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COMPARATIVE STUDY OF WASTE ISOLATION PILOT PLANT (WIPP) TRANSPORTATION ALTERNATIVES

DEPARTMENT OF ENERGY • UNITED STATES OF AMERICA •

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ABSTRACT

The Waste Isolation Pilot Plant (WIPP) is a research and development facility designed to demonstrate the safe disposal of transuranic (TRU) radioactive waste resulting from U.S. defense activities and programs. The U.S. Department of Energy (DOE) has designed the WIPP facility as a deep geologic repository for waste currently stored at or generated by ten DOE defense facilities located throughout the United States. TRU waste is radioactive waste containing alpha-emitting radionuclides with atomic numbers greater than 92, half-lives exceeding 20 years, and concentrations greater than 100 nanocuries per gram of waste.

The WIPP Land Withdrawal Act (Public Law 102-579) was enacted on October 30, 1992. The Land Withdrawal Act (LWA) withdrew the WIPP site from the public domain and transferred them from the Secretary of the Interior to the Secretary of Energy. The LWA also established that "the Secretary of Energy shall conduct a study comparing the shipment of transuranic waste to the WIPP facility by truck and by rail" [section 16(f)]. This report fulfills that requirement.

Chapter 1 (*Introduction*) provides information about the background, purpose, and scope of this study.

Chapter 2 (*Transportation Requirements*) describes relevant transportation requirements of the U.S. Nuclear Regulatory Commission (NRC), the U.S. Department of Transportation (DOT), and the U.S. Department of Energy (DOE).

Chapter 3 (*Responsibilities*) discusses the responsibilities of the DOE, NRC, DOT, States, local, and Indian tribal governments, and DOE contractors.

Chapter 4 (*Transportation System*) discusses the packagings to be used, transportation fleet, shipment options, waste volumes, training, and tracking system.

Chapter 5 (*Transportation Risks*) presents the results of the risk analysis in terms of human health and environmental impacts.

Chapter 6 (*Emergency Response*) reports the responsibilities of organizations responding in the event of an incident/accident involving TRU waste shipments to the WIPP.

Chapter 7 *(Costs)* analyzes costs for transportation using three different options during the disposal phase.

Chapter 8 (*Comparison of Transportation Options*) summarizes transportation risks, emergency responses, and costs for the disposal phase.

Appendix A includes relevant information from the *WIPP Waste Acceptance Criteria* and the NRC TRUPACT-II Certificate of Compliance.

Appendix B provides data pertaining to waste volumes and the number of waste shipments.

Appendix C presents more detailed information about the methodology and input data used in the risk analysis as well as the results obtained.

Appendix D provides additional information about the applicable emergency response programs, DOE field exercise programs, and emergency response capabilities of organizations within the States through which WIPP shipments would pass.

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LIST OF ACRONYMS

AAR	Association of American Railroads
AL	(DOE) Albuquerque Operations Office
AL/EOC	Albuquerque Emergency Operations Center
ALARA	as low as reasonably achievable
ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
BEIR	Committee on Biological Effects of Ionizing Radiation (of the National Academy of Sciences)
CEDE	committed effective dose equivalent
CFR	Code of Federal Regulations
CH	contact-handled
CIS	Chemical Information System
CMR	Central Monitoring Room
COC	Certificate of Compliance
CVSA	Commercial Vehicle Safety Alliance
DEQ	Division of Environmental Quality
DHW	Department of Health and Welfare
DNR	Department of Nuclear Safety
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIC	Emergency Information Center
EM	Environmental Restoration and Waste Management
EMS	Emergency Management System/Emergency Medical Services
EOC	Emergency Operations Center
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
ETA	estimated time of arrival
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FRPCC	Federal Radiological Preparedness Coordinating Committee
FRSA	Federal Railroad Safety Act
GVWR	gross vehicle weight rating
HD	Health Department
HEAST	Health Effects Assessment Summary Tables
HEPA	high efficiency particulate air (filter)
HI	hazard index

HMTA	Hazardous Materials Transportation Act (of 1975)
HMTUSA	Hazardous Materials Transportation Uniform Safety Act (of 1990)
HQ	(DOE) Headquarters
HRCQ	Highway Route Control Quantity
HSDB	Hazardous Substances Data Base
IART	Incident/Accident Response Team
ICRP	International Commission on Radiological Protection
ICS	Incident Command System
IDB	Integrated Data Base
INEL	Idaho National Engineering Laboratory
IRF	impact release fraction
IRIS	Integrated Risk Information System
KAPL	Knolls Atomic Power Laboratory
LANL	Los Alamos National Laboratory
LCF	latent cancer fatality
LET	linear energy transfer
LLNL	Lawrence Livermore National Laboratory
LWA	Land Withdrawal Act
MCLs	maximum contaminant levels
MCSAP	Motor Carrier Safety Assistance Program
MFP	Mixed Fission Product
MOC/M&O	Management and Operating Contractor
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act
NMD	No-Migration Determination
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
OEMT	(DOE) Operational Emergency Management Team
OEPO	Office of Emergency Plans and Operations
ORNL	Oak Ridge National Laboratory
ORR	Operational Readiness Review
OSHA	Occupational Safety and Health Administration
PC	personal computer
PIO	public information officer
PL	Public Law
ppm	parts per million
PRA	Plan for Radiological Accidents

QA	quality assurance
QRU	Quick Response Unit
RAP	Radiological Assistance Plan
RAT	Radiological Assistance Team
RCRA	Resource Conservation and Recovery Act
REAC/TS	Radiation Emergency Assistance Center/Training Site
RERO	Radiological Emergency Response Operations
RfC	reference concentration
RFP	Rocky Flats Plant
RH	remote-handled
ROD	Record of Decision
RRT	Rapid Response Team
SARP	Safety Analysis Report for Packaging
SEIS	Supplement Environmental Impact Statement
SEOC	State Emergency Operations Center
SERC	State Emergency Response Commission
SF	slope factor
SHMRT	State Hazardous Materials Response Team
SRS	Savannah River Site
SSEB	Southern States Energy Board
STAA	Surface Transportation Assistance Act
STEP	States Training and Education Program
TCC	TRANSCOM Control Center
TD	Transportation Department
TDOP	Ten-Drum Overpack
TETRA	Transportation Emergency Training for Response Assistance
TI	Transport Index
TLV	Threshold Limit Value
TRANSAX	Transportation Accident Exercise
TRANSCOM	Transportation Tracking and Communications System
TRF	thermal release fraction
TRRF	total respirable release fraction
TRU	transuranic
TRUPACT-II	Transuranic Package Transporter
TSD	treatment, storage, or disposal (facilities)
VOC	volatile organic compound
WAC	Waste Acceptance Criteria
WACCC	Waste Acceptance Criteria Certification Committee
WCC	Warning Communication Center
WGA	Western Governors' Association

LIST OF ACRONYMS, Concluded

WID	(Westinghouse) Waste Isolation Division
WIEB	Western Interstate Energy Board
WIPP	Waste Isolation Pilot Plant
WIPPTREX	WIPP Transportation Exercise

EXECUTIVE SUMMARY

Overview and Purpose

The Waste Isolation Pilot Plant (WIPP) was authorized by the U.S. Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980 (PL 96-164). The WIPP is a research and development facility to demonstrate the safe disposal of transuranic (TRU) radioactive waste resulting from U.S. defense activities. It is located 26 miles (42 kilometers) east of Carlsbad, New Mexico. The WIPP Land Withdrawal Act (Public Law 102-579) withdrew Federal lands surrounding the WIPP facility from all public use and transferred the title to these lands to the Secretary of Energy. After applicable requirements have been met, TRU waste will be sent to WIPP to initiate the disposal phase, which is planned to last for approximately 20 years. The Land Withdrawal Act (LWA) describes the requirements for this transportation study.

Section 16(f) of the LWA states:

> *(f) STUDY OF TRANSPORTATION ALTERNATIVES.---*
>
> *(1) IN GENERAL.---The Secretary shall conduct a study comparing the shipment of transuranic waste to the WIPP facility by truck and by rail, including the use of dedicated trains, and shall submit a report on the study in accordance with paragraph (2). Such report shall include---*
>
> *(A) a consideration of occupational and public risks and exposures, and other environmental impacts;*
>
> *(B) a consideration of emergency response capabilities; and*
>
> *(C) an estimation of comparative costs.*
>
> *(2) REPORT.--The report required in paragraph (1) shall be submitted to the Congress not later than 1 year after the date of the enactment of this Act.*

WIPP transportation studies in the *Final Supplement Environmental Impact Statement for WIPP* (SEIS) (DOE, 1990a) are the baseline for this report. In an attempt to present the most current analysis, this study incorporates the most relevant data available.

The following three transportation options are evaluated for the Disposal Phase, which is assumed to be 20 years:

- Truck shipments, consisting of a tractor and trailer, with three TRUPACT-IIs or one RH-72B.
- Regular commercial train shipments consisting of up to three railcars carrying up to 18 TRUPACT-IIs or up to six RH-72Bs.

- Dedicated train shipments consisting of a locomotive, an idler car, railcars carrying 18 TRUPACT-IIs or six RH-72Bs, another idler car, and a caboose or passenger car with an emergency response specialist. No other cargo is carried.

Estimates for the number of shipments anticipated during the disposal phase are 28,534 truck shipments, 15,385 regular train shipments, or 6,622 dedicated train shipments depending on the transportation option selected. Both train options include 2,016 and 105 truck shipments of CH- and RH-TRU waste, respectively, from Los Alamos National Laboratory (LANL) and 110 CH-TRU waste truck shipments from the Nevada Test Site (NTS) because these two facilities do not currently have rail access.

Transportation Requirements

The U.S. Department of Energy (DOE) uses DOE Orders to incorporate all Federal requirements into its internal system. Federal requirements for the safe transportation of hazardous (including radioactive) materials are established by Federal statutes and regulations issued by the U.S. Department of Transportation (DOT) and the U.S. Nuclear Regulatory Commission (NRC). The U.S. Environmental Protection Agency (EPA) has issued regulations for the management of solid and hazardous wastes. Under the authority of the Resource Conservation and Recovery Act (RCRA), the EPA regulates the hazardous constituents of wastes that contain both radioactive and hazardous constituents (i.e., mixed waste). The Federal Emergency Management Agency (FEMA) requires preplanning for responses to transportation incidents/accidents.

Considerations of Occupational and Public Risks and Exposures and Environmental Impacts

Occupational and Public Risks and Exposures

Occupational and public risks and exposures were evaluated as follows:

- Ordinary traffic incidents/accidents (traumatic injuries and fatalities) and health effects (latent cancer fatalities) related to vehicle pollution. These impacts are discussed herein as *Nonradiological/Nonchemical Impacts*.

- Potential exposure to low levels of radiation or hazardous materials during incident-free (routine) transportation. These impacts are discussed herein as *Incident-Free Radiological/Chemical Impacts.*

- Potential exposure to radioactive or other hazardous materials from postulated incidents/accidents. These impacts are discussed herein as *Incident/Accident Radiological/Chemical Impacts.*

Nonradiological/nonchemical impacts for the three transportation options are summarized in Table ES-1. These include injuries and fatalities resulting from highway accidents and latent cancer fatalities (LCFs) resulting from truck and train exhaust emissions (Cashwell et al., 1986).

Table ES-1. Nonradiological/Nonchemical Impacts from Transportation of TRU Waste to the WIPP for the Disposal Phase

Transportation Option	Incident/Accident Injuries	Incident/Accident Fatalities	Latent Cancer Fatalities
Truck	110	7.3	0.2
Regular Train	63	2.5	0.7
Dedicated Train	12	1.0	0.06

The maximum incident-free radiological transportation impacts for shipments to the WIPP from each shipment origin site during the disposal phase are presented in Table ES-2. Radiological consequences and risks are reported using units of rem (individual dose) and person-rem (collective dose to a group). The units represent a weighted sum of doses, with impacts estimated as LCFs. Impacts are presented in terms of LCFs as a result of radiological doses received by the public for all three transportation options.

The LCFs presented in Table ES-2 are extremely low in comparison to the LCFs the public will experience from background radiation (natural and manufactured) along the least populated transportation route for the same time frame. Doses to the public from background radiation during the 20-year disposal phase for the least populated truck and train routes to the WIPP are calculated as 961,000 person-rem (480 LCFs based on a population of 133,000) and 2,710,000 person-rem (1,360 LCFs based on a population of 376,000), respectively.

Because the shipment containers are not vented, exposure to the hazardous chemicals of the waste is not expected to occur during incident-free transportation.

Table ES-2. Maximum Radiological Impacts to the Public for Incident-Free Transportation from Individual Waste Origin Sites for the Disposal Phase[a]

Transportation Option	CH-TRU Shipments		RH-TRU Shipments	
	Dose (person-rem)	Latent Cancer Fatalities	Dose (person-rem)	Latent Cancer Fatalities
Truck	2,340	1.2	3,170	1.6
Regular Train	363	0.18	299	0.15
Dedicated Train	363	0.18	51	0.025

[a] Totals are taken from Table C-10 (Appendix C).

The radiological/chemical impacts associated with TRU waste transportation incidents/accidents are bounded by a highly unlikely accident, in which packages are assumed to exceed NRC Type B package certification test conditions, releasing radioactive materials into the environment. For the truck option, the analysis predicted the consequences of radioactive release for three TRUPACT-IIs or one RH-72B exceeding certification test conditions. For the regular train option, the impact of six TRUPACT-IIs or two RH-72Bs exceeding certification test conditions was analyzed. The impacts of up to six TRUPACT-IIs or six RH-72Bs exceeding NRC Type B packaging certification test conditions were evaluated for the dedicated train option. The analysis predicted representative and maximum consequences based on the immediate or delayed response to an incident/accident by emergency response personnel.

Table ES-3 presents the estimated cumulative radiological incident/accident dose risk to the public for shipments to the WIPP, as well as maximum consequences from a single postulated accident for each transportation option. The cumulative incident/accident dose risk to the public is the summation of the probability of highly unlikely accidents occurring that leads to a release of radioactive material multiplied by the consequences (person-rem) of those accidents over the duration of the disposal phase. The transportation options are comparable because the calculated accident dose risk values are essentially the same.

Table ES-3. Predicted Accident Impacts to the Public for Each Transportation Option Studied for the Disposal Phase

Transportation Option	Cumulative Accident-Dose Risk[a] (person-rem)	Representative Consequences[b]		Maximum Consequences[c]	
		Dose (person-rem)	Latent Cancer Fatalities	Dose (person-rem)	Latent Cancer Fatatilities
Truck	2,060	22	0.011	750,000	380
Regular Train	1,940	150	0.075	1,500,000	750
Dedicated Train	1,910	450	0.23	4,500,000	2,300

[a] This is the cumulative accident-dose risk for RH-TRU shipments to the WIPP at the indicated transportation option.

[b] Representative consequences result from one postulated accident scenario in an urban community in which emergency response actions occur in sufficient time to mitigate the initial accident sequence, with a resulting release comparable to a category III severity accident. The reported value is the highest representative consequence for RH-TRU waste shipments and shipment origin sites.

[c] Maximum consequences result from a highly unlikely accident scenario in an urban community in which emergency response actions are delayed until after the initial accident sequence is completed (several hours), with a postulated release comparable to a category VIII severity accident. The reported value is the highest maximum consequence for RH-TRU waste shipment and shipments origin sites.

Risks from nonradioactive hazardous chemicals to a member of the public were predicted for specific incident/accident scenarios. Analyses focused on the impacts from CH-TRU waste shipment incidents/accidents because these would be more severe and bound impacts associated with RH-TRU waste shipments. For the postulated accidents involving the release of hazardous chemicals, it is predicted that the maximum exposure to a member of the public would fall within EPA standards.

Environmental Impacts

Environmental impacts associated with truck and train transportation are considered in this section. Scenarios explored are nonradiological/nonchemical impacts, incident-free radiological/chemical impacts, and incident/accident radiological/chemical impacts.

The resulting impacts to the terrestrial ecosystems for truck and train incident-free transportation were found to be below related standards. For scenarios involving incident/accident situations, the primary impact was related to cleanup efforts.

Considerations of Emergency Response Capabilities

Regardless of the transportation mode, shipments of radioactive materials have the potential to be involved in an incident/accident. The packagings to be used are designed to survive most incident/accident conditions. The potential for an incident/accident mandates emergency response preparedness.

The DOE has developed a WIPP Emergency Response program composed of three basic elements:

- Providing training to ensure State, Indian tribe, and local WIPP emergency response readiness
- Organizing DOE response teams with plans describing roles, responsibilities, and specific procedures
- Ensuring that personnel accompanying a shipment are knowledgeable about appropriate emergency response procedures

As the shipper of the TRU waste, the DOE is responsible for providing the carrier with information about special precautions to be taken during a shipment and procedures to be used during an incident/accident when emergency response is required. The DOE will ensure that any waste or contaminated soil is cleaned up and removed. The DOE is responsible for radiological monitoring and providing assistance during a WIPP-related emergency.

The DOE maintains the Radiological Assistance Program (RAP) to provide technical assistance in the event of a transportation incident/accident. It organizes, equips, and maintains the Incident/Accident Response Team (IART) formed to provide technical expertise to the DOE for WIPP-related incidents/accidents involving Type B packages. The RAP also organizes, equips, and maintains Radiological Assistance

Teams (RATs) that will respond to a radiological incident/accident. The DOE has developed specific procedures for responding to a WIPP-related transportation incident/accident and is responsible for coordinating field exercise programs to simulate transportation incidents/accidents.

In general, emergency response in the event of an incident/accident involving WIPP shipments made by truck or by train would be similar. County or city responders would act as first responders to assess the situation. They perform the initial radiological monitoring at an incident/accident site and serve as the command-and-control authority within their respective jurisdictions. State and Federal teams would respond if requested. All carriers have emergency plans for incidents/accidents involving hazardous materials. Many have their own hazardous materials emergency response team or trained staff who would mobilize outside contractors to assist in cleaning up an incident/accident.

An Estimation of Comparative Costs

Costs in 1993 dollars for each transportation option are based on currently available information, carrier systems, and total number of shipments for each option. Emergency response costs have not been included because they are not within the scope of this study.

The total cost for truck shipments during the 20-year disposal phase using contract rates is estimated to be $236,800,000; total cost using commercial rates is estimated to be $258,100,000.

Total cost for regular train transportation (which necessarily includes some trucking) using class rates is estimated to be $332,000,000 and cost using contract rates is estimated to be $184,400,000. The total cost for dedicated trains is estimated to be $850,700,000 because an additional charge of $55 per mile is included for all shipments. Total costs for all options range from $184,400,000 to $850,700,000.

Comparison of Transportation Options

Radiological and hazardous chemical risks from transportation options pose no significant health risk to the general population or transportation workers. The DOE has implemented an emergency response system for the transportation of TRU waste by truck from the Idaho National Engineering Laboratory and the Rocky Flats Plant. The existing emergency response system will be expanded to encompass training needed for emergency response personnel along the disposal phase transportation corridors. Truck and train contract rate costs are comparable. Future rate costs will be negotiated to further reduce overall rate costs. Table ES-4 summarizes costs and impacts for the three transportation options during the disposal phase.

Table ES-4. Summary of Transportation Options for the Disposal Phase

Category	Injuries/ Fatalities	Maximum Cumulative Radiological Doses to the Public (person-rem)		Maximum Radiological Accident Consequences in LCF to the Public	Minimum Transportation Cost
		CH Waste	RH Waste	RH Waste	
Truck	110/7.3	5,040	3,330	380	$236,800,000
Regular Train	63/2.5	956	369	750	$184,400,000
Dedicated Train	12/1.0	586	81	2,300	$850,700,000

The analyses presented in this study demonstrate that DOE can safely transport TRU waste to the WIPP facility during the disposal phase. This study should not be utilized as the sole basis for selecting a transportation option to support the disposal phase. Further study needs to be conducted. DOE is committed to conducting further study of the WIPP transportation system and will present additional data and analyses as they become available.

1.0 INTRODUCTION

This report fulfills the requirements of the Waste Isolation Pilot Plant Land Withdrawal Act (Public Law 102-579, Section 16(f), Study of Transportation Alternatives). As stated in that section, "...the Secretary shall conduct a study comparing the shipment of transuranic waste to the WIPP facility by truck and by rail, including the use of dedicated trains...."

1.1 Background

The WIPP was authorized by the U.S. Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980 (PL 96-164). Its legislative mandate is to provide a research and development facility to demonstrate the safe disposal of transuranic (TRU) radioactive waste resulting from U.S. defense activities and programs. The DOE has designed the WIPP facility to be a deep geologic repository for transuranic (TRU) waste currently stored at, and/or generated by, ten DOE defense facilities. Waste shipments to the WIPP from Argonne National Laboratory-East (ANL-E), Hanford Reservation, Idaho National Engineering Laboratory (INEL), Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Mound Laboratory, Nevada Test Site (NTS), Oak Ridge National Laboratory (ORNL), Rocky Flats Plant (RFP), and Savannah River Site (SRS) will use Transuranic Package Transporters (TRUPACT-IIs) or remote-handled (RH) casks.

The WIPP Land Withdrawal Act (LWA) was enacted on October 30, 1992. The LWA provides for the withdrawal of the lands surrounding the WIPP facility from all public use (including mining) and transferred control of the lands from the Secretary of the Interior to the Secretary of Energy.

The LWA includes a number of other provisions in addition to the land transfer. These include prerequisites for initiating disposal operations at WIPP, compliance with environmental laws and regulations, decommissioning, mine safety, and economic assistance to the State of New Mexico. Section 16, *Transportation*, includes requirements for the packaging to be certified by the U.S. Nuclear Regulatory Commission (NRC), as well as requirements pertaining to:

- Advance notification to States and Indian tribes prior to shipment of TRU waste to WIPP

- Incident/accident prevention, emergency response training, and provision of emergency response equipment for TRU waste shipped to or from WIPP

- Transportation safety programs

As described in the LWA, TRU wastes are radioactive and contain alpha-emitting radionuclides of atomic number greater than 92, have half-lives longer than 20 years, and are present in concentrations greater than 100 nanocuries per gram of waste.

TRU and TRU-mixed wastes (TRU wastes with hazardous constituents) have been generated primarily through national defense activities from processes used in the fabrication of nuclear weapons at DOE facilities. The principal facilities that historically performed production activities are the Hanford Reservation in the State of Washington, the Savannah River Site in South Carolina, and the Rocky Flats Plant (RFP) in Colorado. These wastes have been either stored at the generating sites or shipped to other sites for storage.

Approximately 2,300,000 cubic feet (65,000 cubic meters) of TRU waste are currently in temporary storage (DOE, 1991d). The maximum total capacity of the WIPP, as specified in the LWA, is 6,200,000 cubic feet (175,584 cubic meters). Wastes generated in the future will include wastes from national defense programs similar to those that produced the existing wastes and from activities to clean up, decontaminate and decommission various DOE facilities.

Waste sent to the WIPP will be placed in excavated rooms in a bedded salt formation located 2,150 feet (655 meters) beneath the land surface, 26 miles (42 kilometers) east of Carlsbad, New Mexico (Figure 1-1). Ultimate disposition of the wastes will be based upon the implementation of the disposal phase.

Almost all TRU waste intended to be disposed of at the WIPP is contact-handled transuranic waste (CH-TRU waste). For the waste to be classified as contact-handled, the maximum radiation dose rate at the surface of the waste container cannot exceed 200 millirems per hour. CH-TRU waste can be handled safely without any shielding other than that provided by the waste container. This CH-TRU waste can be packaged in 55-gallon (208-liter) steel drums or in metal boxes. CH waste comes in a variety of forms, ranging from unprocessed laboratory trash, such as paper, glassware, gloves, and boots, to scrap metal and solidified sludges from the dewatering of liquids.

About three percent of current TRU waste is remote-handled transuranic waste (RH-TRU waste). RH-TRU waste cannot be directly handled in a safe manner as can CH-TRU waste. Because surface radiation levels on containers of this waste exceed 200 millirems per hour, it must be handled and transported in shielded casks.

The LWA specifies that no TRU waste received at the WIPP may have a canister surface radiation dose rate higher than 1000 rems per hour and that no more than five percent by volume of the RH-TRU waste received at the WIPP may have a canister surface dose rate higher than 100 rems per hour. Additionally, the LWA limits the RH-TRU waste to be emplaced at the WIPP to a total of 5.1 million curies.

Environmental impacts of the WIPP were evaluated in the *WIPP Final Environmental Impact Statement* (FEIS) (DOE, 1980) as required by the National Environmental Policy Act (NEPA). The SEIS (DOE, 1990a) provided an analysis of changes in the WIPP Project that occurred following the publication of the FEIS. A Record of Decision (ROD) for the SEIS was published in 1990 (DOE, 1990b).

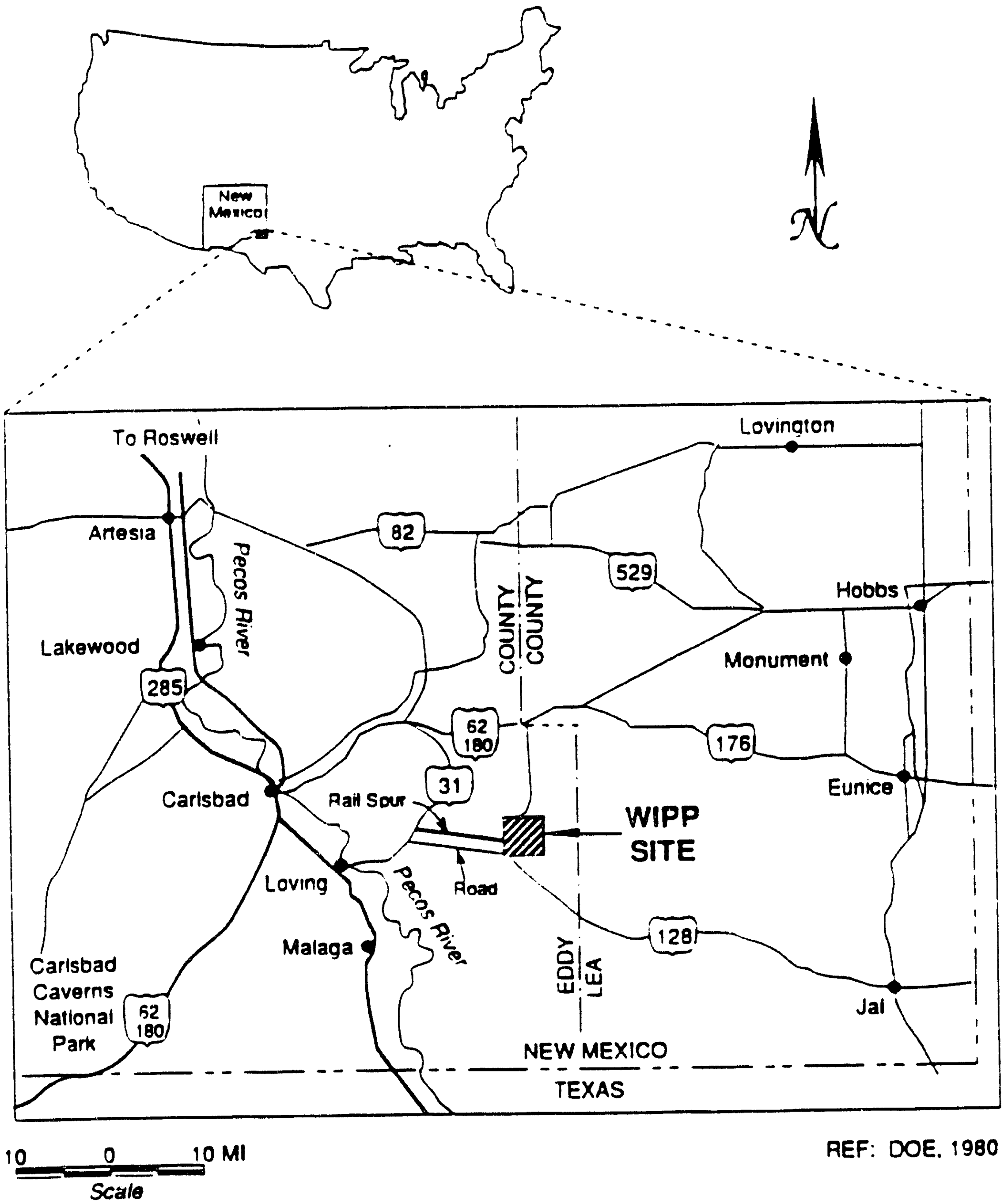

Figure 1-1. Waste Isolation Pilot Plant (WIPP) Location Map

1.2 Purpose

The purpose of this report is to present a study comparing shipment of TRU waste to WIPP by truck and by train. As such, this report complies with the requirements of section 16(f) of the LWA. Major elements of this study described below encompass environmental and safety impacts affecting workers and the public due to TRU waste shipments to the WIPP, as well as cost comparisons for the transportation options.

1.3 Scope

The scope of this report is defined by section 16(f) of the LWA. Recent DOE studies (1993d, 1991a, 1991b, and 1990a) have evaluated many of the topics required by the LWA. This report addresses the LWA transportation requirements and incorporates the relevant transportation data presented in previous DOE studies (1980, 1990a).

Section 16(f) of the LWA requires a study of transportation alternatives and specifies the requirements for this study. It states that the Secretary shall conduct a study comparing the shipment of waste to the WIPP by both truck and train, including the use of dedicated trains. The report based on this study must include consideration of the following topics:

- Occupational and public risks and environmental impacts
- Emergency response capabilities
- Estimation of comparative costs (including truck, regular, and dedicated train transportation)

This study has been organized to address these requirements for each of the transportation options described in the report.

1.3.1 Overall Study Base

This report draws from many of the analyses presented in the SEIS for transportation and emergency response. In instances where the SEIS data and analyses are still valid, they have been incorporated into this report. In instances where SEIS data or analyses require updating, new analyses are presented. Current Integrated Data Base (IDB) data indicate that only 2,300,000 cubic feet (65,000 cubic meters) of TRU waste are currently available for emplacement and that waste generation projections indicate that somewhat less than a total of 6,200,000 million cubic feet (175,584 cubic meters) will be available for emplacement by 2018. This study is based upon a full repository with a capacity of 6,200,000 cubic feet, an amount that is consonent with the volume limitation of the LWA. This results in a conservative analysis, which provides the upper bound for risks, costs, and emergency response.

1.3.2 Transportation Options

The LWA requires that three transportation options be evaluated in this report: truck, regular train, and dedicated train.

A truck shipment will consist of a tractor and a trailer transporting three TRUPACT-IIs or one RH-72B. All trucks used for these shipments will be dedicated to the WIPP Project and not used for other purposes.

For this study, a *regular train* consists of one railcar transporting up to nine TRUPACT-IIs or three RH-72Bs on a train carrying general freight. Up to 18 TRUPACT-IIs or six RH-72Bs could be carried by a regular train. Waste cars would be flanked by idler or buffer cars. This is in accordance with the regulatory requirement for hazardous materials shipments via regular train service (49 CFR 174.85). In the regular train transportation analysis, waste from NTS and LANL during the disposal phase are assumed to be shipped by truck because these sites do not currently have rail access.

A *dedicated train* consists of a locomotive, two empty cars (idler cars) serving as buffers in front and behind, two or three railcars transporting up to 18 TRUPACT-IIs or six RH-72bs, and a caboose or passenger car at the rear of the train. The caboose or passenger car would carry an emergency response specialist trained in WIPP shipments. Dedicated trains would transport waste only and would not be used for transporting other freight.

1.3.3 Risk Analyses

The risk analysis estimates impacts from transportation. Pollution health effects, injuries, fatalities, and radiological and chemical exposures are estimated. Impacts from truck shipments, regular train, and dedicated train have been estimated for the disposal phase.

1.3.4 Emergency Response

In section 16(c), *Accident Prevention and Emergency Response*, of the LWA, the DOE is required to establish a training program for States and Indian tribes through whose jurisdiction TRU waste will be transported. This program must include command and control training, first responder training, and instruction of radiological protection and emergency medical personnel in procedures for responding to an incident/accident involving TRU waste. The DOE is also required to assist the States in acquiring emergency response equipment. If one of the train options is selected for the disposal phase, then consideration will have to be given to what additional training, if any, would be required for railroad employees that is not already included in their training program.

This section of the study describes the emergency response requirements of both truck and train transportation as required in section 16(f) of the LWA. The scope of the emergency response portions of the study encompasses a description of the emergency response capabilities of Federal, State, local, Indian tribe, and private emergency responders along the highway and train corridors from the waste storage sites to the WIPP. Also included with the analyses are the capabilities of regional sources of emergency response assistance such as DOE's region-wide radiological response teams and state hazardous materials (HAZMAT) teams.

