third of a mile from a large fire. Gasoline and diesel fuel vapor explosions may throw fragments of the container and spread the fire. These hazards are well understood by the public. Every fire department trains for fires involving these materials. An off site transportation fire involving DOE owned waste oil products that are not contaminated with radioactivity is not a classified emergency in the DOE system. Timely notification within the occurrence reporting system is expected. By DOT regulations, Hanford must maintain a 24 hour a day contact point to answer emergency responder's questions about the load.

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