Current emergency response capabilities for the disposal phase are examined in this section. Additional capabilities needed to respond to potential incidents/accidents along WIPP shipment routes are also identified.

1.3.5 Comparative Costs

As required in section 16(f) of the LWA, this section defines and compares costs for each transportation option considered in the report. Shipment costs are included for each option for the disposal phase. Cumulative costs were calculated for each shipment from the point of origin to the WIPP. Costs include round trip and total costs for each transportation option. Emergency response costs are not included for purposes of comparison because they are not within the scope of this study.

2.0 TRANSPORTATION REQUIREMENTS

This chapter presents a summary of the regulations affecting shipment of CH- and RH-TRU waste to the WIPP.

Federal requirements for safely transporting radioactive waste are established by Federal statutes and regulations. Agencies within the Federal government have promulgated regulations in the Code of Federal Regulations (CFR). U.S. Nuclear Regulatory Commission (NRC) regulations are found in 10 CFR. Occupational, Safety, and Health Administration (OSHA) regulations are found in 29 CFR. U.S. Environmental Protection Agency (EPA) regulations are found in 40 CFR. Federal Emergency Management Agency (FEMA) regulations are found in 44 CFR. U.S. Department of Transportation (DOT) regulations are found in 49 CFR. U.S. Department of Energy (DOE) regulations are found in the latter part of 10 CFR; DOE also issues Orders that provide policy and guidance to its contractors for operations regarding the implementation of all of these applicable transportation regulations.

2.1 U.S. Department of Transportation (DOT)

The DOT derives its primary regulatory authority for hazardous materials from the Hazardous Materials Transportation Act of 1975 [HMTA; 49 USC (United States Code) §§1801 et seq.] as amended by the Hazardous Materials Transportation Uniform Safety Act of 1990 (HMTUSA; PL 101-615). This authorizes the Secretary of Transportation to set safety regulations applicable to all common modes of transportation. The 1980 *WIPP Final Environmental Impact Statement* (FEIS) and the *Second Modification of the Consultation and Cooperation Agreement* between the DOE and the State of New Mexico committed the DOE-WIPP to comply with applicable DOT and NRC regulations. Applicable hazardous materials regulations are found in 49 CFR Parts 107 and 170-179. The HMTA includes the following major provisions:

- Federal law may preempt State or local government or Indian tribe requirements when the requirement does not meet standards set forth in 49 CFR 107.202.
- DOT has jurisdiction over hazardous materials shipments affecting interstate, intrastate, and foreign commerce.
- DOT is authorized to provide grants for public sector planning and training in support of emergency planning efforts of States, local communities, and Indian tribes to deal with hazardous materials transportation.
- DOT is required to collect information from carriers on transportation incidents/accidents and to publish an annual report.
- For all hazardous materials shipments, including Highway Route Control Quantities, the DOT issues regulations on:
    - Hazardous materials classification

- Packaging
- Marking
- Labeling
- Notification
- Shipping papers
- Placarding
- Routing
- Emergency communications

In addition to the hazardous materials shipments covered by the HMTA, the Federal Railroad Safety Act (FRSA) (45 USC §§ 421-441) and its implementing regulations in 49 CFR Parts 200-268 authorize the DOT through the Federal Railroad Administration (FRA) to regulate all aspects of train safety.

The Surface Transportation Assistance Act (STAA) of 1982 (49 USC §§ 2301-2316) and implementing regulations in 49 CFR Part 350 authorize the Federal Highway Administration to issue grants to States to be used to develop inspection programs. Included in this authorization is the development of procedures to enforce the highway-related portions of 49 CFR Parts 171-179. The STAA includes the maximum weight limits that the states must allow.

The Federal Highway Administration (FHWA) is also authorized to enforce motor vehicle safety requirements. The Motor Carrier Safety Act of 1984 (49 USC §§ 2501-2520, as amended) and its implementing regulations in 49 CFR Parts 350-399 authorize the FHWA to enforce minimum safety standards for commercial motor vehicles and operators. The Commercial Motor Vehicle Safety Act of 1986 (Title XII of PL 99-570) authorizes the FHWA to establish commercial driver's license standards, requirements, and penalties. Testing requirements for such a license include a knowledge test on hazardous materials (see 49 CFR Part 383).

2.2 U.S. Nuclear Regulatory Commission (NRC)

The NRC regulates the packaging, preparation, and transfer of commercial nuclear material under the Atomic Energy Act of 1954 as amended (42 USC § 2011 et seq.) and its implementing regulations at 10 CFR Parts 20, 60, and 71-73. The 1980 WIPP FEIS committed the DOE to comply with NRC regulations. This was reinforced in the *Second Modification of the Consultation and Cooperation Agreement* between the State of New Mexico and the DOE. In this agreement, the DOE committed to transport TRU waste only in NRC-certified packaging. The NRC is responsible for certifying packaging to ensure that specific standards and criteria are met. NRC packaging approval standards are contained in 10 CFR Part 71, *Packaging and Transportation of Radioactive Materials*.

In NRC regulations governing the transportation of radioactive materials (10 CFR Part 71), "packaging" describes the shipping container or cask, and "package" describes the shipping container with its contents. An NRC-certified Type B packaging is required for transporting the type of waste that will be sent to the WIPP. It should withstand both normal transportation conditions and transportation incidents/accidents without releasing its contents.

To certify the packaging design, the applicant (packaging developer) must submit a Safety Analysis Report for Packaging (SARP) to the NRC. A SARP includes:

- A description of the packaging
- An evaluation of the packaging
- A description of the quality assurance (QA) program for the packaging, including:
  - Design
  - Fabrication
  - Assembly
  - Testing
  - Maintenance
  - Repair
  - Modification
  - Use

The packaging description must include the containment system, construction materials, weights and dimensions, methods of fabrication, and lifting and tiedown devices. In addition, the description must include information about the payload, including radioactive constituents, their quantity, fissile constituents, chemical and physical form, and maximum payload-generated heat.

Evaluations must demonstrate compliance with standards specified in 10 CFR Part 71. Standards in Subpart E of 10 CFR Part 71 include general design requirements (fastening devices for containment vessels and maximum surface temperatures, for example), requirements for lifting and tiedown devices, external radiation limits, and special requirements for packaging containing fissile materials or plutonium with activities in excess of 20 curies. Subpart F specifies evaluations that must be performed to demonstrate that the packaging can withstand normal and incident/accident conditions without loss of integrity.

Evaluations of responses to normal transportation conditions must include:

- Exposure to high (100°F/38°C) and low (-40°F/-40°C) temperatures
- Reduced (3.5 psi/24.5 kilopascal) and increased (20 psi/140 kilopascal) external pressure
- Vibration normally incident to transport

- Water spray simulating a heavy rainfall of approximately 2 inches (5 centimeters) per hour for at least one hour

- A free drop from a specified distance (handling drop) with the weight of the packaging determining the drop distance

- Impact by a vertical steel cylinder, 1.25 inches (3.18 centimeters) in diameter, dropped from a height of 40 inches (1 meter) onto the most vulnerable surface of the packaging

Packaging response to incident/accident conditions must also be determined. To be certified by the NRC as Type B (10 CFR 71.73), packaging must demonstrate resistance to severe conditions expected in a transportation accident. To simulate hypothetical incident/accident conditions, the NRC has specified a series of impact, thermal, and immersion tests performed in a specified sequence. Acceptable packaging performance can be demonstrated by analysis and/or testing. For incident/accident conditions, tests must be directed at the weakest part of the packaging where maximum damage is expected. The test sequence and hypothetical incident/accident conditions are:

1. A free fall drop from a height of 30 feet (9 meters) onto a flat, unyielding surface

2. A drop from a height of 40 inches (1 meter) onto a steel bar that is 6 inches (15 centimeters) in diameter and no less than 8 inches (20 centimeters) long, mounted on an unyielding surface

3. Exposure to a surrounding heat flux (engulfing fire) with a minimum temperature of 1475°F (800°C) for 30 minutes

4. Exposure of undamaged packaging to an external pressure equivalent to immersion under at least 50 feet (15 meters) of water for no less than 8 hours

For the QA program, the applicant must identify any established codes and standards proposed for the design, fabrication, assembly, testing, maintenance, and use of the packaging. Quality assurance requirements are described in 10 CFR Part 71, Subpart H.

When the application is judged to be complete and accurate and all pertinent requirements are met, the NRC issues a Certificate of Compliance (COC). The COC specifies procedures for the fabrication, operation, and maintenance of the packaging and defines the payload that may be transported. The certificate is valid for five years. At the end of this period, it may be renewed by submitting an application.

TRUPACT-IIs, which are NRC-certified packaging, will be used to ship CH-TRU waste. They have been designed and constructed and are certified to meet 10 CFR Part 71 requirements for Type B normal form packaging. Type B packaging must be used to ship TRU waste with activity of more than 20 curies of plutonium per package.

On March 3, 1989, the TRUPACT-II developer submitted documentation required for certification to the NRC (on behalf of the DOE). This documentation consisted of a comprehensive SARP (DOE, 1989a) for the TRUPACT-II, a document with additional information requested by the NRC, and the final results of TRUPACT-II tests. The SARP provides a detailed description of the TRUPACT-II design, operation, maintenance, payload (CH-TRU waste), and quality assurance programs. It also documents TRUPACT-II performance in the regulatory tests described previously.

TRUPACT-II compliance with 10 CFR Part 71 was demonstrated by a combination of analyses and testing. A COC was issued by the NRC on August 30, 1989, for the TRUPACT-II packaging. The latest version of the SARP (DOE, 1989a) was sent to the NRC in September 1992. The amended COC was issued by the NRC in November 1992 (NRC, 1992). Currently, TRUPACT-IIs are not certified to transport all TRU waste forms. Modifications to the waste form or additional testing of the waste or the TRUPACT-II will be necessary, and the COC will be amended as required to transport all CH-TRU waste meeting the Waste Acceptance Criteria to the WIPP.

It is anticipated that RH-TRU waste will be transported in the RH-72B. The RH-72B is a smaller version (5/8 the size) of the NuPac 125B. It has been designed to meet NRC Type B requirements. After DOE transportation and packaging approval, the DOE will apply to the NRC for a COC, which must be issued prior to transporting any waste in the RH-72B. The 125B was certified by the NRC and was subsequently used to transport waste from the core of the damaged Three Mile Island reactor. In order for the design of the RH-72B to be certified by the NRC, it will be necessary to demonstrate compliance with the NRC requirements in 10 CFR Part 71 for Type B packaging. Because the RH-72B is a scaled-down version of the 125B, analysis will be the primary method for demonstrating compliance.

2.3 U.S. Department of Energy (DOE)

The DOE requires compliance with transportation rules and regulations primarily through DOE Orders. DOE Orders that directly apply to transportation are briefly summarized below.

- DOE Order 1540.1A, *Materials Transportation and Traffic Management*

  This Order establishes DOE policies and procedures for the management of materials transportation activities, including traffic management, for other than intrabuilding and intrasite transfers.

- DOE Order 1540.2, *Hazardous Material Packaging for Transport - Administrative Procedures*

This Order standardizes the current approval procedure for hazardous material packaging to ensure that DOE packaging designs and transportation operations ensure public health and safety in accordance with DOT regulations and equivalent standards described by the NRC.

- DOE Order 1540.3A, *Base Technology for Radioactive Material Transportation Packaging Systems*

  This Order establishes DOE policies and responsibilities for coordinating and planning base technology for packaging systems used to transport radioactive material.

- DOE Order 5480.3, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes*

  This Order establishes the DOE safety requirements for the packaging and transportation of hazardous materials, hazardous substances, and hazardous wastes.

- DOE Order 5500.1B, *Emergency Management System*

  This Order establishes overall policy and requirements for the DOE Emergency Management System (EMS). EMS provides the framework for development, coordination, and direction of planning, preparedness, and readiness assurance activities.

- DOE Order 5500.2B, *Emergency Categories, Classes, and Notification and Reporting Requirements*

  This Order establishes DOE emergency categories, classes, and notification and reporting requirements to facilitate the communication and reporting of emergency events.

- DOE Order 5500.3A, *Planning and Preparedness for Operational Emergencies*

  This Order establishes requirements for operational emergency planning and preparedness involving the DOE or requiring DOE assistance.

3.0 RESPONSIBILITIES

This chapter describes the primary responsibilities of Federal agencies, States, local governments, Indian tribes, and DOE contractors with respect to WIPP transportation-related issues.

3.1 Federal Responsibilities

The responsibilities of the U.S. Department of Energy (DOE), the U.S. Nuclear Regulatory Commission (NRC), and the U.S. Department of Transportation (DOT) are described in this section.

3.1.1 U.S. Department of Energy (DOE)

The DOE provides management direction and guidance for all WIPP-related transportation activities. The DOE uses Orders to protect the health and safety of the public and workers. These Orders apply the requirements in regulations promulgated by:

- The U.S. Department of Transportation (DOT)
- The U.S. Nuclear Regulatory Commission (NRC)
- The U.S. Environmental Protection Agency (EPA)
- The Federal Emergency Management Agency (FEMA)

States, local governments, and Indian tribes may have different requirements. However, their requirements may be preempted by the Federal requirements if they do not meet the standards in DOT regulation 49 CFR 107.202. That section establishes three different standards for preemption for separate areas of regulation. These standards are intended to ensure that non-Federal requirements do not unduly vary from or pose an obstacle to compliance with Federal law.

The Assistant Secretary for Environmental Restoration and Waste Management (EM) of the DOE provides overall management and guidance for the WIPP program and for transportation activities. EM manages, operates, and maintains TRANSCOM, the current satellite Transportation Tracking and Communications System that will track WIPP shipments. The Assistant Secretary for Environment, Safety, and Health is specifically responsible for overseeing transportation safety.

The DOE Albuquerque Operations Office (DOE/AL) is responsible for all off-site WIPP Project transportation activities. Specific DOE/AL transportation responsibilities include:

- Ensuring that all transportation activities are conducted in accordance with applicable statutes, regulations, and other requirements

- Providing training for emergency response organizations of State and local governments and Indian tribes
- Providing liaison with States, local governments, and Indian tribes regarding transportation issues
- Overseeing the development, certification, manufacture, and maintenance of packaging
- Overseeing the transportation carrier subcontractor responsible for truck shipments
- Overseeing the design, development, and manufacture of transportation equipment for the WIPP
- Conducting studies and analyses to support WIPP transportation
- Overseeing the equipment and providing technical expertise for the Incident/Accident Response Team (IART)

The DOE is represented on the Federal Radiological Preparedness Coordinating Committee (FRPCC) under FEMA leadership. The DOE has the lead role for coordinating radiological monitoring and for assisting during any WIPP-related incident/accident. The DOE maintains the Radiological Assistance Plan (RAP) for each region as well as a Radiological Assistance Team (RAT) for the actual response to emergencies.

3.1.2 U.S. Nuclear Regulatory Commission (NRC)

The NRC certifies the design, manufacturing, and quality assurance (QA) of TRU waste shipment packaging. In this role, the NRC ensures that all packaging proposed and used for shipments of TRU material (including WIPP-related shipments) meets the design requirements specified in 10 CFR Part 71. The Land Withdrawal Act (LWA), section 16(a), reaffirms the responsibility of the WIPP to have its packaging certified by the NRC.

The NRC periodically audits the TRUPACT-II QA program. The QA program includes a rigorous quality records program specifying record-keeping requirements, including the identification of records to be permanently maintained.

3.1.3 U.S. Department of Transportation (DOT)

The DOT is authorized through the Surface Transportation Assistance Act of 1982 (49 USC §§ 2301-2316) to establish the Motor Carrier Safety Assistance Program (MCSAP). Under this act, the DOT issues grants to States for developing inspection programs, overseeing motor vehicle safety, and establishing minimum standards for safe motor vehicle operations. From this, the Commercial Vehicle Safety Alliance

(CVSA) has been established as a cooperative entity to set inspection and out-of-service criteria for vehicle inspections. All of the States (with the exception of South Dakota and Hawaii) are participating members of the CVSA.

The Commercial Drivers License standards, requirements, and penalties in 49 CFR Part 383, as part of the CVSA inspection program, were established in the Commercial Motor Vehicle Safety Act of 1986.

The DOT requires emergency response information for hazardous materials shipments to mitigate any transportation incidents/accidents. Minimum information includes:

- Basic description and technical name of the hazardous material
- Immediate hazards to health
- Risks of fire or explosion
- Immediate precautions to be taken in the event of an accident or incident
- Immediate methods for handling spills or leaks in the absence of fire
- Preliminary first aid measures

This information must be maintained by the carrier and the vehicle driver in a location that is immediately accessible. This information must also be maintained at the facility when the hazardous material is present and must be accessible to facility personnel.

Carriers are required to notify the DOT of hazardous materials transportation incidents/accidents by phone and in writing. The DOT collects this information from the carriers and prepares an annual summary report concerning hazardous (including radioactive) materials transportation incidents/accidents involving:

- Fatalities
- Injuries requiring hospitalization
- Estimated damage to property exceeding $50,000
- An evacuation of the general public lasting one or more hours
- Closing or shutting down one or more major transportation arteries or facilities for one or more hours
- Fire
- Breakage

- Spillage
- Suspected radioactive contamination
- Any situation the carrier thinks should be reported

The DOT document *Guidelines for Selecting Preferred Highway Routes for Highway Route Controlled Quantity Shipments of Radioactive Materials* (DOT, 1984) provides guidelines for State and Indian tribe officials.

3.2 State Responsibilities

States are responsible for emergency response for transportation incidents/accidents, routing for WIPP transportation, and, in the case of New Mexico, project oversight.

States are responsible for responding to incidents/accidents within their borders. As part of this responsibility, States:

- Develop emergency response plans
- Organize, train, and deploy response teams
- Negotiate interstate agreements (multistate compacts) for incidents/accidents close to their borders
- Work with local governments to enhance emergency response skills

For WIPP shipments, States would most likely be responsible for radiological monitoring at any incident/accident site, at least in the initial stages of an accident.

Under DOT requirements (49 CFR 177.825), interstate highways are preferred for Highway Route Control Quantity (HRCQ) shipments of radioactive materials. States may designate alternate preferred routes in accordance with a process established by DOT. For alternative preferred routes to become effective, the State must give written notice to the DOT, and the DOT must acknowledge receipt in writing.

Under the authorizing legislation for WIPP (PL 96-164), DOE must consult and cooperate with officials of the State of New Mexico with respect to the State's health and safety concerns. One of the several agreements between New Mexico and the DOE, the Supplemental Stipulated Agreement, made both parties responsible for coordinating emergency response planning.

Two cooperative agreements between the DOE and regional organizations of States provide a formal mechanism for the DOE to cooperate with large groups of States on WIPP transportation issues. The Western Governors' Association (WGA) (including governors from 11 western States) and the Southern States Energy Board (SSEB) (including 16 southeastern States plus Illinois, Indiana, and Ohio) have worked closely with the DOE to facilitate such programs as emergency response training. Their roles permit the DOE to establish effective liaisons with the States.

3.3 Local Government Responsibilities

Local governments along a transportation route are responsible for emergency response to a transportation accident. In most cases, the local government emergency responder would be the first responder at the incident/accident scene. In this role, the first responder must evaluate the situation, rescue any victims, contain or prevent the spread of contamination, and attempt to secure the site. The first responder is also responsible for notifying the appropriate emergency response officials at the State and Federal levels.

In addition, States must consult with local governments in the course of selecting alternate transportation routes for WIPP shipments.

3.4 Indian Tribal Responsibilities

Indian tribes are responsible for emergency responses for transportation incidents/accidents occurring within their jurisdictions. Indian tribes are responsible for responding to the immediate emergency, saving human life if it is endangered, taking appropriate containment actions, and contacting appropriate Federal and State radiological response team members for assistance. Along with the States, the Indian tribes have been involved in coordination activities with the DOE through specific agreements. Indian tribes also designate preferred routes for WIPP shipments within their land as long as DOT procedures are followed.

3.5 DOE Contractor Responsibilities

Westinghouse Waste Isolation Division (WID) functions as the management and operating contractor (M&O) for the WIPP. In this role, its responsibilities include:

- Assisting in designing, testing, and document preparation for the certification of Type A and B packagings
- Assisting in developing and presenting training materials and courses
- Assisting in procuring transportation equipment (that is, trailers)
- Managing subcontractors and providers of medical personnel training
- Managing the contract carrier
- Participating in the Incident/Accident Response Team (IART)
- Assisting in operating the Central Monitoring Room (CMR) at the WIPP

The contract carrier is responsible for operating the DOE WIPP truck transportation fleet. In this role, they must:

- Provide dedicated tractors and qualified, trained, and dedicated drivers according to requirements in 49 CFR Part 391

- Ensure that vehicles under carrier control are operated in a safe manner

- Use the Transportation Tracking and Communication System (TRANSCOM) (see Section 4.6) to notify the WIPP site CMR, local law enforcement, and other emergency response personnel as required in the event of an incident/accident

- Implement package recovery procedures that ensure recovery of damaged transportation equipment and packages

The M&Os at the generator sites are responsible for certifying that waste meets the WIPP Waste Acceptance Criteria (WAC) and for loading the waste in TRUPACT-IIs or RH-72Bs.

The rail carrier responsibilities include:

- Ensuring that its trains are operated in a safe manner and in accordance with applicable regulations (49 CFR Parts 100-177 and 200-268)

- Utilizing the TRANSCOM system operated by the DOE

- Notifying the WIPP Project Manager in the event of an incident/accident

- Implementing DOE package recovery procedures and assisting the DOE in recovering any damaged packages.

4.0 TRANSPORTATION SYSTEM

This chapter describes the system that will be used to transport WIPP waste. Sections in this chapter describe the containers to be used for transporting the waste and the major components of each transportation option.

4.1 Packaging

The number of TRUPACT-IIs required for the disposal phase is still under study by the DOE. The required number of RH-72Bs (still to be determined) will be built for the disposal phase.

4.1.1 TRUPACT-IIs for CH-TRU Waste

As shown in Figure 4-1, the TRUPACT-II is a container with a flat bottom and a domed top. Containers are transported in an upright position. Overall dimensions of the TRUPACT-II are approximately 8 feet (2.4 meters) across and 10 feet (3 meters) high. To provide double containment for TRU waste, the container consists of inner and outer containment vessels. The inner containment vessel is approximately 6 feet (1.8 meters) across and 6 feet (1.8 meters) high. NRC regulations require that two separate levels of containment be used for shipments of plutonium in excess of 20 curies per container. The inner and the outer containment vessels have removable lids that are held in place by banded locking rings and retaining tabs. Containment vessels are nonvented and are designed for a maximum normal operating pressure of 50 pounds per square inch gauge (3.5 kilograms per square centimeter).

The inner containment vessel is a stainless steel pressure vessel that contains the waste payload. The payload is protected by spacers made of aluminum honeycomb located in each of the two domed heads of the inner vessel (Figure 4-1). The lower body of the inner containment vessel has a closure ring with two grooves, each containing an O-ring seal. The upper lid of the vessel has a flat mating surface that seals against the two O-rings once the lid and the body are assembled. Compression of the O-rings between the lids and the body forms a bore-type seal. As the lid is lowered onto the body, retaining tabs on a locking ring slide through recesses in the mating tabs on the body. When the lid is fully engaged, the locking ring can be rotated to the closed position. However, the locking ring cannot be rotated unless the lid is correctly mated to the body. The locking mechanism secures the lid to the body to maintain leaktight seals under both normal and incident/accident conditions.

The outer containment assembly is made of stainless steel and polyurethane foam. It consists of an exterior stainless steel shell and a stainless steel pressure vessel (Figure 4-1). Between these steel shells is a layer of fire-retardant polyurethane foam approximately 10 inches (25 centimeters) thick. Steel walls surrounding the foam layers are lined with a heat-resistant, ceramic-fiber paper, which enhances the resistance of the polyurethane foam to fire damage. On the outside of this foam and

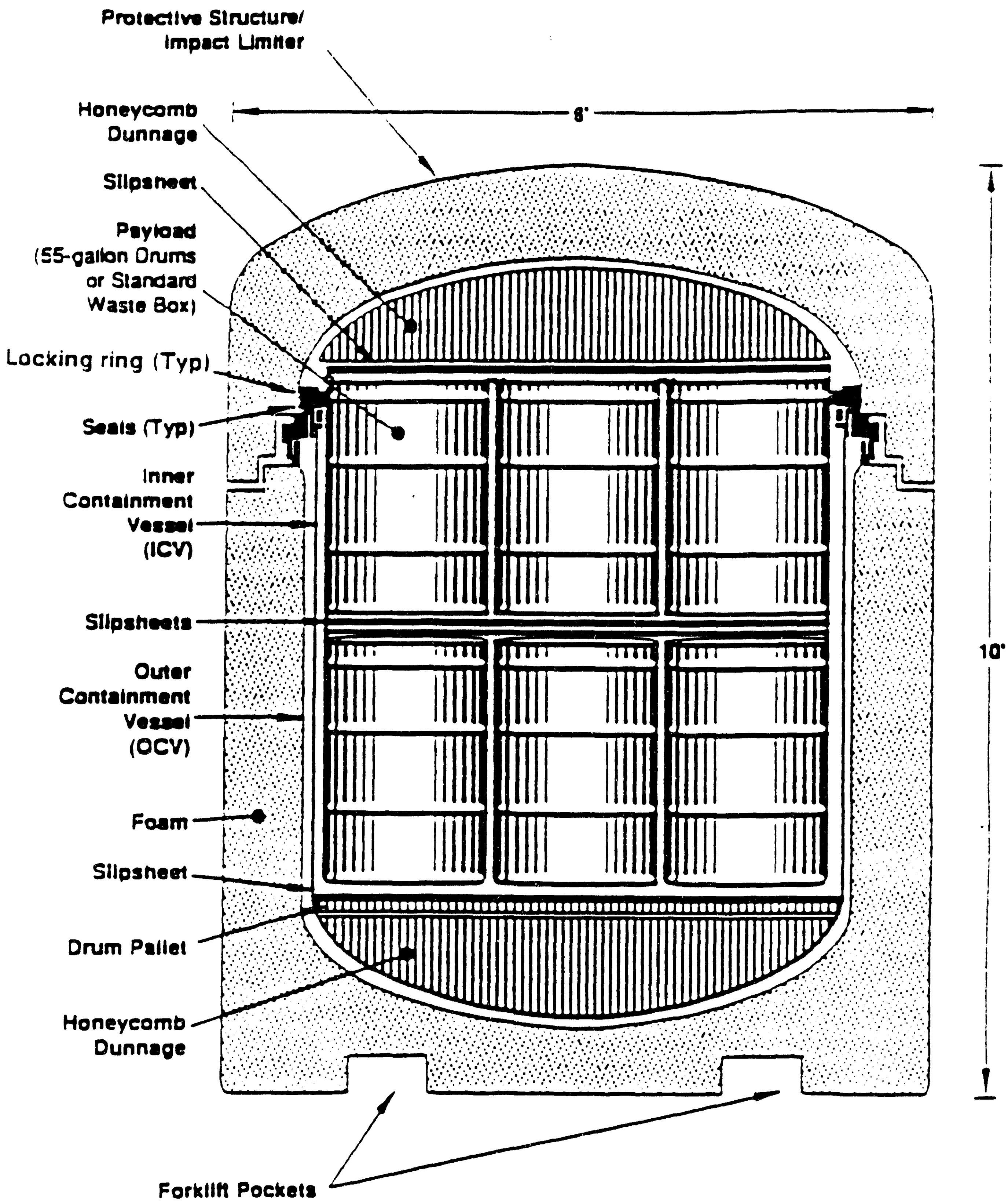

Figure 4-1. TRUPACT-II Shipping Container for CH-TRU Waste (Schematic)

ceramic fiber, the exterior stainless steel shell acts as a protective structure and an impact limiter. This multilayered design increases the overall strength of the container and provides the ability to withstand potential incidents/accidents associated with transportation. As with the inner containment vessel, the lower body of the outer containment vessel has a seal flange ring with two grooves, each containing an O-ring seal. The upper lid of the vessel seals against the two O-ring assemblies. The locking ring secures the lid in place and maintains leaktight seals under both normal and incident/accident conditions, providing the same containment capability as the inner vessel and resulting in double containment.

The maximum capacity of each TRUPACT-II is 7,265 pounds (3,370 kilograms) of payload, including pallets, slip sheets, and waste, packed in either fourteen 55-gallon drums, two 67-cubic-foot (1.9-cubic-meter) standard waste boxes, or one ten-drum overpack (TDOP). Maximum gross shipping weight of a loaded TRUPACT-II is 19,250 pounds (8,730 kilograms). The average empty weight of a TRUPACT-II is 12,705 pounds (15,763 kilograms). The tractor is estimated to weigh 18,000 pounds (8,165 kilograms), as indicated in the contract carrier management plan. The trailer is estimated to weigh 10,000 pounds (4,536 kilograms), for an estimated combined total weight of 28,000 pounds (12,701 kilograms). Actual weights of individual TRUPACT-IIs will vary within design limits. The weight of the waste plus the TRUPACT-II will be load-managed to ensure that each shipment does not exceed the 80,000-pound (36,288-kilogram) gross vehicle weight rating (GVWR) for the tractor, trailer, and cargo. Up to three TRUPACT-IIs will be loaded onto a custom-designed semitrailer pulled by a conventional tractor. For train shipments, up to nine TRUPACT-IIs could be transported on each railcar. The railcars can carry up to 180,000 pounds (81,630 kilograms).

4.1.2 RH-72Bs for RH-TRU Waste

The RH-72B is a cylinder consisting of a separate inner vessel within an outer cask protected by impact limiters at each end. A schematic diagram is shown in Figure 4-2. Neither the outer cask nor the inner containment vessel is vented. Each is capable of withstanding an internal pressure of 150 pounds per square inch (10 kilograms per square centimeter) gauge. Payload capacity of each RH-72B is 8,000 pounds (3,629 kilograms). The payload will consist of RH-TRU waste in 30- or 55-gallon (114- or 208-liter) drums contained in a canister. The weight of the canister is included in the total payload. The RH-72B is designed to allow transport of a single canister per highway shipment. A RH-72B will be loaded onto a custom-designed semitrailer pulled by a conventional tractor. For train shipments, up to three RH-72Bs could be transported on each railcar.

The inner containment vessel is made of stainless steel and provides a cavity approximately 26.5 inches (67 centimeters) across and 123 inches (3.1 meters) long

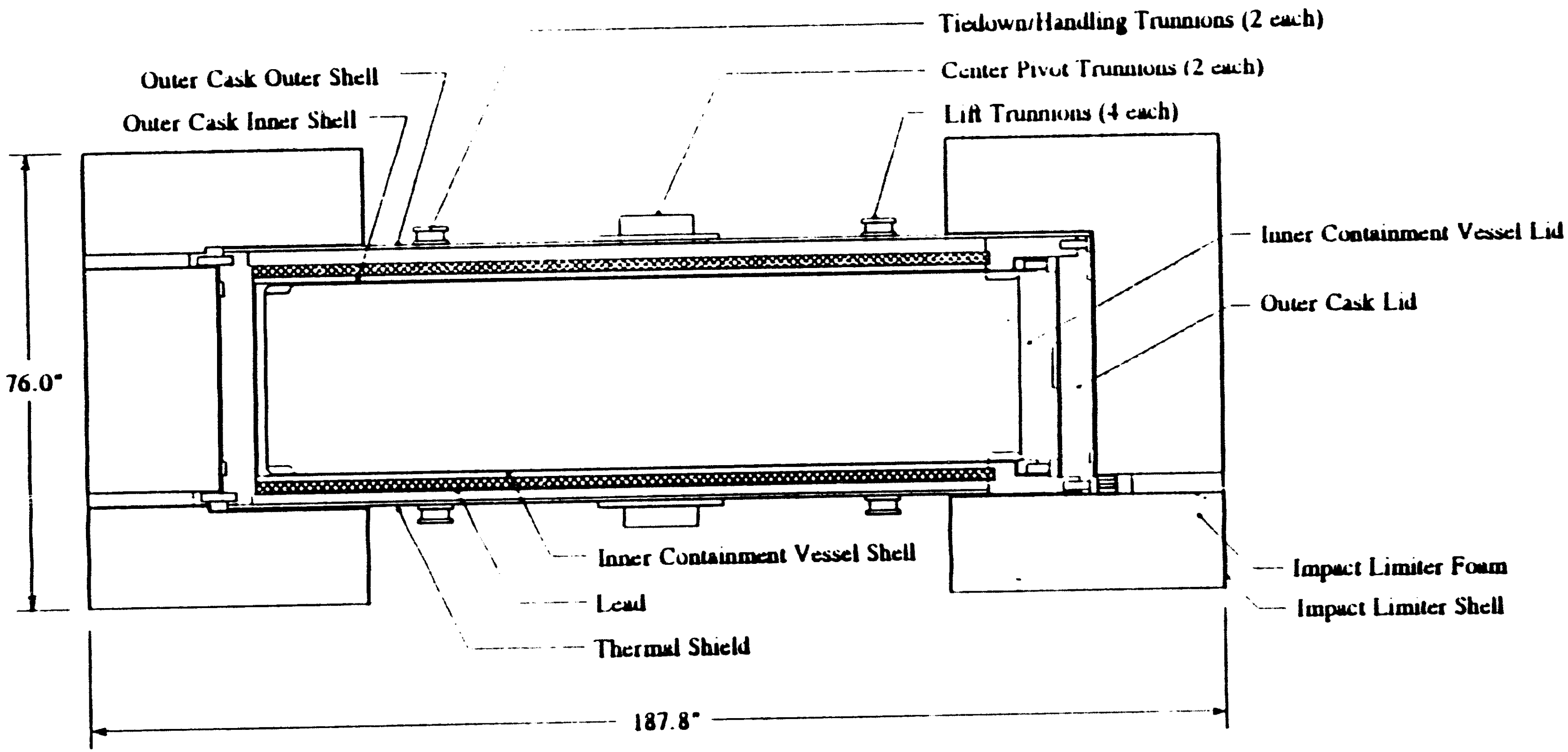

Figure 4-2. RH-72B Shipping Cask for RH-TRU Waste (Schematic)

canister. The lid is secured to the body of the vessel by eight closure bolts. To center the canister and facilitate its insertion/removal, internal spacers are provided at the top and bottom and at two locations near the middle of the inner vessel.

The outer cask is a stainless steel vessel constructed of two concentric shells enclosing a cast-lead shield. The shield is for protection against gamma radiation and is approximately 1.9 inches (4.8 centimeters) thick. The outer cask is approximately 142 inches (3.6 meters) long and has an outer diameter of 42 inches (1.1 meters). It is protected at each end by energy-absorbing impact limiters, which are stainless steel shells filled with polyurethane foam. Impact limiters also act as thermal insulators to protect seal areas from fire in the event of an incident/accident.

The payload canister, or RH waste canister, is a DOT 7A Type A carbon steel single shell container measuring approximately 26 inches (66 centimeters) in diameter with an overall length of 121 inches (3.1 meters). The canister is vented, using a carbon-composite high efficiency particulate air (HEPA) filter, and is capable of transporting three 55-gallon (208-liter) waste drums.

4.2 Transportation Fleet

This section describes the vehicles (trucks, regular trains, and dedicated trains) that will be used for transporting waste.

4.2.1 Trucks

Tractors for transporting CH- and RH-TRU waste to the WIPP will be provided by the contract carrier. Trailers and shipping containers will be provided by the DOE. All vehicles will be late models and be replaced after 3 years or 300,000 miles (482,700 kilometers), whichever comes first, throughout the program. Trucks will transport three TRUPACT-IIs or one RH-72B. A sufficient number of tractors will be located in a 50-mile radius of the WIPP.

All equipment and drivers used by the contract carrier to transport TRU waste will:

- Conform to applicable Federal Motor Carrier Safety Regulations in 49 CFR Parts 350-399
- Comply with DOE contractual agreements
- Meet all functional requirements for TRU waste shipments
- Be operated by driver personnel trained in compliance with 49 CFR Parts 172 and 177
- Have special equipment related to safety

For example, to prevent speed limits from being exceeded, vehicles will be equipped with governors to limit speed to a maximum of 65 miles (105 kilometers) per hour. In addition, tractors will have a Tripmaster, which will automatically record all the speeds reached by the vehicle during travel. Tractors will also be equipped with radiation detection instruments for use by trained drivers in the event of an incident/accident.

Tractor specifications are presented in Appendix L of the WIPP SEIS (DOE,1990a). These specifications are based in part on the experience of DOE and its predecessors of nearly 50 years in the transportation of radioactive materials.

Each TRUPACT-II trailer is a gooseneck, single-drop design commonly used in commercial fleet operations. The trailer is designed to transport up to three loaded TRUPACT-IIs. The TRUPACT-II transportation trailer is 42.2 feet (12.9 meters) long. The load-bearing bed is 40 inches (1 meter) above ground, and, when loaded with TRUPACT-IIs, the overall height is 160 inches (4.1 meters).

Each trailer is provided with 12 special tiedown devices used for securing the TRUPACT-II to the trailer in a vertical position. Tiedowns are adjustable-length U-bolts clamping down on corresponding flanges on the TRUPACT-II. Tiedown flanges on the TRUPACT-II are designed to meet the requirements of 10 CFR 71.45. U-bolt tiedowns on the trailer meet the requirements of 49 CFR 393.102. The TRUPACT-II SARP submitted to the NRC in March 1989 provides the necessary analyses demonstrating how the TRUPACT-II tiedown system meets these requirements. The trailer has been through a series of tests demonstrating that it can be operated safely on the nation's highways without additional requirements.

To facilitate safe and efficient transportation, the DOE has developed detailed operating plans and has provided facilities for communication, including a dual satellite-based vehicle tracking system. This system, called TRANSCOM, is discussed in Section 4.6. In addition, a dedicated carrier has been awarded a contract for the truck transportation of TRU waste to the WIPP. This contract, which runs for three years and has options for two one-year extensions, contains provisions for the safe and efficient transportation of TRU waste and for the proper response to transportation emergencies. The key provisions of the contract include, but are not limited to, the following:

- Tractors are to be domiciled and maintained within 50 miles (80 kilometers) of the WIPP and will be dispatched with a DOE-owned trailer and empty shipping containers for CH-TRU or RH-TRU waste.

- The DOE will operate a transportation operations control center called the Central Monitoring Room (CMR) 24 hours a day, 7 days a week. This center will maintain day-to-day contact with the contract carrier and the drivers.

- The contract carrier will be required to meet Federal regulatory requirements for transporting radioactive and hazardous materials, including driver training.

- At facilities with large volumes of waste, the driver will deposit the trailer and packaging at the loading location designated by the facility and pick up a loaded trailer for the return shipment back to the WIPP.

- At facilities with small volumes of waste, it is probable that the driver will deposit the trailer and packaging at the loading location designated by the facility and wait for facility personnel to load the container and trailer and release it to the driver for the return trip to the WIPP.

- Upon arriving at WIPP, the driver will deposit the trailer and the loaded TRUPACT-IIs or RH-72Bs at a designated location and return with empties to the carrier's local terminal for further dispatching.

- The contract carrier will be required to perform verifiable routine maintenance and inspections on the tractors and trailers before, during, and after each shipment.

- The DOE will be responsible for any maintenance and repairs to the trailer and shipping containers. If the trailer or containers need repair while en route, the contract carrier will follow established procedures after receiving approval from the DOE Manager of Packaging and Transportation for the WIPP.

- The contract carrier is required to provide a dispatcher, who will act as a single point of contact for the DOE Technical Representative in dealing with the scheduling of shipments and with the coordination and resolution of problems associated with shipments.

One of the provisions of the contract is the requirement that the carrier prepare a management plan. The plan has been prepared and is summarized in the 1990 WIPP SEIS (DOE, 1990a).

4.2.2 Regular Train

Regular trains could carry the TRU shipment as part of their regular train service. This study assumes that up to three railcars with TRUPACT-IIs or RH-72Bs could be transported in regular train service. These cars could carry up to 18 TRUPACT-IIs or six RH-72Bs. Details and specifications for rail transportation have yet to be completed.

If procedures for regular trains are developed, they will meet all applicable DOT regulatory requirements.

4.2.3 Dedicated Train

As for regular train transportation, details and specifications for dedicated train shipments are not yet complete. Unlike the regular train, the dedicated train option would be characterized by the following:

- The train would not carry any other cargo.

- A caboose or passenger car would follow the last idler car in order to carry an emergency response specialist.

If procedures for dedicated trains are developed, they will meet all applicable DOT regulatory requirements.

4.3 Shipment Options

This section describes the options for transporting waste by truck or train.

4.3.1 Truck Transportation

TRU waste shipments during the disposal phase will use the routes shown in Figure 4-3. These routes were previously identified in the SEIS (DOE 1990a). The routes were selected in accordance with 49 CFR 177.825. Each truck shipment will carry three TRUPACT-IIs or one RH-72B.

4.3.2 Train Transportation

Routes from the generator/storage site to the WIPP via Class 1 railroad routes were described in the WIPP SEIS (DOE, 1990a). Since the issuance of the WIPP SEIS, some minor route changes have occurred due to rail line abandonments. Typical routes are presented in Figure 4-4. Details and specifications for train transportation have not yet been completed. The present design of the TRUPACT-IIs would allow them to be placed on flatbed cars. Tiedown procedures will need to be developed based on American Association of Railroads and NRC requirements. These procedures must be approved by the originating railroad prior to train shipments.

4.4 Waste Volumes

The 1992 DOE Integrated Data Base (IDB; DOE, 1992) specifies the amount of DOE CH- and RH-TRU waste currently in storage at DOE sites, as well as TRU waste volumes projected to be generated through the year 2018. The amount of waste in storage and projected to be generated is less than the WIPP LWA disposal capacity of 6,200,000 cubic feet (175,584 cubic meters). To present a conservative analysis, the CH-TRU waste volumes for each site were scaled up and added to the RH-TRU waste volumes to obtain a total waste volume of 6,200,000 cubic feet (175,584 cubic meters). Table B-1 (Appendix B) presents both the projected and scaled-up volumes of TRU waste.

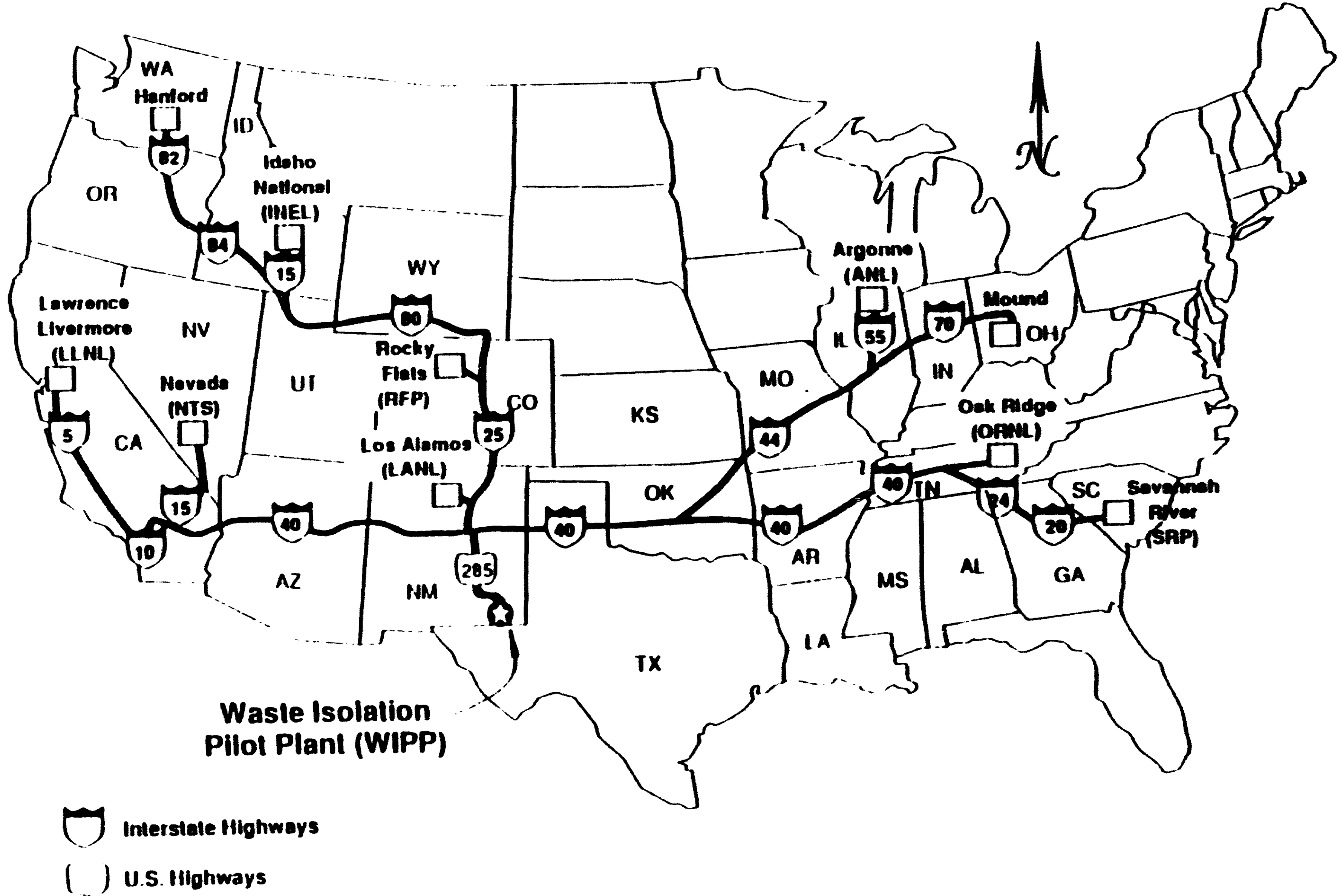

Figure 4-3. Proposed TRU Waste Truck Transportation Routes

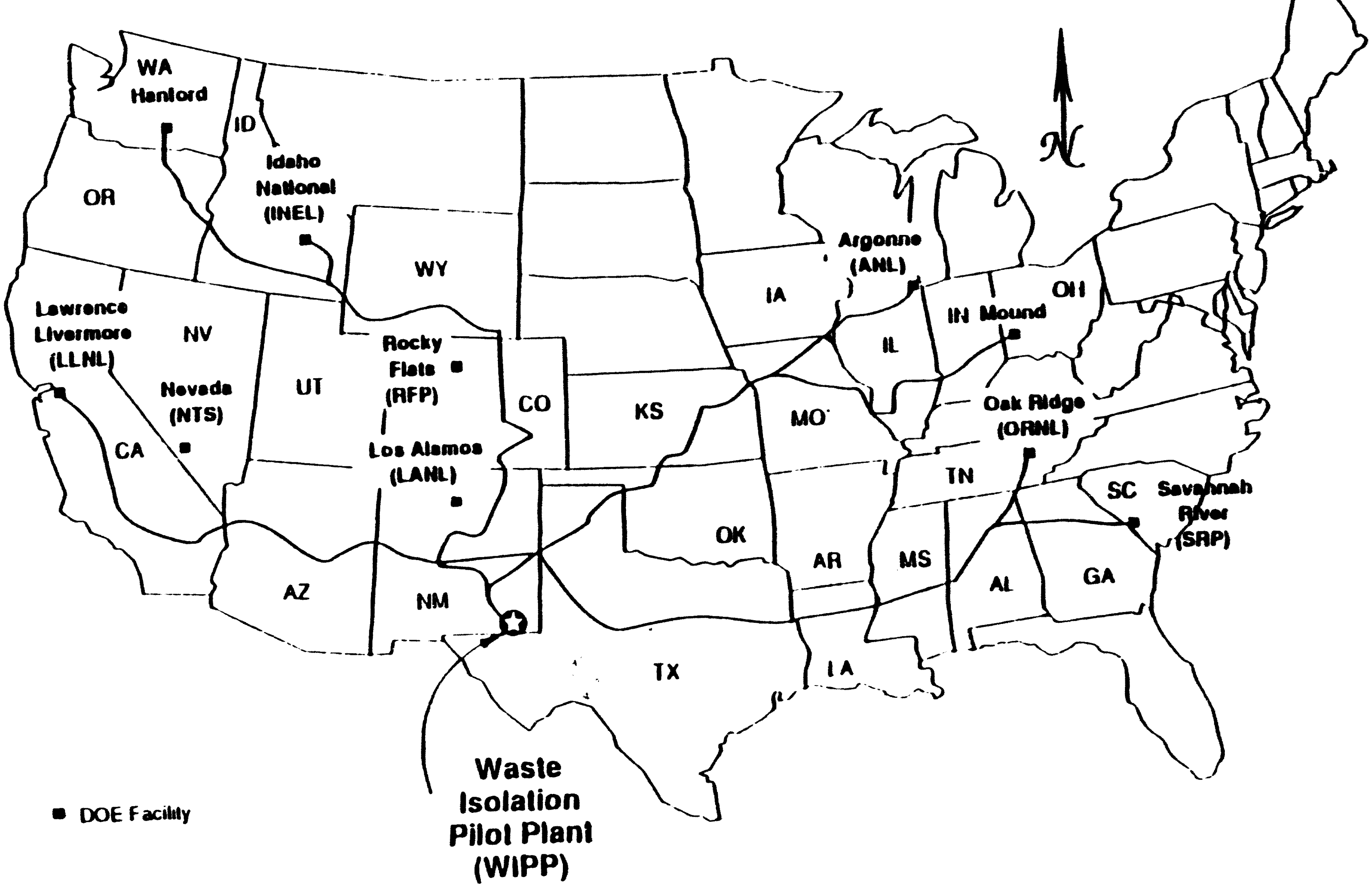

Figure 4-4. Typical Railroad Routes for TRU Waste Tranportation to the WIPP

4.5 Waste Shipments

Table B-2 (Appendix B) presents the number of shipments required to transport the WIPP design capacity volume. Los Alamos National Laboratory (LANL) and the Nevada Test Site (NTS) can currently ship by truck only, because there is no rail access. Therefore, regular train and dedicated train totals presented in the analyses include the truck shipment totals for those facilities.

All TRUPACT-II shipments must be completed within a 60-day period as required by the NRC. The 60-day period starts when the TRUPACT-II outer lid is sealed.

4.6 Tracking System

TRANSCOM, the DOE-wide transportation tracking and communication system, is employed to track the movement of DOE shipments of spent fuel, high-level waste, and other high visibility shipments, including those to the WIPP. Through the use of satellites, TRANSCOM can provide accurate locations of shipments anywhere in the United States (TRANSCOM Management Plan, 02-28-92, #TCOM-MP-01). The system consists of satellite and commercial telecommunications services, database management, and computer applications. TRANSCOM is operated for DOE in Oak Ridge, Tennessee, at the Transcom Control Center (TCC). The center supports the use of TRANSCOM throughout the United States. In addition to the shipper and designated users, TRANSCOM is capable of two-way communication between the vehicle operators (truck and train) and the TCC (TRANSCOM Vehicle Operator Manual, 04-30-93, #TCOM-VOM). In calendar year 1992, a successful Operational Readiness Review (ORR) was performed on TRANSCOM covering documentation, computer hardware and software, and satellite communications and technology (TRANSCOM Operational Readiness Review Final Report, 06-92, #TRANSCOM ORR). TRANSCOM operational readiness is continually tested through real time readiness exercises such as the Transportation Accident Exercises and the WIPP Transportation Accident Exercises.

The TCC will monitor WIPP shipments 24 hours per day, 7 days per week. As part of its many responsibilities, the WIPP Central Monitoring Room (CMR) will also monitor these shipments through TRANSCOM. Both loaded and empty containers will be monitored. The TCC/CMR operators will assist drivers or train crews by providing relevant information on severe weather, road conditions, and significant routing changes affecting the shipment while en route. Information will come from State and local police, local officials, and weather information sources such as the cable television weather channel or the Kavoureas weather satellite.

TRANSCOM users include States and Indian tribes along the WIPP shipment corridors, DOE shippers and receivers, DOE Emergency Operations Centers, DOE Operations Offices, DOE-HQ, the NRC, and the DOT. Currently, Idaho, Wyoming, Utah, Colorado, and New Mexico are on the system. Users of the system must be authorized by the DOE, successfully complete training on TRANSCOM, and be certified as system operators (TRANSCOM Training Manual, 02-28-92, #TCOM-TRN-01). Once certified, users will receive from DOE the TRANSCOM software as a final step to access and use the system. TRANSCOM software provides views of the shipment on either national, State, or county level maps. Satellite location allows the TRANSCOM system to be set to receive location data from 30 seconds up to one hour. For WIPP shipments, the views are updated at least once every 15 minutes (TRANSCOM Software Manual, 02-28-92, #TCOM-SW-01). TRANSCOM, through satellite positioning, can pinpoint any shipment being tracked to within 1,000 feet (305 meters).

TRANSCOM will assist users in responding effectively to any emergency en route. TRANSCOM provides access to shipment documentation, shipment status, two-way messaging, and information from the DOT *Emergency Response Guidebook* that includes a list of response actions and emergency contacts. In addition, emergency conditions can be transmitted immediately via TRANSCOM by the vehicle operator or train crew to the appropriate Federal, State, local, and Indian tribal emergency response organizations. These emergency response capabilities increase security and safety for WIPP shipments en route. TRANSCOM provides users advanced notification 7 days prior to a shipment; ensures that carriers follow the predetermined route; provides assurances that drivers or train crews maintain a safe speed and perform safety checks; and provides warnings and assistance for Federal, State, local, and Indian tribal emergency responders (TRANSCOM Shippers and Receivers Users Manual, 07-31-92, #TCOM-SRUM). If TRANSCOM fails, there is a procedure that the train crew or vehicle operator, designated user, and the TCC staff will follow to notify States and Indian tribes prior to the arrival of shipments at their borders.

4.7 Training

Training for truck and train operations will be prepared and implemented as needed. There are currently no DOE training courses for train transportation.

The DOE has made available an extensive training program for the carrier contract drivers. The following is a brief description of the major courses.

- *Radiation Worker 1 Course* presents the basics of radiation and must be taken by all drivers for the WIPP. This course includes a discussion of the different kinds of radiation and their related health effects and risks. The course emphasizes maintaining radiation levels as low as reasonably achievable (ALARA).

- *Radiation Detection Training* is a one-day field course held at the Interservice Nuclear Weapons School at Kirtland Air Force Base. All drivers are required to take this course. During the training, the driver must use the radiological monitor carried in the cab of the WIPP vehicle to detect both alpha and beta/gamma sources.

- *Vehicle Inspection Course* is a two-week course offered by the Commercial Vehicle Safety Alliance in Oregon. The course provides all carrier drivers with one week of classroom training followed by one week of field training at a port of entry.

- *TRUPACT-II Recovery Training* is a one-day course given to appropriate WIPP personnel, the truck carrier, and the Incident/Accident Response Team (IART). The course stresses the proper methods for lifting a package that has been dislodged from its secured position on the transporter.

- *Communications Training* is a two-hour course instructing all drivers in the proper use of the Improved Mobile Telephone Service, regular cellular and mobile phones, and the TRANSCOM system.

- *Public Affairs Training* is a five-hour class covering the basics of dealing with the public at both the individual and governmental levels.

- Other required short courses for truck drivers include:

  - *Dosimetry Use*

  - *Use of Tripmaster System*

  - *Quarterly Safety Training*

  - *Package Tie-Down Training*

  - *Content of the Contract Carrier Management Plan*.

5.0 TRANSPORTATION RISK

This chapter examines potential human health and environmental impacts associated with the transportation of TRU waste from the generator and storage facilities to the WIPP. Three transportation options are evaluated: truck, regular train, and dedicated train.

Occupational and public risks and exposures were evaluated for: ordinary traffic incidents/accidents and impacts related to vehicle pollution; potential exposures to radiation or hazardous chemicals during incident-free transportation; and potential exposures to radiation or hazardous chemicals estimated from postulated incidents/accidents.

5.1 Human Health Impacts

Occupational and public risks and exposures were evaluated as follows:

- Ordinary traffic incidents/accidents (traumatic injuries and fatalities) and health effects (latent cancer fatalities) related to vehicle pollution. These impacts are discussed herein as *Nonradiological/Nonchemical Impacts.*

- Potential exposure to low levels of radiation or hazardous materials during incident-free (routine) transportation. These impacts are discussed herein as *Incident-Free Radiological/Chemical Impacts.*

- Potential exposure to radioactive or other hazardous materials estimated from postulated incidents/accidents. These impacts are discussed herein as *Incident/Accident Radiological /Chemical Impacts.*

Public risks and exposures were evaluated utilizing data in Table B-2 (Appendix B). Table B-2 determines the estimated number of CH- and RH-TRU waste shipments for each transportation option during the disposal phase. Approximately 28,534 shipments would occur by truck. There are estimated to be 15,746 regular train shipments or 6,622 dedicated train shipments. The two train options include 2,016 CH-TRU and 105 RH-TRU truck shipments from Los Alamos National Laboratory (LANL) and 110 CH-TRU truck shipments from the Nevada Test Site (NTS) because these sites do not currently have train service. This transport data is used in performing all analyses contained in this study.

5.1.1. Nonradiological/Nonchemical Impacts

This subsection discusses the potential for physical injuries and fatalities that could occur during transportation incidents/accidents and the risks associated with vehicle emissions during incident-free transportation. None of these risks is related to the cargo being transported. Incident/accident risks are calculated as numbers of injuries and fatalities. Vehicle-emission risks are calculated as numbers of excess latent cancer fatalities (LCFs) in the exposed population.

Vehicle-emission risks are calculated on a per-shipment basis and on a lifetime basis (by transportation mode) for each transportation option. Estimates of the per-shipment risk include the probability of LCFs from vehicle-emission pollutants (Cashwell et al., 1986) and accident-related injuries and fatalities from a single round trip. Cumulative risk estimates were determined by multiplying per-shipment risks by total shipments.

Additional urban-area health effects may result from particulate material and sulfur dioxide emitted by truck or locomotive diesel engines during a shipment. Table C-19 in Appendix C presents the estimated per-shipment risks for truck and train transportation. The estimated risk shown for each generator/storage facility is on a round trip basis. Appendix C presents detailed descriptions of the methods, models, assumptions, and results used to estimate risks.

The nonradiological/nonchemical transportation impacts are presented in Table 5-1.

TABLE 5-1. Nonradiological/Nonchemical Impacts from Transportation of TRU Waste to the WIPP for the Disposal Phase

Transportation Option	Incident/Accident Injuries	Incident/Accident Fatalities	Latent Cancer Fatalities
Truck	110	7.3	0.2
Regular Train	63	2.5	0.7
Dedicated Train	12	1.0	0.06

The total number of injuries and fatalities projected for truck transportation was calculated based on DOT and Sandia National Laboratories data (Cashwell et al., 1986). In those projections, the injury rate per truck vehicle-mile traveled ranged from 6.16E-07 for urban areas to 1.33E-06 for rural areas (3.83E-07 to 8.27E-05 per vehicle-kilometer, respectively). This is in contrast to the values that were obtained from 23 states during the preparation of the SEIS (DOE, 1990a), indicating an overall weighted average of 3.75E-07 truck vehicle-mile (2.33E-07 vehicle-kilometer).

5.1.2 Incident-Free Radiological/Chemical Impacts

Because TRUPACT-IIs and RH-72Bs are not vented during transportation, exposure to the hazardous components of the TRU waste would not occur during incident-free transportation. The only potential radiation exposure during routine transportation activities will be from radiation that penetrates the TRUPACT-II or the RH-72B. Radiological exposures to truck drivers, to members of the public driving alongside a waste shipment, to the roadside population, and to people in the parking lots where stops are made are estimated by RADTRAN.

Radiological health impacts from incident-free transportation result from low levels of external radiation. External exposures occur from sources outside the body, such as cosmic radiation, and, in the case of this study, from radioactive material totally confined within the transportation package. In this analysis, public and worker exposures to external radiation are reported in units of rem (individual dose) or person-rem (collective dose to a group of individuals, commonly referred to as population dose).

Principal adverse effects from human exposure to low-level radiation are carcinogenicity (ability to cause cancer), mutagenicity (ability to cause inheritable defects), and teratogenicity (ability to cause noninheritable birth defects). For low-level exposures, the most significant risk is that of latent cancer fatalities (LCFs). The summation of radiation doses (collective dose) to a group of individuals may be multiplied by a dose-to-risk conversion factor to estimate the number of incremental LCFs associated with the postulated exposure. Use of a dose-to-risk conversion factor of 500 LCFs per million person-rem (5.0E-4 LCFs per person-rem) for the general population and 400 LCFs per million person-rem (4.0E-4 LCFs per person-rem) for workers are currently accepted values (NRC, 56 FR 23363, *Preamble to Standards for Protection against Radiation*). This difference in dose-to-risk conversion factors for the two population groups is attributable to the presence of children in the general population.

The maximum radiological impacts to the public for incident-free transportation from individual waste origin sites during the disposal phase are presented in Table 5-2. The LCFs presented in Table 5-2 are extremely low in comparison to the LCFs the public will experience from background radiation (natural and manufactured) along the least populated transportation route for the same time frame. Doses to the public from background radiation during the 20-year disposal phase for the least populated truck and train routes to the WIPP are calculated as 961,000 person-rem (480 LCFs based on a population of 133,000) and 2,710,000 person-rem (1,360 LCFs based on a population of 376,000), respectively. Because the shipment containers are not vented, exposure to the hazardous chemicals of the waste is not expected to occur during incident-free transportation.

TABLE 5-2. Maximum Radiological Impacts to the Public for Incident-Free Transportation from Individual Waste Origin Sites during the Disposal Phase[a]

Transportation Option	CH-TRU Shipments (person-rem)		RH-TRU Shipments (person rem)	
	Dose (person-rem)	Latent Cancer Fatalities	Dose (person-rem)	Latent Cancer Fatalities
Truck	2,340	1.2	3,170	1.6
Regular Train	363	0.18	299	0.15
Dedicated Train	363	0.18	51	0.025

[a]Totals are taken from Table C-10 (Appendix C).

Table 5-3 presents the total Incident Free Radiological Impacts during the disposal phase.

TABLE 5-3. Total Incident Free Radiological Impacts for the Disposal Phase

Total Truck Incident-Free[a]	• Transportation crew • Public	2.89E+3 8.34E+3
Total Regular Train Incident-Free[a]:	• Transportation crew • Public	7.22E+2 4.64E+2
Total Dedicated Train Incident-Free[a]:	• Transportation crew • Public	3.04E+2 6.65E+2

[a]Totals are taken from Table C-10 (Appenix C).

For the truck option, calculated doses to the public are estimated to be distributed to over 2.4 million people residing or working along the transportation routes. For the train options, over 2.9 million people are estimated to reside or work along the routes. The estimated population sizes do not consider population movement and relocation over the 20-year duration of the disposal phase.

Doses to maximally exposed individuals from incident-free shipments over the 20-year shipping campaign are presented in Table C-11. Three sets of dose tabulations are provided: one for 100-percent truck shipments, one for regular train, and one for dedicated train. Totals represent the dose expected for an individual whose residence or occupation results in an exposure to all or a large number (depending on the exposure group) of waste shipments. Included are various population groups receiving doses based on the assumptions presented in Table C-3 (Appendix C).

5.1.3 Incident/Accident Radiological/Chemical Impacts

The SEIS (1990) discussed "bounding case" transportation scenarios. These scenarios were used to calculate the impact of very severe accidents in higher population areas along the WIPP-preferred transportation routes. Postulated scenarios involved both CH- and RH-TRU truck and rail shipments using TRUPACT-IIs or RH-72Bs. To present the most current analysis, this study incorporates the most relevant data (waste characterization, inventory volumes, etc.) available.

To follow the logic used when the SEIS was prepared, the RADTRAN code was used to assess transportation impacts. For this analysis, the most recent version of RADTRAN was applied (RADTRAN 4.12). RADTRAN is a computer code used to calculate the impacts of both routine transportation and transportation incidents/accidents.

In the RADTRAN model, risks are predicted based on the likelihood of occurrence and the consequence of incidents/accidents of various severities. More severe incidents/accidents have a higher release fraction (i.e., amount of waste that is released to the environment), but a lower probability of occurrence. The fractions of material released vary as a function of incident/accident severity category. The model provides a probability-weighted estimate of cumulative risk as well as specific consequences of individual incident/accident scenarios. Further discussion of the risk calculations using the RADTRAN code is provided in Appendix C.

Based on the number of transportation packages that could be subjected to incidents/accidents exceeding NRC Type B Package certification test conditions, the range of radiological incident/accident risks for the ten generator/storage sites was calculated and is presented in Table 5-4. Total incident/accident dose risks are also presented in Table 5-4. Incident/accident dose risk to the public is defined as the summation of the probability of highly unlikely accidents occurring that lead to a release of radioactive material multiplied by the consequences (person-rem) of those accidents over the duration of the disposal phase.

Table 5-5 presents representative and maximum calculated consequences (doses) for postulated incident/accident scenarios in which the transportation packages exceed NRC Type B package certification test conditions. Data presented are for the generator/storage shipment sites having the maximum potential consequences. Details of the analysis are presented in Appendix C. Health effects resulting from the calculated doses are estimated to range from:

- 0.011 to 380 LCFs for truck shipments
- 0.075 to 750 LCFs for regular train shipments
- 0.23 to 2,300 LCFs for dedicated train shipments

Table 5-4. Range of Cumulative Radiological Incident/Accident Dose Risks to the Public for Shipments to WIPP over the Lifetime of the WIPP

	CH-TRU (person-rem)	RH-TRU (person-rem)	Total (person-rem)[a,b]
Truck	2.21E-2 to 8.43E+1	3.84E-1 to 1.88E+3	2.06E+3
Regular Train	1.18E-2 to 4.73E+1	1.15E-1 to 1.60E+3	1.94E+3
Dedicated Train	4.26E-2 to 1.92E+1	1.16E-1 to 1.60E+3	1.91E+3

[a] Totals are taken from Table C-10 (Appendix C).
[b] This is the total calculated incident/accident risk dose for train shipments from the Savannah River Site. The dedicated train option retains truck shipments for the Los Alamos National Laboratory and Nevada Test Site because neither site currently has rail access. The incident/accident risk dose contribution for Los Alamos National Laboratory shipments is predicted to total 19.2 person-rems.

The chemical hazard assessment evaluated the consequences of a highly unlikely incident/accident for each of the transportation options addressed in this report (truck, regular train, dedicated train). The analysis focused on the impacts of CH-TRU waste shipment incidents/accidents. Based on the relative capacities of the TRUPACT-II and RH-72B (102 versus 31 cubic feet, or 2.9 versus 0.89 cubic meters) and the waste characterization data presented in the *Interim Mixed Waste Inventory Report* (DOE, 1993a), it was concluded that hazardous chemical impacts resulting from CH-TRU waste incidents/accidents will be larger than the impacts associated with RH-TRU waste shipments. Thus, only the CH-TRU waste is analyzed. Details of the analysis are presented in Appendix C. Based on the conservative analysis as discussed in Appendix C, it may be concluded that the maximum exposure to a member of the public for the postulated incidents/accidents falls within health-based reference values.

5.2 Environmental Impacts

This section discusses other transportation-related environmental impacts that may occur during the disposal phase.

For this analysis, a simple screening procedure was applied to determine if the source poses a potential threat to air quality. The EPA-approved air dispersion model SCREEN was used to determine maximum pollutant concentrations. The reason for first applying a simple screening procedure is to eliminate from further analysis those sources that will not cause or contribute to ambient concentrations in excess of short-term air quality standards or allowable concentrations. A relatively large degree of conservatism is used in the screening procedure to provide reasonable assurance that

Table 5-5. Consequence Comparison for TRU Waste Shipments Involved in Very Severe Incidents/Accidents[a,b]

Transportation Option	Representative Doses[c] (person-rem; rem)	Maximum Doses[d] (person-rem; rem)
CH-TRU Waste		
Truck	1.3E+0 (population dose) 3.2E-3 (maximum individual) 2.6E-5 (individual @ 1,000m)	3.2E+4 (population dose) 8.1E+1 (maximum individual) 6.6E-1 (individual @ 1,000m)
Regular Train	1.5E+0 (population dose) 4.4E-3 (maximum individual) 3.6E-5 (individual @ 1,000m)	1.5E+4 (population dose) 4.4E+1 (maximum individual) 3.6E-1 (individual @ 1,000m)
Dedicated Train	1.5E+0 (population dose) 4.4E-3 (maximum individual) 3.6E-5 (individual @ 1,000m)	1.5E+4 (population dose) 4.4E+1 (maximum individual) 3.6E-1 (individual @ 1,000m)
RH-TRU Waste		
Truck	2.2E+1 (population dose) 1.1E-1 (maximum individual) 9.4E-4 (individual @ 1,000m)	7.5E+5 (population dose) 3.8E+3 (maximum individual) 3.1E+1 (individual @ 1,000m)
Regular Train	1.5E+2 (population dose) 7.6E-1 (maximum individual) 6.3E-3 (individual @ 1,000m)	1.5E+6 (population dose) 7.6E+3 (maximum individual) 6.3E+1 (individual @ 1,000m)
Dedicated Train	4.5E+2 (population dose) 2.3E+0 (maximum individual) 1.9E-2 (individual @ 1,000m)	4.5E+6 (population dose) 2.3E+4 (maximum individual) 1.9E+2 (individual @ 1,000m)

[a] Based on RADTRAN 4 and TICLD calculated consequences for a postulated incident/accident in an urban community.

[b] Incident doses presented are the maximum calculated consequences for each transportation option, considering all shipment origin sites.

[c] Representative consequences result from one postulated accident scenario in an urban community in which emergency response actions occur in sufficient time to mitigate the initial accident sequence, with a resulting release comparable to a category III severity accident. The reported value is the highest representative consequence for RH-TRU waste shipments and shipment origin sites.

[d] Maximum consequences result from a highly unlikely accident scenario in an urban community in which emergency response actions are delayed until after the initial accident sequence is completed (several hours), with a postulated release comparable to a category VIII severity accident. The reported value is the highest maximum consequence for RH-TRU waste shipment and shipments origin sites.

maximum concentrations will not be underestimated. A conservative analysis does not account for factors that reduce pollutant estimates; thus, the estimates are purposely high. If all of the estimated concentrations are still below applicable standards, then further analysis is not necessary. If the results of the screening procedure indicate a potential to exceed allowable concentrations, then a more detailed analysis is appropriate.

5.2.1 Environmental Impacts from Truck Transportation

Potential impacts to the environment due to incident-free truck transportation include vehicle emissions, fugitive dust, and particulate matter from tires. These pollutants are not related to the type of cargo being transported.

Based on a previous study (Rao et al., 1982), estimates have been made for incident-free nonradiological impacts of truck transportation. Potential impacts from vehicle emissions, fugitive dust, and tire particulate matter have been estimated for particulate matter, sulfur oxides (SO_x), nitrogen oxides (NO_x), hydrocarbons (HC), and carbon monoxide (CO). The source term used for these pollutants was based on grams of emission per kilometer of travel. A line-source dispersion model was used to calculate ambient air concentrations of these pollutants during vehicle travel. These concentrations are shown in Table 5-6 and are compared to the related primary and secondary National Ambient Air Quality Standards (NAAQS).

The analysis in *Nonradiological Impacts of Transporting Radioactive Material* (Rao et al., 1982) demonstrates that impacts to the ambient air from incident-free truck transportation are far below any related standard. Emissions of the above pollutants are 0.06 percent or less of their respective standards. Estimated pollutant concentrations are also below the secondary standards by similar amounts. Thus, incident-free nonradiological impacts to terrestrial ecosystems are far less than radiological impacts on human health. Chronic low doses of radiation usually have no measurable effect on ecosystems. Because doses to the public from incident-free transportation are very low, incident-free radiological impacts to terrestrial ecosystems would be insignificant.

A transportation incident/accident by truck could involve up to three TRUPACT-IIs. Even though it is highly unlikely that a release could occur, it is assumed that three TRUPACT-IIs could release all available contaminants to the ambient air. Based on this analysis, particulate matter is calculated to be released in concentrations well below applicable standards at a distance of 6,759 feet (2,060 meters). Particulate matter represents the greatest percentage of any pollutant assumed to be released. Therefore, the nonradiological impacts due to a truck transportation incident/accident are considered to be very small.

The primary impact of a transportation incident/accident on a terrestrial ecosystem would be from the heavy equipment used to clean up the accident. Cleanup would begin within hours after the incident/accident due to occurance on public rights-of-way. This impact would outweigh any effects from radiation or dispersed radionuclides. Radiological impacts to a terrestrial system due to a transportation incident/accident will mandate cleanup. Some contaminant damage could result from the cleanup. Impacted areas would be surveyed to determine the level of cleanup required. Activities involved in the cleanup would include soil removal and

TABLE 5-6. Truck Pollutant Concentrations ($\mu g/m^3$)

POLLUTANT	TRUCK	PRIMARY AND SECONDARY STANDARD (NAAQS)	
Particulates	3.1E-2	50 150	(Annual arithmetic mean) (24-hour average)
SO_x	1.2E-2	80 365 1300	(Annual arithmetic mean) (24-hour maximum) Secondary (3-hour maximum)
NO_x	3.1E-2	100	(Annual arithmetic mean)
HC	7.8E-3	235	(24-hour maximum)
CO	5.2E-2	10,000 40,000	(8-hour average) (1-hour average)

decontamination to the appropriate regulatory standard. The impacted area would be returned to pre-accident conditions.

5.2.2 Environmental Impacts from Train Transportation

Transportation by train includes two options, regular train and dedicated train. Both regular and dedicated train service can transport up to 18 TRUPACT-IIs for each shipment.

Incident-free nonradiological impacts due to the air pollutants resulting from train transportation have been estimated (Rao et al., 1982). Estimated concentrations of the pollutants are presented in Table 5-7. The source term for a train includes exhaust from the train and fugitive dust. Fugitive dust was assumed to be ten percent of vehicle fugitive dust due to the differences between the contact surfaces of the two modes of transportation.

The calculated concentrations of nonradiological pollutants from incident-free train transportation are far below the related NAAQS. Nitrogen oxide concentrations were calculated to be 0.15 percent of the standard, representing the highest percentage. Incident-free impacts to the ambient air and terrestrial ecosystems due to train transportation are considered to be inconsequential. Incident-free radiological impacts due to train transportation are similar to those discussed for truck transportation. The incident-free radiological impacts to the public are expected to bound the impacts to the terrestrial ecosystem.

Radiological impacts due to a train transportation incident/accident are similar to a truck transportation incident/accident. However, TRUPACT-IIs could potentially exceed NRC-Type B package certification test conditions in this scenario since up to 18 TRUPACT-IIs could be transported. Activities involved in the cleanup would include soil removal and decontamination to the appropriate regulatory standard. The impacted area would be returned to near pre-accident conditions.

TABLE 5-7. Train Pollutant Concentrations ($\mu g/m^3$)

POLLUTANT	TRAIN	PRIMARY AND SECONDARY STANDARD (NAAQS)	
Particulates	1.4E-2	50 150	(Annual arithmetic mean) (24-hour average)
SO_x	2.4E-2	80 365 1300	(Annual arithmetic mean) (24-hour maximum) Secondary (3-hour maximum)
NO_x	1.5E-1	100	(Annual arithmetic mean)
HC	4.5E-2	235	(24-hour maximum)
CO	5.6E-2	10,000 40,000	(8-hour average) (1-hour average)

6.0 EMERGENCY RESPONSE

This chapter describes emergency response responsibilities, requirements, capabilities, and needs for the transportation of WIPP waste by truck or train. Emergency response requirements, plans, and capabilities for first responders and medical facilities are included.

Regardless of the transportation mode, radioactive shipments have the potential to be involved in an incident/accident. Type B NRC-certified packagings are required for radioactive materials to be shipped to the WIPP. These packagings are designed to survive incident/accident conditions (see Chapter 4.0). Transportation incidents/accidents involving radioactive materials have occurred: 51 incidents/accidents involving Type B packages occurred between 1971 and 1990. In 49 of these incidents/accidents, no damage to the packaging occurred. In 1971, minor damage (structural integrity of the package remained intact) to a spent fuel container resulted from an incident/accident that occurred in Tennessee on U.S. Highway 25, when a package fell from a trailer. No radioactive material escaped from the package as a result of the accident. In another incident/accident in 1988 in Houston, Texas, a Type B package carrying an iridium-192 radioactive source fell from a pickup truck and was struck by a car. The source dislodged from the package, was found undamaged, and was recovered.

Emergency response capabilities for responding to an incident/accident are required due to the potential release of radioactive material from the package. Occasionally, emergency response efforts to incidents/accidents involving radioactive and/or other hazardous chemicals have met with problems. These problems have been identified in FEMA-REP-5, Revision 1, *Guidance for Developing State, Tribal, and Local Radiological Emergency Response Planning and Preparedness for Transportation Accidents* (FEMA, 1992) and include:

- Lack of coordination among responsible agencies
- Failure to predesignate on-the-scene coordinators or incident commanders
- Lack of carrier and shipper involvement in emergency response planning
- Inadequate communication between emergency response personnel at the scene and agencies away from the scene
- Insufficient communication between officials and the news media

The emergency response program developed by the DOE for the WIPP addresses these shortcomings while training emergency responders about the nature of TRU waste and procedures to be followed in the event of an accident. An effective program has evolved at the WIPP during the past six or seven years which has been given high marks by independent reviewers. In 1989, the National Academy of Sciences (NAS) reviewed the WIPP program and concluded that the emergency response program was comprehensive and adequate.

6.1 General Responsibilities

This section summarizes general responsibilities of the DOE, its contractors, and affected States and Indian tribes for emergency response. Sections 6.6 and 6.7 describe specific DOE roles and responsibilities in responding to an accident. Section 6.8 describes additional State, local, and Indian tribal responsibilities in responding to an emergency. Additional contractor responsibilities are described in Section 6.9. Section 6.10 describes railroad responsibilities. The DOE Albuquerque Operations Office (DOE/AL), the regional emergency response office, and DOE Headquarters (HQ) all have responsibilities in the event of an emergency. These responsibilities are summarized below.

- As the shipper, the DOE is responsible for providing the carrier with information about special precautions to be taken during a shipment and procedures to be used during an incident or accident when emergency response is required. The DOE will determine if a release has occurred and will assist the State, local, and Indian tribal authorities in informing the public. If a release has occurred, the DOE will ensure that any waste or contaminated soil is cleaned up and that the waste is loaded into shipping containers and removed from the incident/accident site.

- The DOE is represented on the Federal Radiological Preparedness Coordinating Committee (FRPCC) and supports the Federal Emergency Management Agency (FEMA). The DOE is responsible for radiological monitoring and providing assistance during a WIPP-related emergency.

- The DOE maintains the Radiological Assistance Program (RAP) for each region (Figure 6-1) and recruits, equips, and maintains Radiological Assistance Teams (RATs). Each team is a pool of skilled emergency response personnel.

- The DOE has developed specific procedures for response to a WIPP incident/accident.

- The DOE is responsible for coordinating the WIPP Transportation Exercise (WIPPTREX) program and the Transportation Accident Exercise (TRANSAX) series. Note: Not every TRANSAX will involve the WIPP.

- DOE/AL organizes, coordinates, and equips the Incident/Accident Response Team (IART).

- DOE/AL is responsible for providing emergency response and medical training to State, local, and Indian tribal emergency responders.

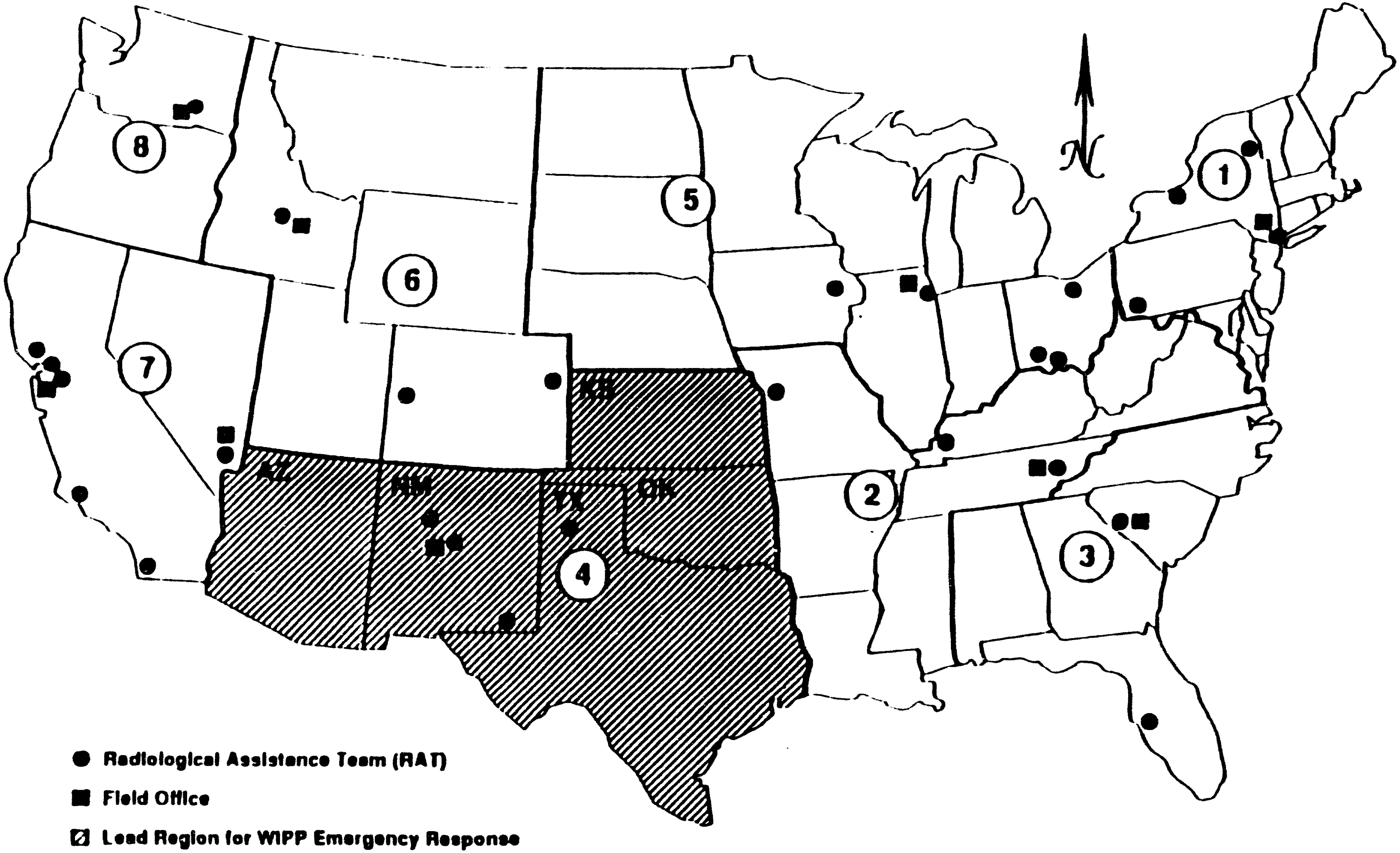

Figure 6-1. Locations of DOE Radiological Assistance Teams (RATs)

- The DOE owns the TRUPACT-IIs and trailers. Tractors are furnished by the carrier under contract to the DOE or MOC.
- The DOE oversees operation of TRANSCOM (see Section 4.6).
- The DOE provides emergency response equipment to selected entities.

DOE contractors are responsible for:

- Assisting the DOE in developing and providing emergency response training
- Coordinating medical training
- Ensuring adequate emergency response training for the WIPP contract carrier, IART, RAP, and RAT
- Assisting in preparing the WIPPTREX program and TRANSAX series
- Taking initial emergency response actions by:
  - Notifying designated authorities about the incident/accident
  - Assisting in recovering the packages if they have been displaced from the trailer or railcar

State, local, and Indian tribal authorities are responsible for:

- Providing emergency response within their jurisdication (as the first responders) and implementing measures to protect life, property, and the environment
- Cordoning off the incident/accident scene
- Performing initial radiological monitoring at an incident/accident site
- Serving as command and control authority within their respective jurisdictions
- Identifying local entities that should receive emergency response training for a particular route
- Participating in the WIPPTREX program and TRANSAX series

6.2 WIPP Emergency Response Program

This section presents an overview of the WIPP emergency response program. The emergency response program for the WIPP is defined in the 1980 WIPP FEIS (DOE, 1980) and in the 1990 WIPP SEIS (DOE, 1990a). Although program modifications and enhancements have been made since the publication of the SEIS, the basic program remains as it was when formulated by the DOE and presented in the FEIS, SEIS, and agreements with the State of New Mexico and the Western Interstate Energy Board (WIEB). These agreements have been implemented for Idaho, Wyoming, Colorado, Utah, and New Mexico.

An agreement between the DOE and the State of New Mexico concerning health and safety issues led to the Stipulated Agreement which accompanied the Consultation and Cooperation Agreement of 1981. The Stipulated Agreement concerns emergency response requirements for transportation incidents/accidents. However, specifics regarding emergency response were not determined until DOE entered into the Supplemental Stipulated Agreement in 1982. In this agreement, the DOE committed to assisting the State of New Mexico in developing an emergency response program providing financial and "in-kind" assistance and providing emergency responders with training, educational materials, and equipment. DOE authorized the development of a training program in July 1987. The DOE provided financial assistance to help provide training for first responders, mitigation personnel, and law enforcement organizations in New Mexico.

Outside New Mexico, the DOE began discussions with the WIEB in 1986 on a number of issues, including emergency training and equipment needs. In 1988, the DOE modified the program developed for New Mexico and made the States Training and Education Program (STEP) available to Idaho, Wyoming, Colorado, New Mexico, and Utah. Under the STEP, emergency response procedures are taught in seven different courses. These courses are discussed in greater detail in Section 6.3 and include:

- *First Responder Course*
- *First Responder Refresher Course*
- *Command-and-Control Course*
- *Mitigation Course*
- *Train-the-Trainer Course*
- *Medical Management Course*
- *Kit Course*

Course outlines are included in Appendix D.

Section 2.8 of the SEIS, "Transportation Emergency Planning," and Appendix C of the same document describe the emergency response program for transportation and document its implementation at the time the SEIS was written (DOE, 1990a). The transportation emergency response program described in subsection 6.11 of the FEIS (DOE, 1980) was implemented by 1989. The DOE then began an initiative for training medical personnel. A Memorandum of Understanding was signed with the Guadalupe Medical Center in Carlsbad and with the Lea Regional Hospital in Hobbs to provide equipment and training to personnel. Appendix C, part 3, of the SEIS provides an emergency response plan for waste transportation to the WIPP. This section includes the emergency response procedures and responsibilities that would go into effect in the event of a WIPP-related transportation incident/accident. When amended by subsequent documents, this section forms the basis for the DOE emergency response approach to WIPP transportation.

The WIPP emergency response program is composed of three basic elements:

1. Providing training to ensure State, local, and Indian tribal WIPP emergency response readiness.

2. Organizing and staffing DOE response teams and providing them with plans describing roles and responsibilities in an incident/accident and with specific procedures for dealing with specific incident/accident conditions.

3. Ensuring that personnel accompanying a shipment are knowledgeable about selected emergency response procedures.

As discussed earlier in this chapter, the DOE has provided, and will continue to provide, emergency response training through the STEP and through a field exercise program. Field exercises include Federal, State, local, and Indian tribal participants. The DOE has been conscientious in developing specific STEP classes, the TRANSAX series, and the WIPPTREX program. Both classroom and field training will continue to play an important role in preparing for potential incidents/accidents throughout the Disposal Phase. These portions of the emergency response program are discussed in Sections 6.3 and 6.4.

Specific plans for roles and responsibilities in an incident/accident have been developed and implemented. The DOE has used existing regionally-based RATs to provide specialized emergency capabilities for responding to WIPP transportation incidents/accidents. The DOE has also developed an IART that will respond to incidents/accidents involving TRUPACT-IIs or RH-72Bs. A plan detailing the specific roles and responsibilities of the teams and procedures for use at an incident/accident has been developed. Sections 6.5 and 6.6 discuss the teams.

Personnel accompanying a shipment will be knowledgeable about selected emergency response procedures and, if physically able, will take appropriate action before the arrival of first responders. Carrier drivers will take initial emergency response actions by notifying the designated authorities about the incident/accident. If shipments move by dedicated train, the emergency response specialist accompanying the train will perform a similar function. Section 6.9 describes carrier emergency response roles.

6.3 States Training and Education Program (STEP)

This section describes the DOE STEP. The following is a brief summary of the seven STEP courses. Although courses were designed for incidents/accidents involving TRUPACT-IIs, they will be modified in the future to accommodate the use of the planned RH-72B. Appendix D presents a detailed description of the STEP.

- *First Responder Course* is an eight-hour course for law enforcement, fire, and medical first responders that introduces the WIPP and provides training for initial response at an incident/accident. This course includes specific procedures for handling incident/accident conditions and for notifying additional personnel at other agencies to provide assistance.

- *First Responder Refresher Course* is a four-hour refresher course for those who have previously attended the eight-hour course.

- *Command-and-Control Course* is a 16-hour course for those who might be in charge of an incident/accident scene. This course includes the first responder course and a detailed discussion of the Incident Command System.

- *Mitigation Course* is an eight-hour course for state radiological professionals who might have monitoring responsibilities at an incident/accident scene. In addition to a WIPP overview, this course includes discussions about monitoring TRU waste and the radiological capabilities of the DOE.

- *Train-the-Trainer Course* is a 12-hour course for state officials who may be involved in training others in emergency response procedures. This course includes the first responder course on the first day and training on the course curriculum and appropriate teaching techniques on the second day.

- *Medical Management Course* is an eight-hour course for hospital emergency-room doctors and nurses who might be called upon to treat victims of a TRU waste incident/accident. This course, offered at hospitals, focuses on the practical aspects of treating patients and includes instruction in setting up a radiation-controlled area.

- *Kit Course* is a two-hour course designed solely for New Mexico to provide training in the use of protective clothing and equipment.

The first training class was conducted in Utah in April 1988. By October 1988, training was offered in Colorado, Idaho, New Mexico, and Wyoming. Training was conducted again in these States in 1989 and the same year in the corridor States along Highway I-20 in anticipation of shipments from the Savannah River Site (SRS) to the WIPP.

In Idaho, Utah, New Mexico, Wyoming, and Colorado, more than 2,400 firemen, policemen, and emergency medical personnel were trained in the First Responders Course at the time the SEIS was written (DOE, 1990a). As of April 30, 1993, a total of more than 8,700 students had participated in STEP training, and an additional 800 people had received medical training.

The LWA requires the Occupational Safety and Health Administration (OSHA) to review WIPP training. OSHA reviewed the three primary courses (First Responder, Command-and-Control, and Mitigation courses) and found them satisfactory in delivering specialized training addressing the hazards of WIPP wastes. They found that the courses do not substitute for other, more generalized emergency training required by the emergency responders' employer. In July 1993, OSHA certified that the Department of Labor reviewed emergency response training programs of the DOE that apply to the WIPP and concurred that the programs are in compliance with 29 CFR 1910.120.

The DOE is continually updating and improving its courses to incorporate changes suggested by reviewers such as OSHA, course attendees (through course evaluations), or other interested parties, such as the States. The DOE has also developed an intensive, WIPP-specific, 3½-day Medical Management Course taught at the Radiation Emergency Assistance Center/Training Site (REAC/TS) in Oak Ridge, Tennessee, that deals with extensive hands-on training in decontamination of injured people. This course was first taught in 1993 only to New Mexico hospital personnel.

STEP training is predominantly offered in the field. The number of attendees varies considerably with the specific location of the courses offered and the needs of State, Indian tribal, local, and other attendees. In general, STEP training is offered at a location approximately every 60 miles along a WIPP transportation route. This is done to minimize student travel, attempting to ensure that no one need travel more than one hour to attend a class. No more than 50 students can be accommodated at any one time by the two instructors normally teaching the classes.

The DOE also works closely with the States through the Western Governors' Association (WGA) and the Southern States Energy Board (SSEB) and with Indian tribes to identify State and local jurisdictions requiring training. Shipments by train or truck would result in training being conducted in the same jurisdictions in which both train and truck routes pass. Different participants will be trained where the routes diverge. For planning purposes, training requirements will be similar for either train or truck shipments.

In consultation with affected States and Indian tribes, as required by the LWA, the DOE intends to continue the STEP throughout the disposal phase. States or Indian tribes may elect to assume control of these programs at some point in the future and incorporate WIPP-specific material into their existing hazardous materials training programs. The DOE will support and assist States or Indian tribes in this effort.

6.4 Field Exercise Programs

Field exercises are an integral part of the WIPP emergency training program and complement the STEP by providing hands-on field experience using an actual TRUPACT-II waste transporter and container. The program began after it was requested by the WIEB as a way to supplement classroom-style training. The two field exercise programs primarily used are the Transportation Accident Exercise (TRANSAX) series and the WIPP Transportation Exercise (WIPPTREX) program.

The TRANSAX series is a national program directed by the DOE using a wide variety of resources at all levels of government. Both the DOE Operations Office where the exercise is held and the DOE Operational Emergency Management Team (OEMT) in Washington, D.C., participate in the program. TRANSAX, which is held biennially, is not confined to a WIPP-related field exercise. The first TRANSAX was held in Colorado Springs in conjunction with the State of Colorado in November 1990. Another exercise was held in Idaho in September 1992, in conjunction with the State of Idaho and the Shoshone-Bannock tribes. Both exercises tested DOE emergency response capabilities and included local responder involvement. Appendix D describes the scenario used for the exercise held in Idaho, lists the organizations in attendance, and highlights results. The most recent TRANSAX was held in September 1993 near Lamy, New Mexico.

The WIPPTREX program was initiated in 1992 to focus on local responders and allow them to apply their STEP training in the field. These exercises are held twice per year, are smaller than the TRANSAX, and are devoted exclusively to the WIPP program. The first WIPPTREX was held in Raton, New Mexico, in October 1992. The second was in Laramie, Wyoming, in April 1993. Another exercise was held in Utah in October 1993. The exercises provide first responders with the opportunity to work with State and Federal teams to deal with simulated technical and communication problems. Appendix D describes the scenario used for the Laramie exercise and lists the organizations in attendance.

6.5 DOE Radiological Assistance Program (RAP)

Since the late 1950s, the DOE has sponsored a RAP to provide technical assistance in the event of a nuclear incident/accident. This nationwide capability is available to provide DOE resources to other DOE facilities as well as to other Federal agencies and State, local, and Indian tribal governments to assist in mitigating radiological incidents/accidents. Emergency response capabilities are located at each of the eight regional offices (see Figure 6.1). All DOE regions except Region 1 will provide emergency response support during the disposal phase. Regional offices are responsible for planning, training, and preparing personnel and for responding to radiological emergencies when requested.

Each region develops a RAP specifically tailored to the resources and operations of that region. The typical plan would include an overview of organizations and responsibilities within that region, a description of the resources and expertise available within that region, the procedure for requesting assistance, and the emergency response activation plan.

Transportation Emergency Training for Response Assistance (TETRA) is a DOE training program designed to train its response personnel to provide assistance during transportation incidents/accidents involving radioactive materials. It is primarily focused toward response outside of DOE sites. TETRA will consist of six "stand-alone" modules on the DOE emergency management system. The program includes training on the interaction of various components of the system and the role of the RAP team members in the DOE system. Some materials covered through the TETRA course include:

- Instruction on response planning
- Hazards awareness
- Incident command
- DOE responder interface with civil incident commanders
- Radioactive materials packaging and labelling
- Area control
- Interaction with outside (non-DOE) response organizations
- Public affairs awareness

The Radiological Assistance Team (RAT) is the component of the RAP that will respond to a radiological incident/accident. The RAT is selected from a pool of individuals who are experts in the monitoring, handling, and disposing of radioactive materials. Actual RATs may vary depending on the availability of potential team members and the specific skills needed at a particular incident/accident. RATs will provide technical assistance at the scene to Federal, State, local, and Indian tribal authorities but will not assume the role of Incident Commander. However, the leader will act as the field crisis manager for the DOE region and will keep an accurate record of the events. Other RAT responsibilities include:

- Assisting in rescue and first aid activities
- Delineating areas of contamination
- Evaluating health hazards
- Preventing the spread of contamination
- Providing assistance to other Federal agencies as required
- Assisting in repackaging or packaging material and certifying when it is safe to ship

If an incident/accident were severe or of long duration, the DOE may decide to send in a post-incident evaluation team to conduct a detailed evaluation of the factors responsible for the incident/accident and of the emergency response and mitigation measures followed. This team will provide guidance and advice to the regional DOE manager.

DOE Region 4 has been assigned the lead by DOE/HQ for WIPP TRUPACT-II radiological response. Region 4 will also be responsible for providing radiological response to incidents/accidents involving the proposed RH-72B. The RAP addresses WIPP-related incidents/accidents and emergency response differently than it does most other radiological incidents/accidents. This is due to the fact that the DOE plays a different role in WIPP shipments because the DOE is the generator and owner of the waste, the supervisor of the carrier, and the receiver of the waste at its WIPP facility. Consequently, DOE has developed a series of protocols calling for specified responses to particular WIPP-related emergency conditions. These are described in *Radiological Assistance Team (RAT) Procedures for TRUPACT-II Transportation Incidents* (DOE, 1991a). Region 4 has also prepared a specific procedure for handling TRUPACT-II incidents/accidents and has trained RAT personnel in handling TRUPACT-II incidents/accidents in both Region 4 and Region 6. Region 4 staff will conduct training for the other regions before the initiation of the disposal phase and will develop procedures for addressing emergency problems associated with other containers as they are certified by the NRC. The DOE will prepare specific procedures for RH-72B shipping cask incidents/accidents. These procedures will be developed prior to initiating the disposal phase.

6.6 Incident/Accident Response Team (IART)

The Incident/Accident Response Team (IART) was formed to provide technical expertise to the DOE for a WIPP-related incident/accident involving Type B containers. The team's role is formally described in *Emergency Response and Recovery Roles and Responsibilities for TRUPACT-II Transportation Incidents* (DOE, 1991b). (See Section 6.7 for a description of this role relative to the TRUPACT-II.) Roles and responsibilities will be modified to include the RH-72B before the initiation of the disposal phase. The IART is composed of a team leader, DOE/AL Packaging and Transportation personnel, the DOE/AL Public Affairs Officer, and packaging and transportation engineers employed at Westinghouse WID. Members of the IART are based primarily in Carlsbad, New Mexico, and will be on call while waste is enroute to the WIPP.

After being notified by the carrier or emergency response personnel of an incident/accident, DOE/AL determines if the IART is needed. After they make the decision to call upon the IART, DOE/AL notifies the CMR operator, who then notifies IART members from an emergency plan notification list. Team members, along with their designated equipment, will be sent to the incident/accident site as soon as possible. This equipment primarily includes communications equipment and procedures such as the TRUPACT-II Recovery Guide. A similar guide will be developed for the RH-72B. Transportation to the incident/accident site will be by DOE charter aircraft if the incident/accident scene is at least 150 miles from Carlsbad. If the incident/accident is less than 150 miles from Carlsbad, the IART members will be transported directly by motor vehicle.

Upon arrival at the incident/accident scene, the team will report to the Incident Commander, assess the condition of the packages, provide advice on recovery and disposition of the container, and provide technical assistance as required. The report *TRUPACT-II Accident Response Team* (DOE, 1993c), includes transportation and packaging and tie-down checklists. The IART will also coordinate the replacement of any tractors, trailers, and/or other equipment and will ensure that qualified replacement drivers are obtained, if required.

In the future, the DOE IART may be expanded to include members with expertise in any new packaging used for transporting TRU wastes. This would include the RH-72B, currently under development. Similarly, as the disposal phase approaches, the DOE will have to assess the response time to an incident/accident across the country and perhaps develop contingency plans for aircraft availability required to reduce response times.

6.7 DOE Emergency Response Roles and Responsibilities in Responding to an Incident/Accident

The DOE has worked to define specific roles and responsibilities for responding to and providing assistance for a particular emergency response incident/accident in order to avoid the sort of organizational problems that can plague emergency responders at a major incident/accident. Results of this work have been printed and distributed in *Emergency Response and Recovery Roles and Responsibilities for TRUPACT-II Transportation Incidents* (DOE, 1991b). This document, currently under revision, focuses on truck transportation and will form the basis for a similar approach for the RH-72B and for incidents/accidents involving train transportation. It will be rewritten to include future roles and responsibilities for responding to incidents/accidents involving the RH-72B and any potential shipments by train.

The DOE approach makes the following determinations:

- If a radiological release has occurred
- Status of the TRUPACT-II and tractor trailer
- If DOT regulations can be met
- If the IART is needed to get the shipment en route to its destination

In all cases, the DOE will communicate with the States, local, and Indian tribal officials to ensure that they are provided with the latest information on the emergency response process. The DOE response would be a tiered or staged response, based on the actual or perceived severity of the incident/accident. Levels of response by the DOE and the triggering condition are listed in Table 6-1.

6.8 State, Local, and Indian Tribal Emergency Response

The States, local governments, and Indian tribes are responsible for responding first at the scene of an incident/accident and implementing procedures to save life and property. There is a large variation in the hazardous materials emergency response capabilities of organizations at the various levels of government. Major differences exist in knowledge and training, experience, and equipment. Despite this variability, the DOE philosophy is to equip the emergency responders along the shipment routes with a basic level of knowledge and skills required to respond correctly to an incident/accident involving TRU shipments. The STEP was designed for this purpose and is discussed in detail in Section 6.3. Nevertheless, beyond those responders trained in the STEP, a considerable number of skilled and effective hazardous materials response organizations are available to enhance the overall emergency response network for WIPP waste shipments. Most of this expertise resides at the State level and in major cities.

6.8.1 State Emergency Response

Twenty-four States are located along the proposed highway and potential rail corridors for WIPP shipments. The emergency response capabilities of these States were assessed with the assistance of the WGA and the SSEB. The results of this survey are presented in a matrix in Appendix D. All 24 States have a number of common characteristics, including:

- A State plan for hazardous materials emergency response, with an agency designated with lead responsibility for radiological incidents or accidents
- At least one trained emergency response team
- A health physicist available for radiological assessments
- Radiation monitors
- Personal protective equipment

Also, the DOE reviewed State emergency response plans for the WIPP SEIS to ensure that all affected States included notification of a trained state responder and the DOE RAP if a WIPP shipment incident/accident were to take place.

Table 6-1. DOE "Tiered" Response

	CONDITION	RESPONSE
Tier 0	No "noteworthy" structural damage to the packaging identified by first responders and/or carrier.	No special deployment unless there is need for a DOE regional representative and a DOE public affairs officer to deal with any public controversy. The Incident/Accident Response Team (IART) is alerted.
Tier I	Status of the TRUPACT-II is unknown, or the outer stainless steel shell may have been pierced, or the transporter is damaged or condition unknown.	The Radiological Assistance Team (RAT) is deployed along with a DOE public affairs officer and a regional DOE representative. The RAT will be equipped to monitor conditions and will carry proper monitoring, protective, and communication equipment. Replacement drivers and specialists on the trailer and TRUPACT-II could be sent if required. The IART is deployed.
Tier II	The outer stainless steel shell has been pierced, the integrity of the TRUPACT-II is uncertain, or there is potential structural damage to the packaging or to the trailer.	The same response as for Tier I, with the addition of deploying the IART, a senior DOE official, and additional health physics support if needed. The IART will include a WIPP TRUPACT-II evaluation team and the transportation manager. The DOE-AL charter airline service will be used to deploy the IART if the accident scene is more than 150 miles from Carlsbad, NM.
Tier III	There is a radiological release, or the contents of the package must be transferred to another container or be repackaged.	Tier III requires the responses of Tier I and II plus a recovery team supplied by the carrier, which would include tractor and trailer experts and replacement equipment as needed. The DOE will also send a hazards assessment group, shipper facility representative, and health physics specialists, if required.

6.8.2 Local Government Emergency Response

There is considerable variability in the capabilities of local emergency responders. They range from skilled and well-trained teams located in larger cities to lesser experienced personnel, such as volunteer fire departments. The DOE STEP, all local government first responders would have a cadre of people trained to respond to a WIPP transportation incident/accident to take necessary actions until more highly trained technical teams arrive.

6.8.3 Indian Tribe Emergency Response

Although the WIPP eventually expects to transport TRU waste through 22 separate Indian tribal lands, only the Shoshone-Bannock (Idaho) and the Confederated Umatilla (Oregon) tribes were surveyed for this report. Both of these Indian tribes have emergency response teams with radiological training. However, the majority of Indian tribes lack an emergency response capability to deal with radiological incidents/accidents and must depend on other governmental entities for emergency response.

6.9 Carrier Emergency Response

Drivers will be able to provide selected emergency response services. Before the first responders arrive at the scene of an incident/accident, drivers can initially assess damage to packages and keep bystanders away from the incident/accident scene. The current WIPP contract carrier's management plan includes requirements for all drivers to maintain a list of emergency contacts and to use their communication equipment (TRANSCOM or mobile telephone) to notify responsible authorities in the event of an incident/accident. Notification priority is:

1. Local authorities

2. State police or local law enforcement agency

3. Central Monitoring Room (CMR)

Drivers will also report any incident/accident to the carrier's traffic manager. Drivers are also trained to assist in any recovery of the package and are equipped with a copy of the WIPP TRUPACT-II Recovery Guide.

If TRUPACT-IIs are shipped by dedicated train, the emergency response specialist accompanying the shipment will be responsible for:

- Visually assessing and monitoring (with a radiation detector) any incident/accident involving the train to determine any problems with the package

- Advising first responders and railroad emergency crews about procedures for handling a displaced or damaged package

- Monitoring the TRANSCOM system to ensure its proper functioning

- Maintaining telephone communication with the WIPP CMR and AL/EOC

- Assisting Federal RAT and IART in their site duties

- Maintaining a current set of WIPP emergency procedures such as those for TRUPACT-II and RH-72B recovery and all applicable material safety data sheets (MSDSs) for any hazardous materials being transported.

6.10 Comparison of Emergency Response to Truck and Train Incidents/ Accidents

Emergency response to an incident/accident involving WIPP shipments by train would be similar in many ways to one for truck shipments. Because trains run on tracks that are not dedicated to a single use, cleanup would begin immediately. County or city personnel would act as first responders to assess the situation and attempt to save lives. State and Federal teams would respond if requested. One major difference is that the train runs on privately owned track that is the responsibility of each railroad. The rail carrier would assist in emergency response. All major rail carriers have emergency plans for hazardous materials incidents/accidents. Many rail carriers, such as the CSX and Burlington Northern, have their own hazardous materials emergency response teams or, as is the case for the Norfolk Southern railroad, trained staff who would mobilize outside contractors to assist in emergency response. However, all rail carriers would enlist outside specialists to assist in cleaning up a serious incident/accident. In addition, the Association of American Railroads' (AAR) Bureau of Explosives maintains a group of emergency responders at 18 different locations across the United States to assist train carriers in emergencies.

To assist in emergency response and clean-up activities, all major rail carriers maintain specialized equipment that can reach the scene of an incident/accident by rail or highway access. This equipment includes wreck trains with:

- Cranes, track-mounted caterpillar tractors, and special tools for clearing an incident/accident scene

- Personal protective equipment

- Monitoring equipment

- Cranes and caterpillar tractors mounted on wheels for travel by road and land to reach an incident/accident scene

- Equipment such as dams, pigs, and absorbents to contain liquid spills

Some rail transport experts contend that dedicated trains provide a safer way to ship nuclear waste because greater control over the speed, routing, and monitoring of the waste can be maintained (Conlon, 1992). For emergency response, dedicated trains offer a distinct advantage. Because of the absence of a mixed cargo, there is less danger that other hazardous materials would be involved in an incident/accident. Involvement of other hazardous materials could exacerbate emergency response problems at the incident/accident location. A "mode and route" study authorized under the Hazardous Materials Uniform Safety Act Amendments of 1990 is currently in progress by the DOT. This study will include an evaluation of the safety of dedicated trains for transporting spent nuclear fuel. The results of this study, when available, should have applicability for emergency response considerations related to the shipment of WIPP waste and may aid decision makers in determining if regular train shipments would be a feasible option.

Training for emergency response to train incidents/accidents would require the DOE to evaluate its STEP training, WIPPTREX field exercises, and TRUPACT-II and RH-72B procedures and to adapt the programs for train transportation. States would have to identify which jurisdictions require training. Required modification of the STEP to adapt it to train shipments would be relatively minor. However, the WIPPTREX would have to be modified considerably so that participants could work with an actual rail car on a rail track. One possible venue for the exercise would be the Transportation Test Center, which conducts emergency response training for trains and is operated by the AAR for the DOT east of Pueblo, Colorado. Radiological procedures for TRUPACT-II and RH-72B incidents/accidents and the TRUPACT-II and the RH-72B Recovery Guide would have to be modified before they could be used for train transportation.

7.0 COSTS

This chapter discusses and compares costs for each transportation option considered in this report. All costs are given in 1993 dollars and are based on the best available current estimates.

7.1 Overview

This section addresses the major cost factors that contribute to the total cost for each of the three transportation options.

Emergency response costs have not been included because these costs are outside the scope of this study. These costs would not constitute a variable that would allow for a significant change in comparing the three transportation options.

7.2 Truck Option

This section describes the costs for the truck option. The following assumptions were used:

- There will always be two drivers per truck.
- Drivers and tractors will be dedicated to WIPP-related shipments.
- A dispatcher will be dedicated to WIPP-related shipments 24 hours per day.
- All trucks will leave from the WIPP site empty, drive to one of the designated sites, and return to the WIPP loaded.
- Average travel speed will be 45 miles per hour (includes rest stop times).
- All applicable DOT regulations will be followed.
- 6.75 miles per gallon will be used, with a fuel cost of $1.20 per gallon.
- The driver will work 250 days per year (50 weeks) and cost $30/hour each in direct labor charges including fringe benefits.
- An additional cost of $240 for two drivers per shipment for four hours each of nondriving time will be added. Nondriving time is for paper work, loading, etc.
- Once loaded, the truck will proceed directly to the WIPP site without stopping except for fuel, food, and ports of entry.
- Costs will not include DOE program administration.
- Adverse weather conditions will not be considered.

- Trucks will be leased and replaced every three years or 300,000 miles.
- All trailers used in the transportation of TRU waste to the WIPP will be DOE owned.
- TRANSCOM, telephone, and other specified equipment will be furnished by the DOE.
- Based on WIPP capacity figures, an estimated 28 trucks and 74 drivers will be used.

Calculations were made to determine the overall number of trucks and drivers needed to complete the disposal phase in the 20-year time frame. Table 7-1 presents the total number of shipment days as 168,640. Using these figures, the average shipment will take six days to complete.

The number of tractors needed for the disposal phase was calculated by subtracting the number of days in maintenance (15) from 365 days, resulting in 350 working days per year. The 350 days divided by the number of days to complete a shipment equals 58 shipments per truck per year. Dividing the total number of shipments by 20 results in an average of 1,420 loads per year. Dividing the average number of shipments per year by the number of shipments per truck per year shows that 25 trucks are needed to complete all the shipments within the 20-year disposal phase. Although an industry-accepted standard of 10 percent downtime was used in the overall calculations for tractors and drivers the carrier contract limits operation to a 2-percent downtime.

The number of drivers was derived by dividing the total number of shipment days (168,640) by the number of driver days (5,000). Because there are two drivers per truck, the minimum number of drivers is 68.

Truck shipment costs for the disposal phase were calculated based on contract rates for round-trip shipments to each site. These costs are shown in Table 7-2. Allowances for downtime and dispatcher costs are included. The last column shows the cost per shipment per site for the disposal phase.

Total costs for the truck contract carrier during the disposal phase were calculated by multiplying the number of estimated shipments for each site by the estimated cost per shipment. These figures are shown in Table 7-3. The estimated total shipment costs for all of the sites during the disposal phase is $236,797,321.

Published commercial truck tariff rates are somewhat higher. Table 7-4 shows that the cost for shipping by commercial carrier is estimated to be $258,055,459. However, it is possible that these rates could be negotiated lower.

Table 7-1. Truck Shipment Days for Drivers

Site	CH Shipments	RH Shipments	Travel Days (Round Trip)	Total Shipment Days
INEL	7,639	218	5	39,285
RFP	408	--	3	1,224
Hanford	3,920	7,244	7	78,148
SRS	4,658	--	7	32,606
LANL	2,016	105	2	4,242
ORNL	206	1,723	6	11,574
NTS	110	--	5	550
ANL-E	49	99	6	888
LLNL	91	--	5	455
Mound	48	--	6	288
			TOTAL SHIPMENT DAYS:	169,260

Table 7-2. Truck Contract Shipment Costs for Round Trip to Each Site

Site	# Hrs. per Driver	Driver Labor[a] (Driving)	Per Diem	Driver Labor[b] (Not Driving)	Fuel	Subtotal[c]	Other Costs	Dispatcher[d]	Cost Per Shipment
INEL	62.0	$3,720	$260	$240	$492	$4,712	$2,592	$137	$7,441
RFP	31.0	1,868	156	240	244	2,500	1,375	69	3,944
Hanford	81.0	4,860	364	240	646	6,110	3,360	179	9,649
SRS	82.0	4,920	364	240	653	6,177	3,397	181	9,755
LANL	18.0	1,080	104	240	141	1,565	864	40	2,469
ORNL	70.0	4,200	312	240	560	5,312	2,922	155	8,389
NTS	54.0	3,240	260	240	428	4,168	2,292	119	6,579
ANL-E	68.0	4,080	312	240	538	5,170	2,843	150	8,163
LLNL	64.0	3,840	260	240	511	4,851	2,668	141	7,660
Mound	72.0	4,320	312	240	572	5,444	2,994	159	8,597

[a]Includes fringes and is multiplied by two for number of drivers
[b]Includes $240 per trip for other driver labor
[c]Other cost is total driver labor x .55
[d]Dispatcher time = $2.21 per hour

Table 7-3. Total Cost for Contract Carrier Truck

Site	Number of Shipments	Total Cost per Shipment	CH Cost/Container (Round Trip)	Total Cost Per Site
INEL	7,763	$7,441	$2,480	$57,764,483
RFP	358	3,944	1,315	1,411,952
Hanford	11,164	9,649	3,216	107,721,436
SRS	4,658	9,755	3,252	45, 438,790
LANL	2,121	2,469	823	5,236,749
ORNL	1,929	8,389	2,796	16,182,381
NTS	110	6,579	2,193	723,690
ANL-E	148	8,163	2,721	1,208,124
LLNL	91	7,660	2,553	697,060
Mound	48	8,597	2,866	412,656
TOTAL SHIPMENT COSTS FOR ALL SITES:				$236,797,321

Table 7-4. Total Cost for Commercial (For-Hire) Carrier Truck[a]

Site Location	Round Trip Miles	Rate/Mile	Cost	CH Cost/Container (Round Trip)	Total Cost Per Site
INEL	2,766	2.91	$8,049	$2,683	$62,484,387
RFP	1,372	2.91	3,993	1,331	1,429,494
Hanford	3,634	2.91	10,575	3,525	118,059,300
SRS	3,674	2.91	10,691	3,564	49,798,678
LANL[b]	794	3.15	2,501	834	5,304,621
ORNL	3,152	2.91	9,172	3,057	17,692,788
NTS	2,408	2.91	7,007	2,336	770,770
ANL-E	3,030	2.91	8,817	2,939	1,304,916
LLNL	2,874	2.91	8,363	2,788	761,033
Mound	3,218	2.91	9,364	3,121	449,472
				TOTAL	$258,055,459

[a] Rate includes: standard rate, HRCQ charge which includes dual drivers w/HRCQ training and satellite tracking

[b] Intrastate shipment

7.3 Regular Train Option

This section describes the costs for regular train shipments during the disposal phase. The costs shown are for both tariff and contract train rates.

For the purpose of this study, the following assumptions have been made to calculate the costs of regular trains:

- Train mileage is the same used for the risk calculations.
- Up to 18 TRUPACT-IIs on two cars may be used to carry waste.
- Each waste shipment will be accompanied by two buffer cars.
- No downtime will be associated with railroad operations.
- Costs will not include DOE program administration.

Tariff or class rates used for calculating shipment costs for regular train shipments are based on rates per loaded car at a specified distance. Rates include loaded cars and buffer cars on a round-trip basis.

The railroad rate proposals, based on nine TRUPACT-IIs or three RH-72Bs per railcar, were used in this study as shown in Tables 7-5 and 7-6. In order to be consistent with the transportation risk assessments in this study, costs based on six TRUPACT-IIs or two RH-72Bs per railcar were calculated and are presented in Tables 7-7 and 7-8. The difference between the cost results for the two configurations are minimal.

Table 7-5. Class Rates for Regular Train Service
(Based on nine TRUPACT-IIs or three RH-72Bs per railcar)

LOCATION	WASTE TYPE	SHIPMENTS 9 CH, 3 RH	ROUND TRIP CARLOAD CHARGE	COST PER CONTAINER	TOTAL COST
INEL	CH	2,515	$32,756	$3,640	$82,381,340
	RH	73	$31,522	$10,507	$2,301,106
RFP	CH	120	$20,369	$2,263	$2,444,280
Hanford	CH	1,307	$48,195	$5,355	$62,990,865
	RH	2,414	$44,966	$14,989	$108,547,924
SRS	CH	1,553	$30,561	$3,396	$47,461,233
LANL	NO TRAIN SERVICE CURRENTLY AVAILABLE				
ORNL	CH	69	$28,124	$3,125	$1,940,556
	RH	574	$25,568	$8,523	$14,676,032
NTS	NO TRAIN SERVICE CURRENTLY AVAILABLE				
ANL-E	CH	16	$28,124	$3,125	$449,984
	RH	33	$26,234	$8,745	$865,722
LLNL	CH	30	$35,689	$3,965	$1,070,670
MOUND	CH	16	$46,421	$5,158	$742,736
				TOTAL:	$332,405,562

Table 7-6. Contract Rates for Regular Train Service
(Based on nine TRUPACT-IIs or three RH-72Bs per railcar)

LOCATION	WASTE TYPE	SHIPMENTS 9 CH, 3 RH	CONTRACT RATE	COST PER CONTAINER	TOTAL COST
INEL	CH	2,515	$14,440	$1,604	$36,316,600
	RH	73	$21,409	$7,136	$1,562,857
RFP	CH	120	$8,650	$961	$1,038,000
Hanford	CH	1,307	$18,712	$2,079	$24,456,584
	RH	2,414	$25,604	$8,535	$61,808,056
SRS	CH	1,553	$21,392	$2,377	$33,221,776
LANL	NO TRAIN SERVICE CURRENTLY AVAILABLE				
ORNL	CH	69	$18,435	$2,048	$1,272,015
	RH	575	$30,245	$10,082	$17,390,875
NTS	NO TRAIN SERVICE CURRENTLY AVAILABLE				
ANL-E	CH	16	$11,550	$1,283	$184,800
	RH	33	$14,200	$4,733	$468,600
LLNL	CH	30	$14,453	$1,606	$433,590
MOUND	CH	16	$12,004	$1,334	$192,064
				TOTAL:	$178,345,817

Table 7-7. Class Rates for Regular Train Service
(Based on six TRUPACT-IIs or two RH-72Bs per railcar)

LOCATION	WASTE TYPE	SHIPMENTS 6 CH, 2 RH	ROUND TRIP CARLOAD CHARGE	COST PER CONTAINER	TOTAL COST
INEL	CH	3,810	$22,321	$3,720	$85,266,220
	RH	109	$20,504	$10,252	$2,234,936
RFP	CH	204	$13,880	$2,313	$2,,831,520
Hanford	CH	1,960	$32,841	$5,474	$64,368,360
	RH	3,622	$30,166	$15,083	$109,261,252
SRS	CH	2,329	$20,825	$3,471	$48,501,425
LANL	TRAIN SERVICE CURRENTLY UNAVAILABLE				
ORNL	CH	103	$23,309	$3,885	$2,400,827
	RH	862	$18,162	$9,081	$15,655,644
NTS	TRAIN SERVICE CURRENTLY UNAVAILABLE				
ANL-E	CH	25	$19,165	$3,194	$479,125
	RH	50	$17,605	$8,803	$880,250
LLNL	CH	46	$24,320	$4,054	$1,118,720
MOUND	CH	24	$31,633	$5,273	$759,192
				TOTAL	$333,757,471

Table 7-8. Contract Rates for Regular Train Service
(Based on six TRUPACT-IIs or two RH-72Bs per railcar)

LOCATION	WASTE TYPE	SHIPMENTS 6 CH, 2 RH	CONTRACT RATE	COST PER CONTAINER	TOTAL COST
INEL	CH	3,820	$14,440*	$2,407*	$55,160,800*
	RH	109	$21,409*	$10,704*	$2,333,581*
RFP	CH	204	$8,650*	$1,442*	$1,764,600*
Hanford	CH	1,960	$18,712	$3,119	$36,675,520
	RH	3,622	$25,604	$12,802	$92,737,688
SRS	CH	2,329	$21,392	$,3566	$49,821,968
LANL	NO TRAIN SERVICE CURRENTLY AVAILABLE				
ORNL	CH	103	$18,435	$3,073	$1,898,805
	RH	862	$30,245	$15,123	$26,071,190
NTS	NO TRAIN SERVICE CURRENTLY AVAILABLE				
ANL-E	CH	25	$11,550	$1,925	$288,750
	RH	50	$1[illegible],200	$7,100	$710,000
LLNL	CH	46	$14,453	$2,409	$664,838
MOUND	CH	24	$12,004	$2,001	$288,096
				TOTAL	$268,415,836

7.4 Dedicated Train Option

Tables 7-9 and 7-10 show the costs associated with the transportation of CH and RH TRU waste by dedicated train service. There are a number of overriding factors in conjunction with the use of this type of service. First is the fact that all cars will be accounted for in the rate scheme. This will include the costs for idler or buffer cars and cabooses. There is also a charge for the emergency response personnel that will accompany the shipment. The largest single factor attributed to the cost of dedicated trains is the $55.00 per mile surcharge in addition to the costs associated with the transport of all other railcars.

For a comparison of contract train service versus dedicated train service, refer to Table 7-11 for the CH shipments from the INEL. The contract train rate for each container on a round-trip basis for the INEL is $1,604 per container. The rate, per container, for dedicated train service is $9,623. The total cost for CH shipments from the INEL site for dedicated train service is $217,901,954. Waste shipments from this one site alone would cost more for dedicated train than for all waste shipped by train under contract rates.

7.5 Comparative Cost Summary

Table 7-11 displays comparative totals and per-container costs associated with transporting TRU waste from all sites to the WIPP facility by the three transportation options. The truck transportation costs were used for LANL and NTS as representative train costs for these sites because they do not currently have train access. Truck and train contract rate costs are comparable. Future rate costs will be negotiated to further reduce overall rate costs.

Table 7-9. Round-Trip Costs for Dedicated Train Service*

LOCATION	WASTE TYPE	NUMBER OF SHIPMENTS (18 CH PER TRAIN, 6 RH PER TRAIN)	WASTE CARS (2)	IDLER CARS (2)	CABOOSE ONE-WAY	DEDICATED RAIL CHARGE AT $5.00/mile	EMERGENCY RESPONSE SPECIALISTS CHARGE	ROUND TRIP CHARGE	COST PER CONTAINER	TOTAL COST
INEL	CH	1,258	42,820	28,136	7,034	$94,875	$348	$173,213	$ 9,623	217,901,954
	RH	36	42,820	28,136	7,034	$94,875	$348	$173,213	$28,868	$6,235,668
RFP	CH	60	22,812	15,196	3,799	$52,360	$348	$ 44,167	$5,232	$5,660,020
Hanford	CH	653	51,212	34,904	8,726	$126,445	$421	$221,708	$12,317	$144,775,324
	RH	1,207	51,212	34,904	8,726	$126,445	$421	$221,708	$36,951	$267,601,656
SRS	CH	776	46,064	27,548	6,887	$101,145	$311	$181,955	$10,108	141,197,080
LANL	NO RAIL SERVICE CURRENTLY AVAILABLE									
ORNL	CH	34	47,460	28,672	7,168	$86,460	$311	$170,071	$ 9,448	$5,782,414
	RH	287	47,460	28,672	7,168	$86,460	$311	$170,071	$28,345	$48,810,377
NTS	NO RAIL SERVICE CURRENTLY AVAILABLE									
ANL-E	CH	8	28,400	19,708	4,927	$71,775	$311	$124,810	$6,934	$ 998,480
	RH	17	28,400	19,708	4,927	$71,775	$311	$124,810	$20,802	$2,121,770
LLNL	CH	16	32,584	23,100	5,775	$89,815	$300	$151,574	$8,421	$2,273,610
MOUND	CH	8	34,756	23,648	5,909	$90,970	$333	$155,616	$8,645	$1,244,928

* Includes costs for nine TRUPACT-IIs/railcar or three RH-72Bs/railcar

Table 7-10. Round-Trip Costs for Dedicated Train Service for Risk Comparison[a]

LOCATION	WASTE TYPE	NUMBER OF SHIPMENTS (18 CH PER TRAIN, 6 RH PER TRAIN)	WASTE CARS (3)	IDLER CARS (2)	CABOOSE ONE-WAY	DEDICATED RAIL CHARGE AT $5.00/mile	EMERGENCY RESPONSE SPECIALISTS CHARGE	ROUND TRIP CHARGE	COST PER CONTAINER	TOTAL COST
INEL	CH	1,258	64,230	28,136	7,034	$94,875	$348	$194,623	$10,813	$244,835,734
	RH	36	64,230	28,136	7,034	$94,875	$348	$194,623	$32,437	$7,006,428
RFP	CH	60	34,218	15,196	3,799	$52,360	$348	$105,921	$5,885	$6,355,260
Hanford	CH	653	76,818	34,904	8,726	$126,445	$421	$247,314	$13,740	$161,496,042
	RH	1,207	76,818	34,904	8,726	$126,445	$421	$247,314	$41,219	$298,507,998
SRS	CH	776	69,096	27,548	6,887	$101,145	$311	$204,967	[illegible]387	159,054,392
LANL	NO RAIL SERVICE CURRENTLY AVAILABLE									
ORNL	CH	34	71,190	28,672	7,168	$86,460	$311	$193,801	$10,767	$6,589,234
	RH	287	71,190	28,672	7,168	$86,460	$311	$193,801	$32,300	$57,744,887
NTS	NO RAIL SERVICE CURRENTLY AVAILABLE									
ANL-E	CH	8	42,600	19,708	4,927	$71,775	$311	$139,322	$7,740	$1,114,576
	RH	17	42,600	19,708	4,927	$71,775	$311	$139,322	$23,221	$2,368,474
LLNL	CH	15	48,876	23,100	5,775	$89,815	$300	$167,866	$9,326	$2,572,980
MOUND	CH	8	52,134	23,648	5,909	$90,970	$333	$172,994	$9,611	$1,383,952

[a] Includes costs for six TRUPACT-IIs/railcar or two RH-72Bs/railcar

Table 7-11. Comparative Cost Summary

LOCATION	NUMBER & TYPE OF CONTAINERS	CONTRACT RATE, REGULAR TRAIN		RAIL CLASS RATE		DEDICATED TRAIN		COMMERCIAL (FOR HIRE) TRUCKLOAD RATE		CONTRACT TRUCKLOAD RATE	
		COST PER CONTAINER	TOTAL COST	COST PER CONTAINER	TOTAL COST	COST PER CONTAINER	TOTAL COST	COST PER CONTAINER	TOTAL COST	COST PER CONTAINER	TOTAL COST
INEL	22,635 (CH)	$1,604	$36,317,000	$3,640	$82,391,000	$9,623	$217,902,000	$2,683	$60,730,000	$2,480	$56,142,000
	218 (RH)	$7,136	$1,563,000	$10,507	$2,301,000	$28,868	$6,238,000	$8,049	$1,755,000	$7,441	$1,622,000
RFP	1,074 (CH)	$961	$1,038,000	$2,283	$2,444,000	$5,251	$5,671,000	$1,331	$1,429,000	$1,315	$1,412,000
HANFORD	11,760 (CH)	$2,079	$24,457,000	$5,355	$62,981,000	$12,317	$144,775,000	$3,525	$41,454,000	$3,216	$37,824,000
	7,244 (RH)	$8,535	$61,808,000	$14,989	$108,648,000	$36,951	$267,602,000	$10,575	$76,605,000	$9,648	$69,887,000
SRS	13,974 (CH)	$2,377	$33,222,000	$3,396	$47,461,000	$10,108	$141,197,000	$3,564	$49,798,000	$3,252	$45,439,000
LANL*	6,048 (CH)	$834	$5,042,000	$834	$5,042,000	$834	$5,042,000	$834	$5,042,000	$823	$4,978,000
	105 (RH)	$2,501	$263,000	$2,501	$263,000	$2,501	$263,000	$2,501	$263,000	$2,469	$259,000
ORNL	618 (CH)	$2,048	$1,272,000	$3,125	$1,941,000	$9,448	$5,782,000	$3,057	$1,889,000	$2,796	$1,728,000
	1,723 (RH)	$10,082	$17,391,000	$8,523	$14,676,000	$28,345	$48,810,000	$9,172	$15,803,000	$8,389	$14,454,000
NTS*	330 (CH)	$2,336	$771,000	$2,336	$771,000	$2,336	$771,000	$2,336	$771,000	$2,193	$724,000
ANL-E	147 (CH)	$1,283	$185,000	$3,125	$450,000	$6,851	$1,001,000	$2,939	$432,000	$2,721	$400,000
	99 (RH)	$4,733	$469,000	$8,745	$866,000	$20,853	$2,121,000	$8,817	$873,000	$8,163	$808,000
LLNL	273 (CH)	$1,606	$434,000	$3,965	$1,071,000	$8,421	$2,274,000	$2,788	$761,000	$2,553	$697,000
MOUND	144 (CH)	$1,334	$192,000	$5,158	$743,000	$8,646	$1,245,000	$3,121	$449,000	$2,868	$413,000
TOTAL	66,392		$184,421,000		$331,947,000		$850,697,000		$298,055,000		$236,797,000
AVERAGE COST PER CONTAINER[b]			$3,000		$5,000		$13,000		$4,000		$4,000

* No rail service available

[b] Includes truck shipments for LANL and NTS

8.0 COMPARISON OF TRANSPORTATION OPTIONS

This chapter summarizes the results of this study and draws preliminary conclusions pertaining to the transportation risks and environmental consequences, emergency response, and costs of the transportation options for shipping waste to the WIPP during the disposal phase.

8.1 Conclusions

1) The analysis provided in this study demonstrates that DOE can safely transport TRU waste to the WIPP facility during the disposal phase.

2) The data presented in this study are based on conservative input.

3) The injuries and fatalities projected for each of the transportation options from ordinary traffic accidents are based on transportation statistics independent of the cargo being transported. It is believed that the administrative requirements placed on the transport of TRU waste by DOE will significantly lower the rates projected in this study.

4) The cumulative radiological dose the public will receive during accident-free transport of TRU waste during the disposal phase (truck or train options) is orders of magnitude less than the cumulative dose that the same population group will receive from background radiation.

5) The radiological impacts associated with transportation accidents exceeding NRC type B package certification test conditions are mitigated by emergency response.

6) For the three transportation options evaluated, the cost of transporting waste by truck or regular train under contract rates is comparable. The cost for transporting waste by dedicated train is significantly greater.

7) No conclusions should be drawn from this study to conclusively determine which transportation option should be selected for disposal phase waste transport operations. Further study needs to be conducted.

8) Radiological and hazardous chemical risks from transportation options pose no significant health risks to the general population or transportation workers.

The results presented in this study are generated from a series of assumptions based on DOE's current understanding of the WIPP program. The major baseline assumptions utilized to generate this study are provided as follows:

* 1990 SEIS baseline for study

* Disposal Phase Options
  - -100% truck
  - -100% rail for sites with rail access
    - -Dedicated train
    - -Regular train

- Disposal volume 6.2 million cubic feet
  - 5.95 million cubic feet of CH waste
  - 250,000 cubic feet of RH waste

- Costs given in 1993 dollars

- Cost analysis is based on shipping costs only; other cost not included
  - Emergency response
  - TRUPACT-II and modifications for CH waste
  - RH-72B cask or new cask for RH waste
  - Rail casks

- Future SEIS and Record of Decision will document the transportation mode for the Disposal Phase

8.2 Transportation Risk

For incident-free transportation, the radiological and hazardous chemical risks are very low as compared to the risk of cancer from background radiation and would not pose a significant risk to the health and safety of the general population or of the transportation workers (see Table 8-1). Table 8-2 presents the incident/accident impacts to the public that are predicted for each of the three transportation options examined in this study.

For nonradiological and nonchemical risks associated with incidents/accidents (injuries and fatalities where the packaging is not involved), the estimated consequences are higher for truck shipments because of the higher number of truck shipments versus both rail options (see Table 8-3). The regular or dedicated train with up to three waste cars would have the lowest risks because of the smaller number of required shipments.

Environmental impacts not directly related to human health and safety are not considered to be significant except in the case of a major incident/accident exceeding NRC Type B Certification test conditions in which no emergency response is provided. In this scenario, an area of contamination could occur in the immediate area of accident scene. Environmental impacts from radiation exposure to the environment would be relatively minor, as DOE is committed to rapidly cleaning up contamination to an environmentally acceptable condition. However, the cleanup process typically utilizes heavy equipment which may result in significant impacts to the plant and animal life living in the cleanup area. The extent of these impacts, in terms of the time for the contaminated area to completely rejuvenate, would be dependent upon the nature of the ecosystem involved. In any event, DOE is committed to mitigating damage to the environment and returning lands to near original condition as rapidly as possible.

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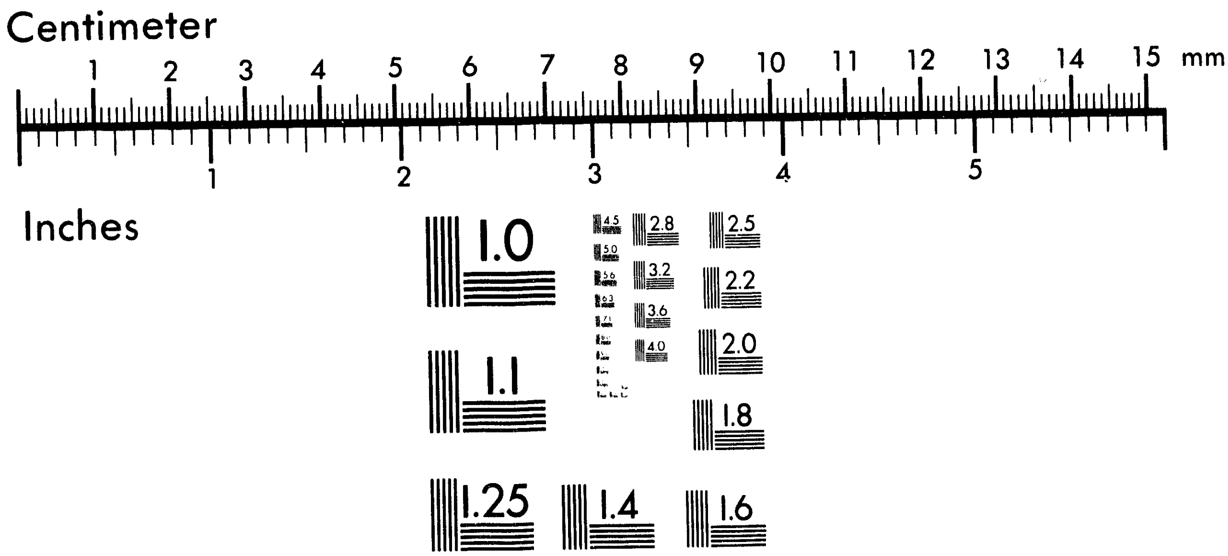

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Table 8-1. Total Incident-Free Radiological Transportation Impacts for the Disposal Phase

TRANSPORTATION OPTION	PUBLIC		TRANSPORTATION CREW[a]	
	Dose (person-rem)	Latent Cancer Fatalities	Dose (person-rem)	Latent Cancer Fatalities
Collective Impacts				
Truck	8340	4.2	2890	1.2
Regular Train	1330	0.67	723	0.29
Dedicated Train	666	0.33	305	0.12
Maximum Individual Impacts[b]				
Truck	2.7	--	10	--
Regular Train	1.6	--	4.3	--
Dedicated Train	0.7	--	3.2	--

[a] Transportation crew is defined as those who drive the truck or operate the train.

[b] Individual doses are presented in units of rem. Latent Cancer Fatalities are not presented for individuals, as the dose-to-risk conversion factor is statistically developed on a population basis and is inappropriate to apply on an individual basis.

Table 8-2. Predicted Incident/Accident Impacts to the Public for Each Transportation Option Studied

TRANSPORTATION OPTION	CUMULATIVE ACCIDENT-DOSE RISK (person-rem)	REPRESENTATIVE CONSEQUENCES[b]		MAXIMUM CONSEQUENCES[c]	
		Dose (person-rem)	Latent Cancer Fatalities	Dose (person-rem)	Latent Cancer Fatalities
Truck	2060	22	0.011	750,000	330
Regular Train	1940	150	0.075	1,500,000	750
Dedicated Train	1910	450	0.23	4,500,000	2,300

[a] This is the cumulative accident-dose risk for RH-TRU shipments to the WIPP at the indicated transportation option.

[b] Representative consequences result from one postulated accident scenario in an urban community in which emergency response actions occur in sufficient time to mitigate the initial accident sequence, with a resulting release comparable to a category III severity accident. The reported value is the highest representative consequence for RH-TRU waste shipments and shipment origin sites.

[c] Maximum consequences result from a highly unlikely accident scenario in an urban community in which emergency response actions are delayed until after the initial accident sequence is completed (several hours), with a postulated release comparable to a category VIII severity accident. The reported value is the highest maximum consequence for RH-TRU waste shipment and shipments origin sites.

Table 8-3. Nonradiological/Nonchemical Impacts from Incident-Free Transportation of TRU Waste to the WIPP for the Disposal Phase

Transportation Option	Accident Injuries	Accident Fatalities	Latent Cancer Fatalities
Truck	110	7.3	0.2
Regular Train	63	2.5	0.7
Dedicated Train	12	1.0	0.06

8.3 Emergency Response

DOE has an emergency response system in place for truck transportation along the routes from INEL to WIPP and RFP to WIPP. The system has been reviewed by various regulatory agencies and States and judged to be satisfactory. Training has been and will continue to be provided to personnel who would respond to truck incidents/accidents. Preparations have included an extensive training program and a number of field exercises. To date, only preliminary efforts have been made to implement a similar system for all areas involved in waste shipments during the disposal phase, since the decision to start the disposal phase has not been made. A decision to transport the TRU waste by train during the disposal phase could lead DOE to reconsider its training courses and field exercises over a much wider area. However, current analysis leads DOE to believe that existing courses and field exercises could be updated and presented with relatively few changes. For train transportation, some changes to existing courses and field exercises would be useful to ensure that effective training programs and field exercises are offered to first responders.

8.4 Cost

Costs in 1993 dollars for each transportation option are based on currently available information, carrier systems, and total number of shipments for each option. Emergency response costs have not been included because they are not within the scope of this study.

The total cost for truck shipments during the 20-year disposal phase using contract rates is estimated to be $236,800,000; total cost using commercial rates is estimated to be $258,100,000.

Total cost for regular train transportation (which necessarily includes some trucking) using class rates is estimated to be $332,000,000 and cost using contract rates is estimated to be $184,400,000. The total cost for dedicated trains is estimated to be $850,700,000 because an additional charge of $55 per mile is included for all shipments.

8.5 Comparison of Transportation Options

Radiological and hazardous chemical risks from transportation options pose no significant health risk to the general population or transportation workers. The DOE has implemented an emergency response system for the transportation of TRU waste by truck from the Idaho National Engineering Laboratory and the Rocky Flats Plant. The existing emergency response system will be expanded to encompass training needed for emergency response personnel along the disposal phase transportation corridors. Truck and train contract rate costs are comparable. Future rate costs will be negotiated to further reduce overall rate costs. Table 8-4 summarizes costs and impacts for the three transportation options during the disposal phase.

TABLE 8-4. Summary of Transportation Options for the Disposal Phase

Category	Injuries/ Fatalities	Maximum Cumulative Radiological Doses to the Public (person-rem)		Maximum Radiological Accident Consequences in LCF to the Public	Minimum Transportation Cost
		CH Waste	RH Waste	RH Waste	
Truck	110/7.3	5,040	3,330	380	$236,800,000
Regular Train	63/2.5	956	369	750	$184,400,000
Dedicated Train	12/1.0	586	81	2,300	$850,700,000

Each of the assumptions listed previously significantly impact the results generated in this study. For example, the volume of waste expected to be transported during the disposal phase is based on the maximum volume permitted for both CH and RH waste in P.L 102-579. Should actual disposal phase waste volumes be significantly less than that permitted, transportation risks as well as cost would be reduced significantly as they are volume dependent. Additionally, the assumptions utilized to generate this study do not provide a basis for optimizing transportation costs and public risks. Such a transportation system could include a combination of both truck and train transport of TRU waste. As such, DOE is committed to continuing its evaluation and analysis of the transportation system needed to support disposal operations at WIPP. Future studies will include reevaluation of those assumptions listed above as WIPP program information changes, as well as determining from a cost and risk perspective what is the most appropriate method of transporting TRU waste to WIPP during the disposal phase.

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APPENDIX A

WIPP WASTE ACCEPTANCE CRITERIA, WASTE CHARACTERISTICS, SHIPMENT TRANSPORT INDEX VALUES, AND TRUPACT-II CERTIFICATE OF COMPLIANCE

APPENDIX A

A.0 INTRODUCTION

This appendix presents a summary and a discussion of the purpose and implementation of the WIPP Waste Acceptance Criteria (WAC). In addition, waste characteristics as presented in Revision 8 of the Integrated Data Base (IDB) (DOE, 1992) are included. A reproduction of the NRC Certificate of Compliance is presented as an annex to this appendix.

A.1 WIPP Waste Acceptance Criteria

The DOE has established the WAC for the safe handling and long-term disposal of TRU radioactive waste at the WIPP (DOE, 1991c). These criteria establish conditions governing the physical, radiological, and chemical composition of the waste to be emplaced in the WIPP, in addition to citing specifications for waste packaging, to provide for the health and safety of workers and the public. Prior to any waste shipment leaving any generator or storage facility for the WIPP, the shipment must be certified to meet the WAC. Similarly, the certification of shipments received at the WIPP will be verified prior to emplacement.

The WAC were developed by a DOE-wide committee of experts on the handling and transportation of radioactive material. Basic concepts and limits chosen as WAC requirements are based on:

- Personnel safety, handling, and storage restrictions at the WIPP facilities
- Methods of handling equipment
- Procedures

Technical justification for the selection of the various requirements is provided in the WAC support documents.

RCRA regulations, as they apply to the WIPP, include standards for the owners/operators of permitted and interim-status treatment, storage, or disposal (TSD) facilities that are codified in 40 CFR Parts 264 and 265. These require the owner/operator to obtain a chemical and physical characterization of the waste and to ensure that the waste shipped to the facility is the waste specified on the shipping manifest. These RCRA requirements for the WIPP facility will be satisfied at the generator sites before transportation of waste to the WIPP. Applicable RCRA requirements to be met for each category of waste present at the site are described in the WIPP RCRA Part A and Part B Permit Applications (DOE, 1993c) as well as in the No-Migration Determination (NMD) published by the EPA (EPA, 1990).

The WAC were established with the assumption that the radiological hazards of TRU-mixed waste (TRU waste containing hazardous constituents defined in 40 CFR Part

261, Subparts C and D) are much greater than any hazards from associated hazardous constituents.

To ensure compliance with the WAC, the DOE has established the WIPP Waste Acceptance Criteria Certification Committee (WACCC) and requires that each facility certify that their WIPP-bound waste meets the WAC.

Each waste generating or waste storage facility will prepare a TRU Waste Certification Plan that describes its site certification program and how that program ensures that their waste meets the WAC.

Following the formal approval of Certification and Quality Assurance Plans for the waste generator or storage facility, a compliance verification audit was performed by the WACCC. Subsequent periodic audits will be performed to verify that the facility is following the approved plans. Audit frequency will be determined by the Chairperson of the WACCC, in consideration of systematic requirements and facility certification status, but will generally be conducted on an annual basis at all facilities. The management of the generator/storage facility is expected to respond to findings and recommendations noted in the audit report, indicating the corrective action taken (or to be taken) to preclude recurrence. If subsequent facility audits determine that corrective action has not been satisfactorily implemented, then the WACCC will decertify the waste from that facility so that it cannot be accepted at the WIPP. Table A-1 presents a summary of the WAC limiting parameters for CH-TRU waste and the preliminary WAC for RH-TRU waste.

The following documents are required for each generator/storage facility:

- Waste characterization site-specific implementation plans
- Site QA project plans for WIPP waste characterization activities
- Program plans for TRU waste certification
- Site-specific TRUPACT-II Authorized Methods for Payload Control (TRAMPAC) compliance plans

A.2 Waste Characteristics and Shipment Transport Index Values

There is a continuing effort to characterize the waste at each of the generator/storage facilities. Current radiological characterization data are presented in Rev. 8 of the IDB (DOE, 1992) and provide information about the radionuclide inventory (radioactivity, mass, and percent activity of radionuclides in the waste) by site.

Tables A-2 and A-3 present the isotopic compositions of mixes used to describe CH and RH waste. IDB waste characterization data are not as precise and complete as an analyst would prefer. Consequently, a number of assumptions and engineering judgments were made, and are acknowledged and justified in the appropriate subsections, to complete quantification of radionuclide distribution and calculation of

Table A-1. Summary of the WAC Limiting Parameters for CH-TRU Waste

CRITERION/REQUIREMENT AND SECTION	**LIMITING PARAMETER(S)**	**SOURCE(S) OF LIMIT(S)**
WASTE CONTAINER REQUIREMENTS/CRITERIA		
Waste Containers 3.2.1	• Containers shall be noncombustible and meet DOT Type A packaging requirements.	1
	• Current TRUPACT-II requirements limit acceptable containers to 55-gallon drums, standard waste boxes (SWBs), or SWB overpack of 55-gallon drums or test bins.	2
Waste Package Size 3.2.2	• Current TRUPACT-II limits are 55-gallon drums in two seven-packs or two SWBs.	2
Waste Package Handling 3.2.3	• All packages shall be configured as specified in the TRUPACT-II SARP (see 3.2.2 above).	2
WASTE FORM REQUIREMENTS/CRITERIA		
Immobilization 3.3.1	• Waste materials shall be immobilized if > 1% by weight is particulate material < 10 microns in diameter, or if > 15% by weight is particulate material < 200 microns in diameter.	1
Liquids 3.3.2	• Only residual liquids; as a guideline, residual liquid in well-drained internal containers to be restricted to approximately 1 volume % of the internal container; aggregate amount of residual liquid < 1 volume % of external container.	1
Pyrophoric Materials 3.3.3	• No non-radionuclide pyrophorics permitted. Radionuclides in pyrophoric form are limited to < 1% by weight in each waste package.	2.3
Explosives and Compressed Gases 3.3.4	• No explosives (49 CFR Part 173, Subpart C) are permitted.	1, 2, 3
	• No compressed gases are permitted.	2
TRU Mixed Wastes 3.3.5	• TRU wastes shall contain no hazardous wastes unless they exist as co-contaminants with transuranics.	1
	• Waste generators must determine if their waste is regulated by RCRA, and met the requirements in the WIPP RCRA Part A and Part B Permit Applications.	3

Table A-1. Summary of the WAC Limiting Parameters for CH-TRU Waste, Continued

WASTE PACKAGE REQUIREMENTS/CRITERIA (Continued)		
CRITERION/REQUIREMENT AND SECTION	**LIMITING PARAMETER(S)**	**SOURCE(S) OF LIMIT(S)**
Nuclear Criticality (Pu-239 FGE) 3.4.2	• Accepted package limits, including two times the error, are:	2
	· < 200g/55-gallon drum	2
	· < 325g/SWB	2
	• The sum of the FGE of all packages in a TRUPACT-II payload shall be < 325g.	
Pu-239 Equivalent Activity 3.4.3	• Waste packages shall not exceed 1000 Ci of Pu-239 equivalent activity (PE-Ci).	1
Surface Dose Rate 3.4.4	• Drums or SWBs shall not exceed 200 mrem/hr surface reading, or 10 mrem/hr at 2 m.	1, 2
	• Shielded containers are allowed for ALARA purposes only.	2
	• Neutron contributions of > 20 mrem/hr shall be separately documented.	1
	• External dose rates on the loaded TRUPACT-II shall not exceed 200 mrem/hr surface, or 10 mrem/hr at 2 m.	2
Removable Surface Contamination 3.4.5	• Removable package surface contamination shall not be > 40 pCi/100 cm^2 alpha, and not < 450 pCi/100 cm^2 beta/gamma.	1
Thermal Power 3.4.6	• Thermal (wattage) limits for individual waste packages, including the error, are contained in the TRUPACT-II SARP	2
	• TRUPACT-II load limits are contained in the TRUPACT-II SARP.	2
	• TRUPACT-II design limit is 40 watts.	2

Table A-1. Summary of the WAC Limiting Parameters for CH-TRU Waste, Continued

WASTE PACKAGE REQUIREMENTS/CRITERIA (Continued)		
CRITERION/REQUIREMENT AND SECTION	**LIMITING PARAMETER(S)**	**SOURCE(S) OF LIMIT(S)**
TRU Mixed Wastes (Cont.) 3.3.5	• Generators must document procedures for sampling, analytical protocols, QA/QC guidelines, and other information called for in 40 CFR § 264.13 and 265.13 in a site-specific QAPjP. • Characteristic ignitable (D001), corrosive (D002), and reactive (D003) wastes are not acceptable at WIPP. • Any waste container sent to WIPP or loaded into a bin destined for WIPP must meet the two times (2X) the maximum comparability requirement for 5 nonflammable VOCs as specified in the NMD. • Any waste container sent to WIPP must meet the ten times (10X) the average comparability requirement for 3 nonflammable VOCs as specified in the NMD. • Sludges shall be analyzed for total VOCs and toxic metals specified in the NMD.	3 1, 2, 3 3 3 3
Specific Activity of Waste 3.3.6	• Waste shall be greater than 100 nanocuries of TRU per gram of waste, exclusive of added shielding, rigid liners, and the waste containers, including alpha contaminated wastes handled as TRU under DOE Order 5820.2A.	1
WASTE PACKAGE REQUIREMENTS/CRITERIA		
Waste Package Weight 3.4.1	• Current waste package limits are 1000 lbs per 55-gallon drum, or 4000 lbs per SWB. • TRUPACT-II payload is limited to 7265 lbs. • TRUPACT-II is limited to 19,250 lbs total gross weight, with a total shipment of GVW of 80,000 lbs.	2 2 2

Table A-1. Summary of the WAC Limiting Parameters for CH-TRU Waste, Continued

WASTE PACKAGE REQUIREMENTS/CRITERIA (Continued)		
CRITERION/REQUIREMENT AND SECTION	**LIMITING PARAMETER(S)**	**SOURCE(S) OF LIMIT(S)**
Gas Generation 3.4.7	• All confinement layers, such as bags, shall be closed only by a twist-and-tape or fold-and-tape method.	2
	• No sealed containers > 1 gallon may be in the waste.	2
	• The maximum number of confinement layers shall be known.	2
	• Waste packages emplaced in WIPP during the experimental period shall not exceed 50% of the lower exposure limit in any layer of confinement for hydrogen and methane.	3
	• Total flammable VOCs are limited to 500 ppm in the headspace gas of waste packages.	2
	• If total flammable VOCs are > 500 ppm in headspace, a flame test must be performed prior to emplacement in the WIPP.	3
	• If total flammable VOCs are > 500 ppm in headspace, a Le Chatelier calculation is necessary.	3
	• All chemicals/materials > 1% by weight must be evaluated for compatibility within the waste form and with TRUPACT-II materials of construction.	2
	• Trace chemicals (<1 weight % limit) must total < 5% by weight of the waste in any package.	2
	• Chemicals/materials present in concentrations greater than one weight percent, shall conform to the allowable chemicals in each waste material type.	2
	• Real-time radiography or equivalent examination.	4
	• Visual characterization of solid waste for 10 waste material categories listed in QAPP.	4
	• Analysis of sludges for pH and major cations and anions listed in SNL Bin-Scale Test Plan.	4
	• Total alpha activity of waste on a container basis using methodology listed in QAPP.	4

Table A-1. Summary of the WAC Limiting Parameters for CH-TRU Waste, Concluded

WASTE PACKAGE REQUIREMENTS/CRITERIA (Continued)		
CRITERION/REQUIREMENT AND SECTION	**LIMITING PARAMETER(S)**	**SOURCE(S) OF LIMIT(S)**
Gas Generation 3.4.7 (cont)	• All waste packages shipped in TRUPACT-II shall be vented with one or more filters that meet specifications listed in the TRUPACT-II SARP.	2
	• All rigid liners shall be punctured or vented.	2
Labeling 3.4.8	• A unique identification barcode label reasonably expected to last 10 years shall be affixed.	1, 2
	• Each package shall have appropriate DOT labels.	1, 2, 3
	• Each package shall be marked with the shipping category.	2
DATA PACKAGE REQUIREMENTS/CRITERIA		
Data Package/Certification 3.5.1	• A data package with certification shall be transmitted prior to shipment.	1
	• Documentation for certification of individual packages or a group of packages for shipment in each TRUPACT-II unit shall be submitted.	2
	• A hazardous waste manifest shall be utilized for each shipment of TRU mixed waste.	3
	• Information required by the WCPP shall be provided.	4
OTHER REQUIREMENTS/CRITERIA		
Additional Requirements 3.6.1	• All packages in a single TRUPACT-II shall belong to the same shipping category.	2
	• Each package shipped shall belong to one of the content codes defined in TRUCON.	2
	• Retrievable stored waste that has been unvented shall be vented and aspirated per the TRUPACT-II SARP.	2
	• Payload control procedures outlined in Section 7.4.3 of the TRUPACT-II SARP shall be followed.	2

Source(s) of Limit(s)

1. WIPP Operations and Safety Criteria
2. Transportation: Waste Package Requirements: TRAMPAC
3. RCRA Requirements
4. Performance Assessment Criteria

Table A-2. Isotopic Composition, by Activity Percent, of Mixes Used to Describe Composition of Contact-Handled TRU Waste at Each Site[a] (Retrievably Stored and Newly Generated)

		Composition of mix, activity %							
Site	Major radionuclides	Mix-1[b]	Mix-2	Mix-3	Mix-4	Mix-5	Mix-6	Mix-7	Mix-8
ANL-E	235U	·	< 1.00						
	238Pu	1.00	·						
	239Pu	22.90	36.60						
	240Pu	6.90	·						
	241Pu	10.20	63.40						
	Total	100.00	100.00						
HANF	90Sr-90Y	1.20							
	106Ru-106Rh	0.40							
	137Cs-137mBa/137Ba	1.30							
	144Ce-144Pr	4.00							
	147Pm	3.00							
	238Pu	6.90							
	239Pu	2.00							
	240Pu	0.50							
	241Pu	13.50							
	MFP[c]	66.50							
	Other	0.70							
	Total	100.00							
INEL[d]	232U	·	·	·	•	·	10.00	·	·
	233U	·	·	·	•	·	90.00	·	·
	235U	·	·	3.50	•	·	·	·	·
	236U	·	·	17.00	•	·	·	·	·
	237Np	·	·	·	•	·	·	·	100.00
	238Pu	0.30	·	·	•	·	·	·	·
	239Pu	11.00	20.00	·	•	4.50	·	·	·
	240Pu	2.60	9.30	·	•	3.20	·	·	·
	241Pu	79.00	·	·	•	·	·	·	·
	242Pu	Trace	·	·	•	·	·	·	·
	241Am	5.40	70.00	·	•	·	·	·	·
	243Am	·	·	·	•	·	·	100.00	·
	Other	1.70	0.70	·	•	·	·	·	·
	Total	100.00	100.00	20.50	•	7.70	100.00	100.00	100.00
LANL	238Pu	80.00	1.90	74.00	10.00	·			
	239Pu	18.00	0.50	26.00	62.00	100.00			
	241Am	2.00	86.90	·	28.00	·			
	MFP[c]	·	10.70	·	·	·			
	Total	100.00	100.00	100.00	100.00	100.00			
LLNL	238Pu	0.57	0.81	0.33	0.53	0.78			
	239Pu	12.30	3.56	7.87	2.22	5.78			
	240Pu	2.84	2.87	9.86	1.79	2.88			
	241Pu	82.83	87.93	75.80	54.88	88.83			
	241Am	1.46	4.83	5.84	40.80	3.98			
	Total	100.00	100.00	100.00	100.00	100.01			
MOUND	238Pu	92.31							
	239Pu	3.45							
	240Pu	0.05							
	241Pu	4.16							
	Total	100.00							

Table A-2. Isotopic Composition, by Activity Percent, of Mixes Used to Describe Composition of Contact-Handled TRU Waste at Each Site[a] (Retrievably Stored and Newly Generated), Concluded

		Composition of mix, activity %							
Site	Major radionuclides	Mix-1[b]	Mix-2	Mix-3	Mix-4	Mix-5	Mix-6	Mix-7	Mix-8
NIS	238Pu	3.51							
	239Pu	63.11							
	240Pu	25.37							
	241Pu	8.00							
	242Pu	0.01							
	241Am	Trace							
	Total	100.00							
ORNL	60Co	·	0.01	·					
	90Sr	·	2.08	·					
	99Tc	·	0.02	·					
	137Cs	·	3.27	·					
	232Th	Trace	Trace	Trace					
	233U	24.60	0.02	·					
	235U	Trace	Trace	Trace					
	238U	Trace	Trace	·					
	237Np	·	Trace	·					
	238Pu	·	7.92	·					
	238Pu	35.10	0.35	62.50					
	240Pu	·	0.72	·					
	241Pu	3.90	81.36	·					
	241Am	·	0.52	·					
	244Cm	·	2.83	31.60					
	252Cf	·	·	5.70					
	Other	36.4	0.93	·					
	Total	100.00	100.03	99.8					
RFP	235U	Trace							
	238Pu	0 40							
	239Pu	1' 20							
	240Pu	2.70							
	241Pu	73.80							
	242Pu	Trace							
	241Am	11.90							
	Total	100 00							
SRS	237Np	·	·	·	·	·			
	238Pu	0 57	97.79	·	·	·			
	239Pu	9 49	0.06	·	·	·			
	240Pu	2.25	0.03	·	·	·			
	241Pu	85.98	2.12	·	·	·			
	241Am	1 71	·	·	·	·			
	244Am	·	·	·	·	·			
	Other	·	·	·	·	·			
	Total	100.00	100.00	100.00	100.00	100.00			

[a]Data from ref. 5. The data are as reported by the sites even though some of the columns do not add up to 100%.
[b]The mixes represent major waste stream composition variations or composite values. For the percent of each mix in the waste at each site, see Table. 3.13.
[c]MFP is mixed fission product.
[d]INEL also has a Mix-9, but no activity percent data were provided for it.
[e]Information reported as unknown.

Table A-3. Isotopic Composition, by Weight Percent, of Mixes Used to Describe Composition of Remote-Handled TRU Waste at Each Site[a] (Retrievably Stored and Newly Generated)

Site	Major radionuclides	Mix-10[b]	Mix-11	Mix-12	Mix-13	Mix-14	Mix-15	Mix-16
		Composition of mix, activity %						
ANL-E	138	84 60						
	^{238}U	<1.00						
	^{239}Pu	1 40						
	^{240}Pu	1.00						
	^{241}Pu	0						
	Total	13.00						
		100.00						
HANF	^{60}Co	-	1.50					
	^{90}Sr-^{90}Y	1.20	-					
	^{106}Ru-^{106}Rh	0 40	-					
	^{137}Cs-^{137m}Ba-^{137}Ba	1.30	-					
	^{144}Ce-^{144}Pr	4 0	-					
	^{147}Pm	3 00	-					
	^{238}Pu	6.90	-					
	^{239}Pu	2.00	0.30					
	^{240}Pu	0.50	0.20					
	^{241}Pu	13.50	10.00					
	MFP[c]	66.50	87.00					
	Other	0.70	10					
	Total	100.00	100.00					
INEL	^{63}Ni	-	-	[d]	[d]	-	-	5.00
	^{85}Kr	-	-	[d]	[d]	0.17	-	-
	^{90}Sr	-	-	[d]	[d]	1 47	-	17.00
	^{95}Zr	-	-	[d]	[d]	10.53	-	-
	^{134}Cs	-	-	[d]	[d]	1.69	-	-
	^{137}Cs	-	-	[d]	[d]	1 43	-	18.00
	^{144}Ce	-	-	[d]	[d]	18.15	-	-
	^{147}Pm	-	-	[d]	[d]	2.62	-	-
	^{235}U	Trace	Trace	[d]	[d]	-	-	-
	^{238}U	Trace	Trace	[d]	[d]	-	-	-
	^{238}Pu	-	-	[d]	[d]	0.03	53.70	-
	^{239}Pu	3.00	71.00	[d]	[d]	-	-	-
	^{240}Pu	2.00	29.00	[d]	[d]	-	-	-
	^{241}Am	-	-	[d]	[d]	-	46.30	-
	MFP[c]	95.00	-	[d]	[d]	-	-	-
	Total	100.00	100.00			35.09	100.00	40.00
LANL	^{239}Pu	13.62	4.54					
	^{240}Pu	1.25	0.42					
	^{241}Pu	0.12	0.04					
	^{242}Pu	0.01	-					
	MFP[c]	85.00	95.00					
	Total	100.00	100.00					

Table A-3. Isotopic Composition, by Weight Percent, of Mixes Used to Describe Composition of Remote-Handled TRU Waste at Each Site[a] (Retrievably Stored and Newly Generated), Concluded

		Composition of mix, activity %						
Site	Major radionuclides	Mix-10[b]	Mix-11	Mix-12	Mix-13	Mix-14	Mix-15	Mix-16
ORNL	60_{Co}	-	54.33	3.52				
	90_{Sr}	-	0.55	66.33				
	137_{Cs}	-	4 40	16.67				
	154_{Eu}	-	-	9.34				
	232_{Th}	-	Trace	-				
	233_{U}	-	0.17	0.19				
	235_{U}	-	Trace	[d]				
	238_{U}	-	Trace	-				
	238_{Pu}	-	Trace	0.27				
	239_{Pu}	4 52	1.38	-				
	241_{Am}	1.05	1.28	0.69				
	244_{Cm}	46 43	15.99	2.69				
	252_{Cf}	16.52	-	-				
	Other	31 48	21.90	-				
	Total	100.00	100.00	99.70				

[a]Data from ref 5. The data are as reported by the sites even though some of the columns do not add up to 100%.
[b]The mixes represent major waste stream composition variations or composite values. For the percent of each mix in the waste at each site, see Table 3.13.
[c]MFP - mixed fission product.
[d]Information reported as unknown

associated shipment Transport Index (TI) values. In 10 CFR Part 71, *Packaging and Transportation of Radioactive Material*, TI is defined as "the dimensionless number (rounded up to the first decimal place)...expressing the maximum radiation level in millirem (one-thousandth of a rem) per hour at 3.3 feet (1 meter) from the external surface of the package." TI values, when determined, are input data for calculating the radiological risks of transportation by the RADTRAN code. This section describes how the TIs were determined for TRU waste intended for shipment to the WIPP.

The principal tool used for calculating TIs was the Microshield Code (Grove Engineering, Inc., 1988). The software can model from one to five shielding layers and various geometries. It allows creation of custom waste form and shielding constituents. Microshield incorporates libraries of radionuclide kinetics, energetics, absorption coefficients, buildup factors, and dose integration options. Specific parameters are presented for CH and RH waste calculations.

TI calculations were made on a "realistically conservative" basis. This means that the best available characterization information was used, but when assumptions were substituted for unavailable data, the selected assumptions were conservative (gave the greater TI). For example, the weight of CH waste in a drum is an important parameter because of self-shielding: that is, the greater the weight of the waste, the greater the shielding. However, the weight of CH waste in a drum is not, in general, known, nor is the parameter constant. To base the analysis on the maximum allowable weight per drum is not conservative -- that approach over-estimates self-shielding and gives low TIs. To base the analysis on only the weight of air in a drum is maximally conservative, but unrealistic -- that approach underestimates self-shielding and gives very high TIs. Discussions with waste generators support the realistically conservative assumption of 110 pounds (50 kilograms) of waste per drum, because over 90 percent of waste drums are expected to meet or exceed that value.

TIs have been calculated and published before, such as in the WIPP SEIS (DOE, 1990a). The present analysis was expected to give TIs that were close approximations to past results. We expected that differences would be attributed to changes in inventories or projections, refinement in waste characteristics data, or correction of errors in past IDBs. However, TI results for CH-TRU wastes from several sites were greater than published TIs. The greatest single contributor to the external dose rate of CH-TRU waste packages is the flux of 0.66 MeV photons from the decay of ^{137}Cs. However, past IDBs listed the radionuclides in CH-TRU waste based on weight percent only and did not list ^{137}Cs. A radiologically significant amount of ^{137}Cs does not have a significant weight compared to the tabulated radionuclides.

Thus, past CH-TRU waste shipment TIs did not include ^{137}Cs as part of the source term and were lower than currently calculated. Radionuclides were tabulated by activity percent in the IDB (DOE, 1992), so ^{137}Cs (as well as other fission products) are listed and can be included in the source term for calculating TIs. Further discussion of this point is presented in the site-specific-results subsections that follow.

A.2.1 Contact-Handled Waste

Assumed CH-TRU characteristics were based on the estimated physical composition of retrievably stored, newly generated, and buried TRU waste at DOE sites (Table 3-7 of the IDB, Rev. 8; DOE, 1992). Some initial sensitivity analyses were run with Microshield to determine if uncertainties in specific material composition affected the TI. Within the four-significant-figure precision of Microshield results, no difference results from assuming that all plastic is polyethylene, or polyvinylchloride, or some mixture. Likewise, results are unchanged by assumptions regarding type of rubber, or whether sludges are silicate- or nitrate-based, or whether "noncorroding metal" is copper, Inconel, or even lead. The results are affected, within the precision of Microshield, by the total volume percent of metal, which is tabulated in the IDB.

IDB characterization data (weighted between stored and projected volumes, if the IDB specified different compositions) were converted to whole-number atom ratios of carbon, hydrogen, oxygen, sodium, silicon, aluminum, iron (for steel), chlorine (from plastics), nitrogen, and copper (noncorroding metal) for Microshield input on a site-by-site basis.

TI results are very sensitive to the bulk density assumed for the waste. A value of 15.6 lbs/ft^3 (0.25 gm/cm^3), equivalent to 110 pounds (50 kilograms) of waste per drum, was selected as realistically conservative. The TRUPACT-II was modeled as containing the waste from 14 drums. The software used does not provide a way to model the shielding provided by the metal in those 14 drums, and no shielding credit was taken for the drum metal. Shielding provided by the inner and outer TRUPACT-II waste containers, the urethane foam impact absorber, and the outer protective shell of the TRUPACT-II was modeled.

Radionuclide inventories were based on Table A-2, Isotopic Composition, by Activity Percent, of Mixes Used to Describe Composition of Contact-Handled TRU Waste at Each Site. Nuclide input to Microshield was normalized for the various waste mixtures and volumes of stored and projected wastes on a site-by-site basis. The normalization by isotopic mixture ratios was based on the volumes, total activities, and isotopic mix ratios of TRU wastes stored or to be newly generated at each site (Table 3.13 of the IDB, Rev. 8; DOE 1992). Modeling of the "Mixed Fission Products" (MFP) or "other" nuclides listed in Table A-2 was done on site-specific bases and discussed in subsequent subsections.

Normalized radionuclide content per TRUPACT-II for each site is presented in Table A-4. Table A-4 was developed based on resolution of site-specific issues to characterization data presented in Table A-2 and accounts for radioactive decay (10 years) and associated ingrowth of daughter products.

A.2.2 Contact-Handled Waste - Site-Specific Issues

ANL-E: The last three nuclides in Table A-2 should be plutonium isotopes, not uranium isotopes. TIs were calculated using corrected data.

Table A-4. Average Radionuclide Source Term in One TRUPACT-II of Contact-Handled TRU Waste by Site (Limiting Criteria for TRUPACT-II Canisters)

ANL-E SOURCE NUCLIDES:

Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	2.7311E-06	Ac-228	1.0014E-17	Am-241	1.2909E-01
Ce-144	0.0000E+00	Cf-252	0.0000E+00	Cm-244	0.0000E+00
Co-60	0.0000E+00	Cs-137	0.0000E+00	Fr-223	3.7689E-08
Np-237	2.2648E-07	Pa-231	1.9033E-05	Pa-233	2.2206E-07
Pa-234	1.1200E-04	Pa-234m	7.0000E-02	Pm-147	0.0000E+00
Pu-238	0.0000E+00	Pu-239	4.7486E+00	Pu-240	4.4953E-01
Pu-241	6.3216E+00	Pu-242	0.0000E+00	Ra-228	1.0017E-17
Ru-106	0.0000E+00	Sr-90	0.0000E+00	Tc-99	0.0000E+00
Th-227	2.6558E-06	Th-230	8.7492E-11	Th-231	9.0000E-02
Th-232	3.2848E-17	Th-234	7.0000E-02	U-233	3.3162E-12
U-234	1.9656E-06	U-235	9.0000E-02	U-236	1.3314E-07
U-238	7.0000E-02				

INEL SOURCE NUCLIDES:

Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	3.7696E-13	Ac-228	1.9361E-17	Am-241	2.1349E+00
Ba-137m	2.1051E-01	Ce-144	0.0000E+00	Cf-252	0.0000E+00
Cm-244	0.0000E+00	Co-60	0.0000E+00	Cs-137	2.2253E-01
Np-237	6.4661E-06	Pa-231	3.8408E-12	Pa-233	6.3924E-06
Pm-147	0.0000E+00	Pu-238	9.2405E-02	Pu-239	3.6889E+00
Pu-240	8.6908E-01	Pu-241	1.6357E+01	Pu-242	0.0000E+00
Ra-226	1.8048E-13	Ra-228	1.9367E-17	Rn-222	1.7967E-13
Ru-106	0.0000E+00	Sr-90	2.1974E-01	Tc-99	0.0000E+00
Th-229	3.9181E-14	Th-230	1.2430E-10	Th-231	3.6321E-08
Th-232	6.3506E-17	U-233	1.3423E-10	U-234	2.7258E-06
U-235	3.6336E-08	U-236	2.5741E-07	U-238	0.0000E+00
Y-90	2.1979E-01				

Table A-4. Average Radionuclide Source Term in One TRUPACT-II of Contact-Handled TRU Waste by Site (Limiting Criteria for TRUPACT-II Canisters), Continued

LLNL SOURCE NUCLIDES:

Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	8.3156E-13	Ac-228	5.2297E-17	Am-241	3.3806E+00
Ce-144	0.0000E+00	Cf-252	0.0000E+00	Cm-244	0.0000E+00
Co-60	0.0000E+00	Cs-137	0.0000E+00	Np-237	9.9301E-06
Pa-231	8.4726E-12	Pa-233	9.8135E-06	Pm-147	0.0000E+00
Pu-238	3.6962E-01	Pu-239	8.1377E+00	Pu-240	2.3475E+00
Pu-241	3.5915E+01	Pu-242	0.0000E+00	Ra-226	7.2191E-13
Ra-228	5.2312E-17	Rn-222	7.1867E-13	Ru-106	0.0000E+00
Sr-90	0.0000E+00	Tc-99	0.0000E+00	Th-229	5.7594E-14
Th-230	4.9720E-10	Th-231	8.0123E-08	Th-232	1.7154E-16
U-233	2.0353E-10	U-234	1.0903E-05	U-235	8.0156E-08
U-236	6.9530E-07	U-238	0.0000E+00		

NTS SOURCE NUCLIDES:

Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	2.535E-13	Ac-228	2.2261E-17	Am-241	4.1088E-06
Ce-144	0.0000E+00	Cf-252	0.0000E+00	Cm-244	0.0000E+00
Co-60	0.0000E+00	Cs-137	0.0000E+00	Np-237	7.5057E-09
Pa-231	2.5813E-12	Pa-233	7.3648E-09	Pa-234	9.6609E-16
Pa-234m	6.0388E-13	Pm-147	0.0000E+00	Pu-2[illegible]	1.2937E-01
Pu-239	2.4793E+00	Pu-240	9.9894E-01	Pu-241	1.9156E-01
Pu-242	3.9299E-04	Ra-226	2.5267E-13	Ra-228	2.2260E-17
Rn-222	2.5153E-13	Ru-106	0.0000E+00	Sr-90	0.0000E+00
Tc-99	0.0000E+00	Th-229	4.2823E-18	Th-230	1.7402E-10
Th-231	2.4411E-08	Th-232	7.2996E-17	Th-234	6.0388E-13
U-233	1.1422E-13	U-234	3.8162E-06	U-235	2.4421E-08
U-236	2.9587E-07	U-238	6.0968E-13		

Table A-4. Average Radionuclide Source Term in One TRUPACT-II of Contact-Handled TRU Waste by Site (Limiting Criteria for TRUPACT-II Canisters), Continued

RFP SOURCE NUCLIDES:					
Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	6.0692E-07	Ac-228	1.1661E-16	Am-241	2.4551E+01
Ce-144	0.0000E+00	Cf-252	0.0000E+00	Cm-244	0.0000E+00
Co-60	0.0000E+00	Cs-137	0.0000E+00	Fr-223	8.3754E-09
Np-237	7.7429E-05	Pa-231	4.2295E-06	Pa-233	7.6581E-05
Pm-147	0.0000E+00	Pu-238	7.2076E-01	Pu-239	2.1744E+01
Pu-240	5.2345E+00	Pu-241	8.8552E+01	Pu-242	0.0000E+00
Ra-226	1.4077E-12	Ra-228	1.1664E-16	Rn-222	1.4041E-12
Ru-106	0.0000E+00	Sr-90	0.0000E+00	Tc-99	0.0000E+00
Th-227	5.9019E-07	Th-229	4.9480E-13	Th-230	9.6955E-10
Th-231	2.0000E-02	Th-232	3.8250E-16	U-233	1.6332E-09
U-234	2.1262E-05	U-235	2.0000E-02	U-236	1.5504E-06
U-238	0.0000E+00				

Table A-4. Average Radionuclide Source Term in One TRUPACT-II of Contact-Handled TRU Waste by Site (Limiting Criteria for TRUPACT-II Canisters), Continued

HANFORD SOURCE NUCLIDES:

Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	2.3905E-13	Ac-228	1.2907E-17	Am-241	1.9951E-01
Ba-137m	2.9922E+00	Ce-144	6.3505E-04	Cf-252	0.0000E+00
Cm-244	0.0000E+00	Co-60	0.0000E+00	Cs-137	3.1630E+00
Np-237	3.5001E-07	Pa-231	2.4356E-12	Pa-233	3.4318E-07
Pm-147	2.4993E-01	Pr-144	6.3507E-04	Pr-144m	9.0814E-06
Pu-238	7.4478E+00	Pu-239	2.3393E+00	Pu-240	5.7939E-01
Pu-241	9.7698E+00	Pu-242	0.0000E+00	Ra-226	1.4547E-11
Ra-228	1.2911E-17	Rh-106	4.8519E-04	Rn-222	1.4481E-11
Ru-106	4.8519E-04	Sm-147	8.0683E-11	Sr-90	3.0292E+00
Tc-99	0.0000E+00	Th-230	1.0019E-08	Th-231	2.3033E-08
Th-232	4.2338E-17	U-233	5.1250E-12	U-234	2.1970E-04
U-235	2.3042E-08	U-236	1.7161E-07	U-238	0.0000E+00
Y-90	3.0300E+00				

LANL SOURCE NUCLIDES:

Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	1.2690E-11	Am-241	7.3413E+01	Ba-137m	1.4961E+00
Ce-144	0.0000E+00	Cf-252	0.0000E+00	Cm-244	0.0000E+00
Co-60	0.0000E+00	Cs-137	1.5815E+00	Np-237	2.3970E-04
Pa-231	1.2929E-10	Pa-233	2.3717E-04	Pm-147	0.0000E+00
Pu-238	1.2521E+02	Pu-239	1.2418E+02	Pu-240	0.0000E+00
Pu-241	0.0000E+00	Pu-242	0.0000E+00	Ra-226	2.4455E-10
Rn-222	2.4345E-10	Ru-106	0.0000E+00	Sr-90	1.5617E+00
Tc-99	0.0000E+00	Th-229	1.5972E-12	Th-230	1.6843E-07
Th-231	1.2227E-06	Th-232	0.0000E+00	U-233	5.1220E-09
U-234	3.6935E-03	U-235	1.2232E-06	U-238	0.0000E+00
Y-90	1.5621E+00				

Table A-4. Average Radionuclide Source Term in One TRUPACT-II of Contact-Handled TRU Waste by Site (Limiting Criteria for TRUPACT-II Canisters), Continued

MOUND SOURCE NUCLIDES:					
Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	7.1510E-14	Ac-228	2.2254E-19	Am-241	1.0474E-02
Ce-144	0.0000E+00	Cf-252	0.0000E+00	Cm-244	0.0000E+00
Co-60	0.0000E+00	Cs-137	0.0000E+00	Np-237	1.8375E-08
Pa-231	7.2860E-13	Pa-233	1.8016E-08	Pm-147	0.0000E+00
Pu-238	1.7113E+01	Pu-239	6.9980E-01	Pu-240	9.9895E-03
Pu-241	5.1290E-01	Pu-242	0.0000E+00	Ra-226	3.3425E-11
Ra-228	2.2260E-19	Rn-222	3.3275E-11	Ru-106	0.0000E+00
Sr-90	0.0000E+00	Tc-99	0.0000E+00	Th-230	2.3020E-08
Th-231	6.8902E-09	Th-232	7.2996E-19	U-233	2.6906E-13
U-234	5.0483E-04	U-235	6.8931E-09	U-236	2.9587E-09
U-238	0.0000E+00				

Table A-4. Average Radionuclide Source Term in One TRUPACT-II of Contact-Handled TRU Waste by Site (Limiting Criteria for TRUPACT-II Canisters), Continued

ORNL SOURCE NUCLIDES:					
Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-225	3.8320E-04	Ac-227	1.2138E-06	Ac-228	2.8016E-02
Am-241	6.0315E+00	Ba-137m	1.5488E+00	Ce-144	0.0000E+00
Cr-252	0.0000E+00	Cm-244	7.6860E+00	Co-60	1.0739E-02
Cs-137	1.6371E+00	Fr-221	3.8320E-04	Fr-223	1.6751E-08
Np-237	4.0014E-02	Pa-231	8.4589E-06	Pa-233	4.0013E-02
Pa-234	6.4000E-05	Pa-234m	4.0000E-02	Pm-147	0.0000E+00
Pu-238	2.8507E+01	Pu-239	2.2893E+00	Pu-240	2.8269E+00
Pu-241	1.9704E+02	Pu-242	0.0000E+00	Ra-224	2.2546E-02
Ra-225	3.8473E-04	Ra-226	5.5678E-11	Ra-228	2.8018E-02
Rn-222	5.5428E-11	Ru-106	0.0000E+00	Sr-90	1.6166E+00
Tc-99	6.9998E-02	Th-227	1.1804E-06	Th-228	2.2574E-02
Th-229	3.8699E-04	Th-230	3.8397E-08	Th-231	4.0000E-02
Th-232	4.0000E-02	Th-234	4.0000E-02	U-233	4.0998E-01
U-234	8.4205E-04	U-235	4.0000E-02	U-236	8.3591E-07
U-238	4.0000E-02	Y-90	1.6171E+00		

Table A-4. Average Radionuclide Source Term in One TRUPACT-II of Contact-Handled TRU Waste by Site (Limiting Criteria for TRUPACT-II Canisters), Concluded

SRS SOURCE NUCLIDES:					
Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	7.6823E-13	Ac-228	4.0058E-17	Am-241	5.3282E+00
Ce-144	0.0000E+00	Cf-252	0.0000E+00	Cm-244	2.0391E+00
Co-60	0.0000E+00	Cs-137	0.0000E+00	Np-237	3.0700E+00
Pa-231	7.8272E-12	Pa-233	3.0700E+00	Pm-147	0.0000E+00
Pu-238	5.9324E+01	Pu-239	7.5178E+00	Pu-240	1.8007E+00
Pu-241	4.3096E+01	Pu-242	0.0000E+00	Ra-225	6.1036E-08
Ra-226	1.1587E-10	Ra-228	4.0086E-17	Rn-222	1.1535E-10
Ru-106	0.0000E+00	Sr-90	0.0000E+00	Tc-99	0.0000E+00
Th-229	6.1761E-08	Th-230	7.9801E-08	Th-231	7.4020E-08
Th-232	1.3146E-16	U-233	1.3224E-04	U-234	1.7500E-03
U-235	7.4051E-08	U-236	5.3298E-07	U-238	0.0000E+00

Hanford: Radionuclide data for Hanford lists 66.5 activity percent as MFP and 0.7 activity percent as "other." Communications with the IDB staff in Oak Ridge and with the IDB site contact at Hanford did not provide a definitive resolution of the radionuclide constituents in MFP. Assumptions were made that about half of the initial MFP was ^{90}Sr and ^{137}Cs, which were then decayed for three half lives (nine years), so that the Microshield input was about two activity percent for each nuclide (in addition to the amounts tabulated in Table A-2). These assumptions result in a large uncertainty, as well as a high TI (>20 for one TRUPACT-II). Previous TIs for this waste (such as in the SEIS) were less than 1 mrem/hr. A postulated explanation for the increase is that past IDBs listed radionuclides in CH waste by <u>weight</u> percent. Specific activities for ^{90}Sr and ^{137}Cs are more than three orders of magnitude greater than the specific activity of ^{239}Pu, so radiologically significant amounts of the fission products do not even appear within the two-place precision of the weight percent inventory table. Past calculations of TIs for Hanford CH did not include fission products because the fission products were not listed. Indeed, Table D.3.3, *Average Radioactivity in a Shipment of CH TRU Waste*, from the SEIS (DOE, 1990a), does not list any fission products in any CH waste.

INEL: Isotope composition for mix 4 is unknown. This mixture is 6E-06 (less than 1 part in 100,000) of the total activity from INEL, amounting to less than 3 curies total. Mix 4 was not included in the TI calculations.

LANL: Rev. 8 of the IDB (DOE, 1992) does not list the relative amounts of mixes 1 through 5. Rev. 7 of the IDB (DOE, 1991d) did list the relative volume amounts of mixes 1 through 5. If one assumes that the bulk density of LANL waste is independent of isotopic mixture, the Rev. 8 nuclide activity percent list can be calculated from the Rev. 7 nuclide weight percent list. Therefore, the Rev. 8 activities were normalized using the Rev. 7 mix ratios (mix 1 = 38%, mix 2 = 11%, mix 3 = 7.1%, mix 4 = 41.9%, and mix 5 = 2%). MFP in mix 2 were assumed to be half ^{90}Sr and half ^{137}Cs.

LLNL: No site-specific assumptions were made for LLNL.

Mound: No site-specific assumptions were made for Mound.

NTS: No site-specific assumptions were made for NTS.

ORNL: Initial dose rate calculations for ORNL CH gave results in excess of 1 rem/hr for a single CH waste drum (versus the CH limit of 200 mrem/hr). IDB data were questioned, and the ORNL IDB staff concluded that four waste drums from Knolls Atomic Power Laboratory (KAPL) had been misclassified as CH, rather than RH, because of lead shielding in the drums. ORNL data were revised by subtracting the inventory of the KAPL drums.

RFP: No site-specific assumptions were made for RFP.

SRS: The "others" nuclides for mixes 4, 5, and 6 were assumed to be the decay products, after two years of decay, from 100 percent initially pure ^{237}Np, ^{241}Am, and ^{244}Cm, respectively.

A.2.3 Remote-Handled Waste

Assumed RH-TRU waste characteristics were based on the estimated physical composition of retrievably stored, newly generated, and buried TRU waste at DOE sites (Table 3.7 of the IDB, Rev. 8.; DOE 1992), supplemented by *A Characterization Study of RH-TRU Wastes Existing in Storage and Expected to Be Generated* (Warrant, 1985), and *Remote-Handled Transuranic Solid Waste Characterization Study: Oak Ridge National Laboratory* (Stewart et al., 1989). As with CH-TRU analyses, some details of RH-TRU waste composition, such as polyethylene versus polyvinylchloride plastics, are not significant within the precision of Microshield. However, RH-TRU waste from some sites is higher in dense waste forms such as grout, concrete, or salt cake. Because these denser waste forms affect self-shielding within the waste, site-specific waste forms were modeled, both as to whole-number atom ratios of chemical composition and bulk density.

The vast majority of RH-TRU waste is not yet in the final form or container in which the waste will be shipped to, and disposed of, in the WIPP. For this analysis, all RH-TRU waste is assumed to be packaged in the RH waste canister and shipped in the 72B cask. Because most sites intend to place 55-gallon (208-liter) drums into the canister, a waste volume of 165 gallons (624 liters) per canister was used (except as noted for ANL-E), rather than the 235-gallon (890-liter) volume of the canister. No shielding credit was taken for containers inside the canister, primarily because of software limitations.

Radionuclide inventories were based on Rev. 8 of the IDB (DOE, 1992), as presented in Table A-3. However, the average activity per unit volume of RH waste, as stored, and as tabulated in the IDB, does not necessarily meet WIPP WAC limits. Preliminary analyses were made for each site, on an isotopic mixture-by-mixture basis, to ensure that the radionuclide source term met both the 23 Ci/liter-limit and the 100-rem/hr surface dose rate limit (30 rem/hr for ANL-E, discussed below). For those isotopic mixtures that exceeded either limit, the source term was reduced until the limits were met. Normalization of isotopic mixture ratios was then performed. The lists of radionuclides used as Microshield input are presented in Table A-5, with an indication for each site as to the more restrictive criterion, 23 Ci/liter or 100 rem/hr. Even though provision exists in the WIPP WAC (DOE, 1991c) for 5-volume percent of RH-TRU waste to have surface dose rates up to 1000 rem/hr, this analysis was limited to waste of 100 rem/hr-dose rates.

A.2.4 Remote-Handled Waste - Site-Specific Issues

ANL-E: Alpha-gamma hot cells at ANL-E are limited to 30-rem/hr surface dose rates for wastes and are loaded in 30-gallon (114-liter) drums. The dose rate limit and the container size limit are imposed by the configuration of the cells at ANL-E. Both limits

Table A-5. Average Radionuclide Source Term in One Canister of Remote-Handled TRU Waste by Site (Limiting Criteria for Canister Contents)

ANL-E SOURCE NUCLIDES:					
Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	1.0829E-12	Ac-228	1.7136E-16	Am-241	1.2241E-01
Ba-137m	4.8868E+02	Cs-137	5.1658E+02	Np-237	2.1475E-07
Pa-231	1.1033E-11	Pa-233	2.1055E-07	Pa-234	1.2320E-02
Pa-234m	7.7000E+00	Pu-239	1.0597E+01	Pu-240	7.6919E+00
Pu-241	5.9941E+00	Ra-228	1.7141E-16	Th-230	9.6241E-09
Th-231	1.0434E-07	Th-232	5.6207E-16	Th-234	7.7000E+00
U-233	3.1444E-12	U-234	2.1621E-04	U-235	1.0438E-07
U-236	2.2782E-06	U-238	7.7000E+00		

ORNL SOURCE NUCLIDES:					
Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-225	1.0646E+01	Ac-227	2.5519E-10	Am-241	2.2595E+01
Ba-137m	8.4129E+01	Cm-244	1.3701E+01	Co-60	3.8525E+00
Cs-137	8.8931E+01	Eu-154	9.1390E+00	Fr-221	1.0646E+01
Np-237	7.3774E-05	Pa-231	2.6001E-09	Pa-233	7.2994E-05
Pu-239	2.4973E+03	Pu-240	1.7603E-02	Ra-225	1.0688E+01
Ra-228	1.1514E-19	Sr-90	2.2295E+02	Th-229	1.0751E+01
Th-231	2.4588E-05	Th-232	4.7004E-19	U-233	1.1389E+04
U-235	2.4598E-05	U-236	2.7719E-09	Y-90	2.2301E+02

Table A-5. Average Radionuclide Source Term in One Canister of Remote-Handled TRU Waste by Site (Limiting Criteria for Canister Contents), Continued

HANFORD SOURCE NUCLIDES:					
Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	4.2365E-12	Am-241	1.4134E+01	Ba-137m	2.1517E+03
Ce-144	4.5024E-02	Cs-137	2.2745E+03	Np-237	2.4795E-05
Pa-231	4.3164E-11	Pa-233	2.4311E-05	Pa-234	9.2944E-02
Pa-234m	5.8090E+01	Pm-147	1.7716E+01	Pr-144	4.5025E-02
Pr-144m	6.4385E-04	Pu-238	5.2892E+02	Pu-239	4.1458E+01
Pu-241	6.9210E+02	Ra-226	1.0331E-09	Rh-106	3.4253E-02
Rn-222	1.0284E-09	Ru-106	3.4253E-02	Sm-147	5.7191E-09
Sr-90	2.2460E+03	Th-230	7.8410E-07	Th-231	4.0819E-07
Th-234	5.8090E+01	U-233	3.6306E-10	U-234	1.7234E-02
U-235	4.0836E-07	U-238	5.8090E+01	Y-90	2.2466E+03

LANL SOURCE NUCLIDES:					
Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ac-227	1.3812E-10	Ac-228	2.7640E-15	Am-241	1.5042E-01
Ba-137m	3.1734E+03	Cs-137	3.3546E+03	Np-237	2.6389E-07
Pa-231	1.4072E-09	Pa-233	2.5874E-07	Pa-234	2.4413E-12
Pa-234m	1.5260E-09	Pu-239	1.3516E+03	Pu-240	1.2407E+02
Pu-241	7.3659E+00	Pu-242	9.9308E-01	Ra-228	2.7648E-15
Sr-90	3.3125E+03	Th-231	1.3308E-05	Th-232	9.0661E-15
Th-234	1.5260E-09	U-233	3.8640E-12	U-234	2.1392E-14
U-235	1.3313E-05	U-236	3.6747E-05	U-238	1.5406E-09
Y-90	3.3134E+03				

Table A-5. Average Radionuclide Source Term in One Canister of Remote-Handled TRU Waste by Site (Limiting Criteria for Canister Contents), Concluded

INEL SOURCE NUCLIDES:					
Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ba-137m	4.4124E+03	Ce-144	2.6678E-01	Cs-134	1.5430E+01
Cs-137	4.6643E+03	Kr-85	7.5169E+01	Nb-95	2.5471E-15
Nb-95m	9.7681E-18	Ni-63	0.0000E+00	Np-237	0.0000E+00
Pm-147	6.8465E+01	Pr-144	2.6678E-01	Pr-144m	3.8150E-03
Pu-238	4.7736E+02	Pu-239	0.0000E+00	Pu-240	0.0000E+00
Pu-242	0.0000E+00	Ra-226	9.3235E-10	Rn-222	9.2817E-10
Sm-147	2.2102E-08	Sr-90	2.9727E+03	Tc-99	0.0000E+00
Th-230	6.4214E-07	U-234	1.4082E-02	U-235	0.0000E+00
U-236	0.0000E+00	U-238	0.0000E+00	Y-90	2.9735E+03
Zr-95	1.1522E-15				

were assumed to continue. Furthermore, no process is planned within the DOE complex that would "concentrate" ANL-E waste to higher dose rates. The source term for ANL-E RH waste was scaled to comply with the 30-rem/hr limit.

Results: TI results for CH-TRU and RH-TRU shipments are presented in Table A-6, by site. Values include the TI for a single TRUPACT-II, at the centerline of the center TRUPACT of three on a truck trailer, and at the centerline of a row of six TRUPACT-II containers on a railcar. Table A-7 gives RH-TRU waste TI values for a single cask (truck shipment configuration) and for two casks (railcar configuration).

Table A-6. Calculated Site-Specific CH and RH TI Values

Site	○ One TRUPACT-II Container	○○○ Three TRUPACT-II Containers per Truck	○○○○○○ Six TRUPACT-II Containers per Railcar
ORNL	14.0	26.2	33.2
ANL-E	<0.1	<0.1	0.1
LLNL	<0.1	<0.1	<0.1
INEL	1.6	3.0	3.8
LANL	10.7	20.1	25.4
HANFORD	22.3	41.8	53.0
MOUND	<0.1	<0.1	<0.1
NTS	<0.1	<0.1	<0.1
RFP	<0.1	<0.1	<0.1
SRS	1.8	3.4	4.3

Table A-7. RH TI Values

Site	■ One Cask per Truck	■■ Two Casks per Railcar
ANL-E	4.9	9.6
INEL	20.2	39.4
LANL	17.1	33.4
ORNL	4.4	8.6
HANFORD	16.8	32.8

ANNEX 1
NRC CERTIFICATE OF COMPLIANCE
FOR THE TRUPACT-II SHIPPING CONTAINER

NRC FORM 618
CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES

1. CERTIFICATE NUMBER	b. REVISION NUMBER	c. PACKAGE IDENTIFICATION NUMBER	d. PAGE NUMBER	e. TOTAL NUMBER PAGES
9218	4	USA/9218/B(U)F	1	4

PREAMBLE

a. This certificate is issued to certify that the packaging and contents described in Item 5 below, meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO (Name and Address)

Department of Energy
Transportation & Packaging
Safety Div., EH-33.3
Washington, DC 20585

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION:

Nuclear Packaging Inc. application dated March 3, 1989, as supplemented.

c. DOCKET NUMBER 71-9218

CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

a) Packaging

(1) Model No.: TRUPACT-II

(2) Description

A stainless steel and polyurethane foam insulated shipping container designed to provide double containment for shipment of contact-handled transuranic waste. The packaging consists of an unvented, 1/4-inch thick stainless steel inner containment vessel (ICV), positioned within an outer containment assembly (OCA) consisting of an unvented 1/4-inch thick stainless steel outer containment vessel (OCV), a 10-inch thick layer of polyurethane foam and a 1/4 to 3/8-inch thick outer stainless steel shell. The package is a right circular cylinder with outside dimensions of approximately 94 inches diameter and 122 inches height. The package weighs not more than 19,250 pounds when loaded with the maximum allowable contents of 7,265 pounds.

The OCA has a domed lid which is secured to the OCA body with a locking ring. The OCV containment seal is provided by a butyl rubber O-ring (bore seal). The OCV is equipped with a seal test port and a vent port.

The ICV is a right circular cylinder with domed ends. The outside dimensions of the ICV are approximately 73 inches diameter and 98 inches height. The ICV lid is secured to the ICV body with a locking ring. The ICV containment seal is provided by a butyl rubber O-ring (bore seal). The ICV is equipped with a seal test port and vent port. Aluminum spacers are placed in the top and bottom domed ends of the ICV during shipping. The cavity available for the contents is a cylinder of approximately 73 inches diameter and 75 inches height.

5. (a) Packaging (continued)

(3) Drawings

The packaging is constructed in accordance with Nuclear Packaging Inc. Drawing No. 2077-500 SNP, Sheets 1 through 11, Rev. K.

The contents are positioned within the packaging in accordance with Nuclear Packaging Inc. Drawing Nos. 2077-007 SNP, Rev. C, and 2077-008 SNP, Sheets 1 and 2, Rev. C.

(b) Contents

(1) Type and form of material

Dewatered, solid or solidified transuranic wastes. Wastes must be packaged in 55-gallon drums, standard waste boxes (SWB), or bins. Wastes must be restricted to prohibit explosives, corrosives, nonradioactive phrophorics and pressurized containers. Within a drum, bin or SWB, radioactive pyrophorics must not exceed 1 percent by weight and free liquids must not exceed 1 percent by volume. Flammable organics are limited to 500 ppm in the headspace of any drum, bin or SWB.

(2) Maximum quantity of material per package

Contents not to exceed 7,265 pounds including shoring and secondary containers, with no more than 1000 pounds per 55-gallon drum and 4,000 pounds per SWB.

Maximum number of containers per package and authorized packaging configurations are as follows:

(i) 14 55-gallon drums,
(ii) 2 SWBs,
(iii) 2 SWBs, each SWB containing one bin,
(iv) 2 SWBs, each SWB containing 4 55-gallon drums,
(v) 1 ten-drum overpack (TDOP), containing 10 55-gallon drums,
(vi) 1 TDOP, containing 1 SWB,
(vii) 1 TDOP, containing 1 bin within an SWB, or
(viii) 1 TDOP, containing 4 55-gallon drums within an SWB.

Fissile material not to exceed 325 grams Pu-239 equivalent with no more than 200 grams Pu-239 equivalent per 55-gallon drum or 325 grams Pu-239 equivalent per SWB. Pu-239 equivalent must be determined in accordance with Appendix 1.3.7 of the application.

Decay heat not to exceed the values given in Tables 6.1 through 6.3 "TRUPACT-II Content Codes", (TRUCON), DOE/WIPP 89-004, Rev. 6.

(c) Fissile Class I

Physical form, chemical properties, chemical compatibility, configuration of waste containers and contents, isotopic inventory, fissile content, decay heat, weight and center of gravity, radiation dose rate must be determined and limited in accordance with Appendix 1.3.7 of the application, "TRUPACT-II Authorized Methods for Payload Control", (TRAMPAC).

Each drum, bin or SWB must be assigned to a shipping category in accordance with Table 5, "TRUPACT-II Content Codes", (TRUCON), DOE/WIPP 89-004, Rev. 6, or must be tested for gas generation and meet the acceptance criteria in accordance with Attachment 2.0, to Appendix 1.3.7 of the application.

Each drum, bin or SWB must be labeled to indicate its shipping category. All drums, bins or SWB's within a package must be of the same shipping category.

Each drum, bin, SWB, or TDOP must be equipped with filtered vents prior to shipment in accordance with Appendix 1.3.7 of the application. Drums which were not equipped with filtered vents during storage must be aspirated before shipment. The minimum aspiration time must be determined from Tables 7.1 through 9.3 in "TRUPACT-II Content Codes", (TRUCON), DOE/WIPP 89-004, Rev. 6.

9. In addition to the requirements of Subpart G of 10 CFR Part 71:

   (a) Each package must be prepared for shipment and operated in accordance with the procedures described in Chapter 7.0, "Operating Procedures", of the application.

   (b) Each package must be tested and maintained in accordance with the procedures described in Chapter 8.0, "Acceptance Tests and Maintenance Program", of the application.

1. The contents of each package must be in accordance with Appendix 7.4.3., "Payload Control Procedures", of the application.

2. Prior to each shipment, the lid and vent port seals on the inner and outer containment vessels must be leak tested to 1×10^{-7} std cm^3/sec in accordance with Chapter 7.0, "Operating Procedures", of the application.

3. All free standing water must be removed from the inner containment vessel cavity and the outer containment vessel cavity before shipment.

4. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR §71.12.

5. Expiration date: August 31, 1994.

REFERENCES

Safety Analysis Report for the TRUPACT-II Shipping Package dated March 3, 1989.

Supplements dated: May 26, June 27, June 30, August 3, and August 8, 1989;

April 18, July 10, July 25, August 24, and December 20, 1990; April 11, April 29,

and June 17 1991; and September 24, 1992.

"TRUPACT-II Content Codes", (TRUCON), DOE/WIPP 89-004, Rev. 6, dated September 1992.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Ross Chappell for

Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards
and Transportation, NMSS

Date: NOV 19 1992

APPENDIX B

TRU WASTE VOLUMES AND NUMBER OF WASTE SHIPMENTS

APPENDIX B

This appendix provides information on the volume of TRU waste to be shipped to the WIPP. Additionally, the number of shipments for trucks, regular trains, and dedicated trains is presented. These data are necessary for assessing the potential impacts of transportation.

Waste volumes are based on data presented in the 1992 Integrated Data Base, Rev. 8 (DOE, 1992). Currently, TRU waste generating sites project a total of 3,675,055 ft^3 (104,078 m^3) of CH-TRU and 295,030 ft^3 (8,355 m^3) of RH-TRU waste, for a total of 3,970,085 ft^3 (112,433 m^3) of TRU waste for disposal at WIPP. The WIPP Land Withdrawal Act (LWA) limits the WIPP disposal capacity to 6,200,000 ft^3 (175,584 m^3) of disposed waste. In order to present a conservative transportation risk analysis, CH-TRU waste volume was scaled up to 5,904,970 ft^3 (167,229 m^3) and summed with the projected RH-TRU waste volume to achieve the LWA limit of 6,200,000 ft^3 (175,584 m^3) (Table B-1).

The RH-TRU waste volume was not scaled up because the DOE has stated in the *1980 Environmental Impact Statement for the Waste Isolation Pilot Plant Record of Decision* and the *1990 Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant* a 250,000 ft^3 (7,080 m^3) limit for RH-TRU waste will be set in addition to 6.2 million ft^3 (175,584 m^3) of CH-TRU waste. The Land Withdrawal Act (LWA) sets a 6.2 million ft^3 (175,584 m^3) overall limit with no reference to any RH-TRU volume limit. However, the LWA sets a maximum activity of 5,100,000 curies for RH-TRU. DOE 1992 data indicated that slightly over 295,000 ft^3 (8,354 m^3) of RH-TRU waste is either in storage or will be generated for disposal at the WIPP. Thus RH-TRU waste volumes were not scaled up.

Scaled-up CH-TRU waste was assumed to have the same characteristics of stored and newly generated waste. Many uncertainties regarding waste characteristics and volumes exist. Furthermore, it is assumed that all CH-TRU waste will be packaged in Type A 55-gallon drums and shipped in TRUPACT-II containers. Table B-2 presents the estimated conservative number of shipments to the WIPP based on the 6.2 million ft^3 (175,584 m^3) waste disposal limit.

Table B-1. Volumes of Stored and Newly Generated TRU Waste, Scaled Up to Equal the Design Capacity of the WIPP

Waste Facility	Estimates from 1992 Integrated Data Base (IDB)[a]			Additional Volume for Up-scaling (ft³)	Estimate Used In This Analysis (ft³)
	Stored Waste[b] (ft³)	Newly Generated Waste[c] (ft³)	Total Base 1992 IDB (ft³)		
CH-TRU Waste					
Idaho National Engineering Laboratory (INEL)	1,321,699	144,933	1,466,632	889,909	2,356,541
Rocky Flats Plant (RFP)	32,984	45,239	78,223	47,463	125,686
Hanford Reservation (Hanford)	352,691	399,907	752,598	456,654	1,209,252
Savannah River Site (SRS)	189,677	704,534	894,211	542,581	1,436,792
Los Alamos National Laboratory (LANL)	271,396	115,621	387,017	234,831	621,848
Oak Ridge National Laboratory (ORNL)	23,647	15,818	39,465	23,946	63,411
Nevada Test Site (NTS)	21,065	-0-	21,065	12,782	33,847
Argonne National Laboratory-East (ANL-E)	530	8,775	9,305	5,646	14,951
Lawrence Livermore National Laboratory (LLNL)	7,049	10,312	17,361	10,534	27,895
Mound Laboratory (Mound)	9,009	169	9,178	5,569	14,747
Subtotal	2,229,747	1,445,308	3,675,055	2,229,915	5,904,970
RH-TRU Waste					
INEL	1,961	4,873	6,834		
Hanford	7,098	220,577	227,675		
ORNL	46,492	7,639	54,131		
ANL-E	-0-	3,108	3,108		
LANL	2,773	509	3,282		
Subtotal	58,324	236,706	295,030		295,030
TOTAL					6,200,000

[a] DOE, 1992 [b] Table 3.5, 1992 IDB [c] Table 3.13, 1992 IDB

Table B-2. Number of Shipments Estimated for the WIPP Disposal Phase[a]

Site	Volume Scaled Up (ft^3)	Disposal Phase Shipments		
		Truck[b]	Regular Train[c]	Dedicated Train[d]
CH WASTE[b]				
INEL	2,356,541	7,639	3,820	1,274
RFP	125,686	408	204	68
Hanford	1,209,252	3,920	1,960	654
SRS	1,436,792	4,658	2,329	777
LANL[e]	621,848	2,016	2,016	2,016
ORNL	63,411	206	103	35
NTS[e]	33,847	110	110	110
ANL-E	14,951	49	25	9
LLNL	27,895	91	46	16
Mound	14,747	48	24	8
Subtotal	5,904,970	19,145	10,637	4,967
RH WASTE				
INEL	6,834	218	109	37
Hanford	227,675	7,244	3,622	1,207
ORNL	54,131	1,723	862	288
ANL-E	3,108	99	50	17
LANL[e]	3,282	105	105	105
Subtotal	295,030	9,389	4,748	1,655
TOTAL	6,200,000	28,534	15,385	6,622

Table B-2. Footnotes

[a] Assumptions:
0.208 m^3 of CH waste/55-gallon drum
0.89 m^3 of RH waste/RH cask
35.315 ft^3/m^3

[b]

$$\frac{(14\ drums)}{TRUPACT} \times \frac{(0.208m^3)}{drum} \times \frac{(3\ TRUPACTs)}{truck\ shipment} \times \frac{(35.315ft^3)}{m^3} = \frac{308.51ft^3}{truck\ shipment}$$

$$\frac{(0.89m^3)}{RH\ cask} \times \frac{(1\ RH\ cask)}{truck\ shipment} \times \frac{(35.315ft^3)}{m^3} = \frac{31.43ft^3}{truck\ shipment}$$

[c]

$$\frac{(14\ drums)}{TRUPACT} \times \frac{(0.208m^3)}{drum} \times \frac{(6\ TRUPACT)}{regular\ train\ shipment} \times \frac{(35.315ft^3)}{m^3} = \frac{617.02ft^3}{regular\ train\ shipment}$$

$$\frac{(0.89m^3)}{RH\ cask} \times \frac{(2\ RH\ casks)}{regular\ train\ shipment} \times \frac{(35.315ft^3)}{m^3} = \frac{62.86ft^3}{regular\ train\ shipment}$$

[d]

$$\frac{(14\ drums)}{TRUPACT} \times \frac{(0.208m^3)}{drum} \times \frac{(18\ TRUPACT)}{dedicated\ train\ shipment} \times \frac{(35.315ft^3)}{m^3} = \frac{1851.07ft^3}{dedicated\ train\ shipment}$$

$$\frac{(0.89m^3)}{RH\ cask} \times \frac{(6\ RH\ casks)}{dedicated\ train\ shipment} \times \frac{(35.315ft^3)}{m^3} = \frac{188.58ft^3}{dedicated\ train\ shipment}$$

[e] Only truck shipments will occur from these facilities.

APPENDIX C

TRANSPORTATION RISK

APPENDIX C

C.0 INTRODUCTION

This appendix presents the methodology and analysis for determining human health impacts associated with shipping CH- and RH-TRU waste by truck or train to the WIPP. Shipping impacts can be divided into three general categories: radiological, chemical, and nonradiological/nonchemical. Each of these categories can be subdivided into impacts from normal or incident-free transportation and from accidents. Additionally, three shipping cases are analyzed: truck, regular train, and dedicated train.

The transportation analysis presented in the report was conducted similarly to assessments such as NUREG-0170 (NRC, 1977), the WIPP FEIS (DOE, 1980), and the WIPP SEIS (DOE, 1990a). Since 1980, computer models and basic assumptions have been refined, but the approach to estimating the consequences and risks has remained the same. This methodology has proven to be accurate, reliable, and technically acceptable.

The transportation system configurations evaluated in this study involve the movement of up to 18 separate Type B transportation packages per shipment. An analysis was conducted to determine the likelihood or credibility of multiple package failures for very severe accidents. As discussed in Appendix C.1, most accidents are unlikely to cause a Type B package containment failure or result in a release of radioactive or hazardous chemical materials. This analysis conservatively assumes a package containment failure if Type B package certification test conditions are exceeded.

C.1 Radiological Impacts

This section discusses potential radiological impacts from transporting TRU waste.

C.1.1 Analytical Codes

The analytical codes or models used for this analysis have been extensively documented in the WIPP SEIS (DOE, 1990a). RADTRAN was used to calculate radiological risks. RADTRAN was originally developed by Sandia National Laboratories to support preparation of the *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes* (NRC, 1977). This code has undergone almost 17 years of development and is continuing to be refined. RADTRAN 4 (version 4.0.13) (Neuhauser and Kanipe, 1992) was used for the current analyses and was accessed using TRANSNET, a Sandia National Laboratories centralized MICRO VAX II computer system. The TRANSNET system incorporates transportation models and data bases that may be accessed via a modem-equipped personal computer.

RADTRAN calculates doses for various population subgroups (e.g., workers, the public) for normal transportation conditions. For the public, it calculates doses to people:

- In the vicinity of the transportation vehicle while it is stopped
- Surrounding the transportation route
- Sharing the transportation route with the vehicle

The dose assessment incorporates a point-source approximation for distances between the receptor and the source of more than twice the largest physical dimension of the source. A line-source approximation is applied for exposure distances less than twice the largest package dimension. The RADTRAN code also incorporates features to take credit for shielding for typical structures in urban and suburban settings. RADTRAN also calculates a hypothetical maximum exposure to an individual who resides along the surface transportation route. The model assumes that the individual lives approximately 100 feet (30 meters) from the surface transportation link and that the vehicle passes by at approximately 40 miles per hour (46 kilometers per hour). RADTRAN also incorporates algorithms to predict radiological impacts from accidents exceeding transportation package performance conditions. The code evaluates both internal exposure pathways (i.e., inhalation, resuspension, and ingestion) and external exposure pathways (i.e., cloudshine, groundshine) to project potential accident consequences and risks (probability x consequence) to the general public.

The HIGHWAY model (Johnson et al., 1993a) was used to determine truck travel mileages and travel distance in rural, suburban, and urban population zones. For rail shipments, the INTERLINE model (Johnson et al., 1993b) was used to determine the mileages and fractions of travel in each population zone. Both models have been recently revised to incorporate updated 1990 census data.

C.1.2 Methodology

Low levels of penetrating radiation from radioactive material shipments pose an external exposure pathway to transportation workers and the public during normal (incident-free) transportation conditions. Shipment external radiation levels are regulated by the DOT and NRC on the basis of the Transport Index (TI). As discussed in Appendix A, the TI represents the radiation dose rate (in mrem/hr) at 3.3 feet (1 meter) from the surface of the shipping package. Table A-5 summarizes the calculated TI values by shipment origin site, waste category (CH-TRU or RH-TRU), and transportation mode (i.e., truck, regular train, dedicated train). Calculated TI values are dependent on:

- Distribution and quantity of radionuclides per shipment
- Self-shielding characteristics of the waste

- Waste configuration
- Bulk density
- Whole-atom ratios of chemical composition

- Configuration and shielding characteristics of the shipment packages

Calculated TI values are key inputs to the RADTRAN code to evaluate normal transportation impacts. Other key inputs to assess normal transportation impacts are the shipment route length and the fraction of travel in urban, suburban, and rural zones. These zones were determined using the HIGHWAY (Johnson et al., 1993a) and INTERLINE (Johnson et al., 1993b) models and are summarized in Table C-1.

Routes were selected for analysis based on:

- 49 CFR 177.825, for truck, which regulates highways and state-approved, non-interstate segments between the shipment origin sites and the WIPP

- The most direct Class A/B mainlines between the shipment origin sites and the WIPP for train

RADTRAN default urban, suburban, and rural population densities of 3,861, 719, and 6 persons per square kilometer were used in the analysis. These population densities are typical of urban, suburban, and rural communities, as specified in NUREG-0170 (NRC, 1977), and are consistent with values used in the WIPP SEIS (DOE, 1990a).

Exposures to individuals residing or working in buildings along the route were determined using RADTRAN Shielding Option 2. This option estimates exposures to individuals in buildings at reduced rates and takes representative credit for shielding benefits afforded by typical building structures found in the three population areas.

Other RADTRAN input parameters are summarized in Table C-2 and are representative of the waste categories (CH-TRU or RH-TRU) and shipment modes analyzed.

Table C-1. Distances to the WIPP and Travel in Various Population Zones[a]

	Total Distances	Population Zone Miles		
	Miles	Rural	Suburban	Urban
TRUCK				
Idaho National Engineering Laboratory	1383	1256	112	15
Rocky Flats Plant	686	606	65	15
Hanford Reservation	1817	1661	136	20
Savannah River Site	1791	1464	297	30
Los Alamos National Laboratory	397	360	30	7
Oak Ridge National Laboratory	1528	1320	188	20
Nevada Test Site	1204	1135	53	16
Argonne National Laboratory-East	1462	1237	208	18
Lawrence Livermore National Laboratory	1437	1297	94	46
Mound Laboratory	1561	1318	220	23
RAIL				
Idaho National Engineering Laboratory	1725	1585	121	19
Rocky Flats Plant	977	869	86	22
Hanford Reservation	2299	2123	152	24
Savannah River Site	1839	1414	365	60
Oak Ridge National Laboratory	1572	1193	333	46
Argonne National Laboratory-East	1305	1159	129	17
Lawrence Livermore National Laboratory	1633	1474	130	29
Mound Laboratory	1654	1399	222	33

[a] Mean population densities are utilized and correspond to:
- Rural (16 persons per square mile, or 6 persons per square kilometer)
- Suburban (1,862 persons per square mile, or 719 persons per square kilometer)
- Urban (10,000 persons per square mile, or 3,861 persons per square kilometer).

As discussed previously, RADTRAN calculates a hypothetical maximum dose to an individual who resides along the surface transportation route and is exposed to every shipment during normal transportation conditions. Supplemental calculations were performed to evaluate other maximum individual dose scenarios due to:

- Inspections
- Food or refueling stops
- Traffic congestion
- Railyard activities

Exposure receptors (worker and the public) and scenarios analyzed generally follow approaches taken in the WIPP SEIS (DOE, 1990a), with the exception that maximum individual doses for dedicated train shipments have been added. Individual dose estimates were calculated using the shipment TI value and line source (l/r) approximations and without allowing for attenuation of radiation by the air or any intervening structures. Maximum individual dose bases and assumptions regarding exposure frequencies, distances, and durations are summarized in Table C-3.

Accidents must exceed the transportation package performance conditions to result in a potential release to the environment. As described in Subsection 2.2, the TRUPACT-II is designed and licensed in accordance with NRC regulations for Type B packages. The Safety Analysis Report for Packaging (SARP) for the RH-72B cask is currently being reviewed and will be certified in accordance with NRC regulations for Type B packages.

To predict potential radiological impacts from accidents, this analysis uses an accident severity classification scheme and associated probabilities of occurrence derived from NUREG-0170 (NRC, 1977) and the WIPP SEIS (DOE, 1990a). Accident severity categories define the seriousness of an accident in terms of mechanical and thermal (fire) loads and influence the potential amount of radioactive material released during an accident. Most accidents are unlikely to cause any release, but very severe accidents (much more severe than represented by NRC certification standards for Type B containers) may cause some of the radioactive material to escape. NUREG-0170 (NRC, 1977) defined eight accident severity categories. The first two accident categories were defined to be less serious than the hypothetical accident conditions specified in 10 CFR Part 71 for testing Type B packaging and were retained in this analysis. Thus, the TRUPACT-II container and RH-72B cask would be very unlikely to result in any releases to the environment for severity category I or II accidents. NUREG-0170 (NRC, 1977) defined the remaining six categories to postulate increasingly severe, but less likely, accidents resulting in a release of radioactive materials from Type B packages.

Table C-2. RADTRAN Input Data

Parameter	CH-TRU Waste			RH-TRU Waste		
	Truck	Regular Train	Dedicated Train	Truck	Regular Train	Dedicated Train
Package type	TRUPACT-II			RH-72B		
Average radioactive content of package	(Site-specific, see Tables A-2 and A-3)					
Packages/shipment	3[a]	6[a]	18[b]	1[a]	2[a]	6[b]
Transport Index (TI), mrem/hr	(Site-specific, see Table A-6)					
Package length dimension, m	6.9	14.4	14.4	3.3	8.1	8.1
Number of crew members[c]	2	5	5	2	5	5
Distance from source to crew (m)						
Actual distance	4.6	152[c]	21[d]		152[c]	21[d]
Effective distance[e]	6.3	152	32	5	152	29
Speed, km/hr[c]						
Urban population zone	24.2	24.2	24.2	24.2	24.2	24.2
Suburban population zone	40.3	40.3	40.3	40.3	40.3	40.3
Rural population zone	88.6	64.4	64.4	88.6	64.4	64.4
Stop time per kilometer, hr/km[c]	.011	.0033	.0013[f]	.011	.0033	.0013[f]
Number of people exposed while stopped[c]	50	100	100	50	100	100
Number of people per vehicle[c]	2	3	3	2	3	3
Population density, people/km^2[c]						
Urban population zone	3861	3861	3861	3861	3861	3861
Suburban population zone	719	719	719	719	719	719
Rural population zone	6	6	6	6	6	6
Accident release fractions	(See Tables C-6 and C-7)					

[a]Treated in RADTRAN code as one effective package.
[b]Treated in RADTRAN code as three effective packages.
[c]Source: Neuhauser and Kanipe, 1992.
[d]Nominal dimension of idler car and couplers.
[e]Actual distance increased to account for crew exposure to primarily one package.
[f]Dedicated train stop time per kilometer is estimated as 40 percent of regular train value based on communication with the National Transportation Systems Center.

Table C-3. Maximum Individual Dose Assumptions for Normal Transportation Conditions

Truck Shipments		
Exposure Categories	**Exposure Conditions**	
Crew Member		
- In-Transit	Exposure Frequency:	See Note "a"
	Exposure Distance:	
	- CH-TRU	21 feet (6.3 meters)
	- RH-TRU	16 feet (5 meters)
	Exposure Duration:	In-transit time
	Exposure Model:	RADTRAN 4
- Stops (Inspections)	Exposure Frequency:	Every 100 miles (161 kilometers)
	Exposure Distance:	3.28 feet (1 meter)
	Exposure Duration:	.25 hour
	Exposure Model:	TI dose
- Stops (Food Stops)	Exposure Frequency:	Every 200 miles (322 kilometers)
	Exposure Distance:	
	- Dining	66 feet (20 meters)
	- Surveillance	33 feet (10 meters)
	Exposure Duration:	
	- Dining	1 hour
	- Surveillance	1 hour
	Exposure Model:	Line source
- Stops (Refueling)	Exposure Frequency:	Every 850 miles (1,369 kilometers)
	Exposure Distance:	
	- Near Activities	16 feet (5 meters)
	- Far Activities	33 feet (10 meters)
	Exposure Duration:	
	- Near Activities	0.33 hour
	- Far Activities	0.33 hour
	Exposure Model:	Line source
Departure Inspections	Exposure Frequency:	See Note "b"
	Exposure Distance:	10 feet (3 meters)
	Exposure Duration:	0.5 hour
	Exposure Model:	Line source
State Inspections	Exposure Frequency:	See Note "c"
	Exposure Distance:	10 feet (3 meters)
	Exposure Duration:	1 hour
	Exposure Model:	Line source
Member of Public Sharing Route	Exposure Frequency:	One-time event (traffic congestion case)
	Exposure Distance:	10 feet (1 meter)
	Exposure Duration:	0.5 hour
	Exposure Model:	TI dose
Member of Public Adjacent to Route	Exposure Frequency:	Every shipment
	Exposure Distance:	99 feet (30 meters)
	Exposure Duration:	Time for shipment to pass at 24 km/hr
	Exposure Model.	RADTRAN 4
Member of Public at Stops	Exposure Frequency:	See Note "d"
	Exposure Distance:	66 feet (20 meters)
	Exposure Duration:	2 hours
	Exposure Model:	Line source

Table C-3. Maximum Individual Dose Assumptions for Normal Transportation Conditions, Continued

Regular Train Shipments		
Exposure Categories	**Exposure Conditions**	
Crew Member		
- In-Transit	Exposure Frequency:	See Note "a"
	Exposure Distance:	500 feet (152 meters)
	Exposure Duration:	In-transit time
	Exposure Model:	RADTRAN 4
- Stops (Inspections)	Exposure Frequency:	See Note "e"
	Exposure Distance:	3.28 feet (1 meter)
	Exposure Duration:	See note "e"
	Exposure Model:	TI dose
Yard Crew	Exposure Frequency:	See Note "f"
	Exposure Distance:	33 feet (10 meters)
	Exposure Duration:	2 hours
	Exposure Model:	See Note "f"
Departure Inspections	Exposure Model:	Assumed to be the same as for truck shipments, because fewer rail shipments will be required but more items to inspect/survey per shipment
State Inspections	Exposure Frequency:	See Note "c"
	Exposure Distance:	10 feet (3 meters)
	Exposure Duration:	0.75 hour (duration less than truck because no queue time is expected)
	Exposure Model:	Line source
Member of Public Adjacent to Route	Exposure Frequency:	Every waste shipment
	Exposure Distance:	99 feet (30 meters)
	Exposure Duration:	Time for shipment to pass at 24 km/hr
	Exposure Model:	RADTRAN 4
Member of Public at Stops	Exposure Frequency:	Every waste shipment
	Exposure Distance:	660 feet (200 meters)
	Exposure Duration:	20 hours
	Exposure Models:	Point source

Table C-3. Maximum Individual Dose Assumptions for Normal Transportation Conditions, Continued

Dedicated Train Shipments		
Exposure Categories	**Exposure Conditions**	
Crew Member		
- In-Transit	Exposure Frequency:	See Note "a"
	Exposure Distance:	
	- CH-TRU	105 feet (32 meters)
	- RH-TRU	95 feet (29 meters)
	Exposure Duration:	In-transit time
	Exposure Model:	RADTRAN 4
- Stops (Inspections)	Exposure Frequency:	See Note "e"
	Exposure Distance:	3.28 feet (1 meter)
	Exposure Duration:	See Note "e"
	Exposure Model:	TI dose (three railcar case)
Yard Crew	Exposure Frequency:	See Note "f"
	Exposure Distance:	33 feet (10 meters)
	Exposure Duration:	2 hours
	Exposure Model:	See Note "f"
Departure Inspections	Exposure Model:	Assumed to be the same as for truck shipments, because fewer rail shipments will be required but more items to inspect/survey per shipment
State Inspections	Exposure Frequency:	See Note "c"
	Exposure Distance:	10 feet (3 meters)
	Exposure Duration:	2.25 hours (3 times regular train duration)
	Exposure Model:	Line source
Member of Public Adjacent to Route	Exposure Frequency:	Every waste shipment
	Exposure Distance:	99 feet (30 meters)
	Exposure Duration:	Time for shipment to pass at 24 km/hr
	Exposure Model:	RADTRAN 4
Member of Public at Stops	Exposure Frequency:	Every waste shipment
	Exposure Distance:	660 feet (200 meters)
	Exposure Duration:	20 hours
	Exposure Models:	Point source

Table C-3. Maximum Individual Dose Assumptions for Normal Transportation Conditions, Concluded

NOTES

[a] The fraction of round trip shipments in which a crew member is estimated to participate is calculated based on an availability of 5,400 hours per year (225 days at 24 hours per day), an average travel speed of 35 mph for truck and 20 mph for rail, and working ten years in the same career position.

[b] During the disposal phase, an individual is assumed to be exposed to one-third of the shipments (three shifts per day) and to work in the same position for ten years.

[c] During the disposal phase, an inspector is assumed to be exposed to 20 percent of all shipments.

[d] Estimated based on a member of the public working at a truckstop. During the disposal phase, the individual is assumed to be exposed to one-third of the shipments (three shifts per day) and to work in the same position for ten years.

[e] Individual crew member doses during stops for inspections and servicing (e.g., air hose connections) were calculated assuming an exposure duration of 1 percent of the stop time, calculated as 0.033 hour per kilometer for regular train shipments and 0.0013 hour per kilometer for dedicated train shipments.

[f] A yard crew member is assumed to be exposed to one-third of the shipments (three shifts per day) and to work in the same position for ten years.

NUREG-0170 (NRC, 1977) classification scheme for truck accidents is illustrated in Figure C-1 and uses crush force and fire duration to determine the seriousness of an accident. The crush force may result from either an internal load (e.g., container crushed upon impact by other containers in the load) or a static load (e.g., container crushed beneath vehicle). The classification approach used for train accidents is shown in Figure C-2. While fire duration is retained as the thermal parameter, the NRC decided to use puncture and impact speed as the mechanical measure of accident severity. This was done because crushing from the impact of other containers in the cargo was considered less relevant for rail shipments.

As discussed in the WIPP SEIS (DOE, 1990a), for higher accident severities, there is an incremental increase in mechanical and thermal loads. At the highest severity category, impact forces can be 100 times greater than those in category II, and fire durations can exceed 1.5 to 2 hours. The majority of truck (99.90 percent) and rail (99.83 percent) accidents that involve fires however, last less than 30 minutes (Wolff, 1984). The probability of such accidents diminishes as their severity increases.

Table C-4 presents the fractional occurrences for truck incidents in each of the eight incident severity categories. Table C-5 presents the fractional occurrences for train incidents in each of the eight incident severity categories.

A key parameter for analyzing incidents is the estimated release fraction of radioactive material escaping to the environment. Particulate matter can result from impacts during incidents that fracture the radioactive material or from fires that can entrain impact-generated particulate matter, cause off-gassing of volatile fission products, or thermally degrade and then entrain particulate matter from previously intact material. For accident conditions greater than severity category II, the parameter determines the fraction of radioactive material released to the environment and available for dispersal downwind from the accident site. Inhalation is a primary internal exposure pathway for people that results from breathing respirable (< 10 microns) particulate matter. As the particulate matter moves downwind, some settles out onto the ground where it can expose people to penetrating radiation until the soil is decontaminated or until it is weathered or washed away by natural processes. This pathway constitutes the "groundshine" exposure resulting from an incident. After settling, some fraction of the particles can also be resuspended into the air due to wind or other surface disturbance. These particles can then be inhaled by people as were those in the initial plume and constitute the source term for the resuspension dose pathway. Finally, particles in the air can also expose people to penetrating radiation (aside from inhalation). This pathway constitutes a "cloudshine" exposure. The sum of the exposures from these pathways constitutes the total exposure. For this analysis, the ingestion pathway (wherein particles settle on plants which are then ultimately consumed by people) was not assessed. Development of RADTRAN ingestion parameters (i.e., soil transfer factor, food transfer factor) are currently in draft form. Additionally, based on dose conversion factors for the radionuclides of interest, inhalation exposures result in doses typically one to two orders of magnitude greater than those from ingestion for equal uptakes of radioactive material. Also, any accident resulting in contamination of crops would result in interdiction of those crops

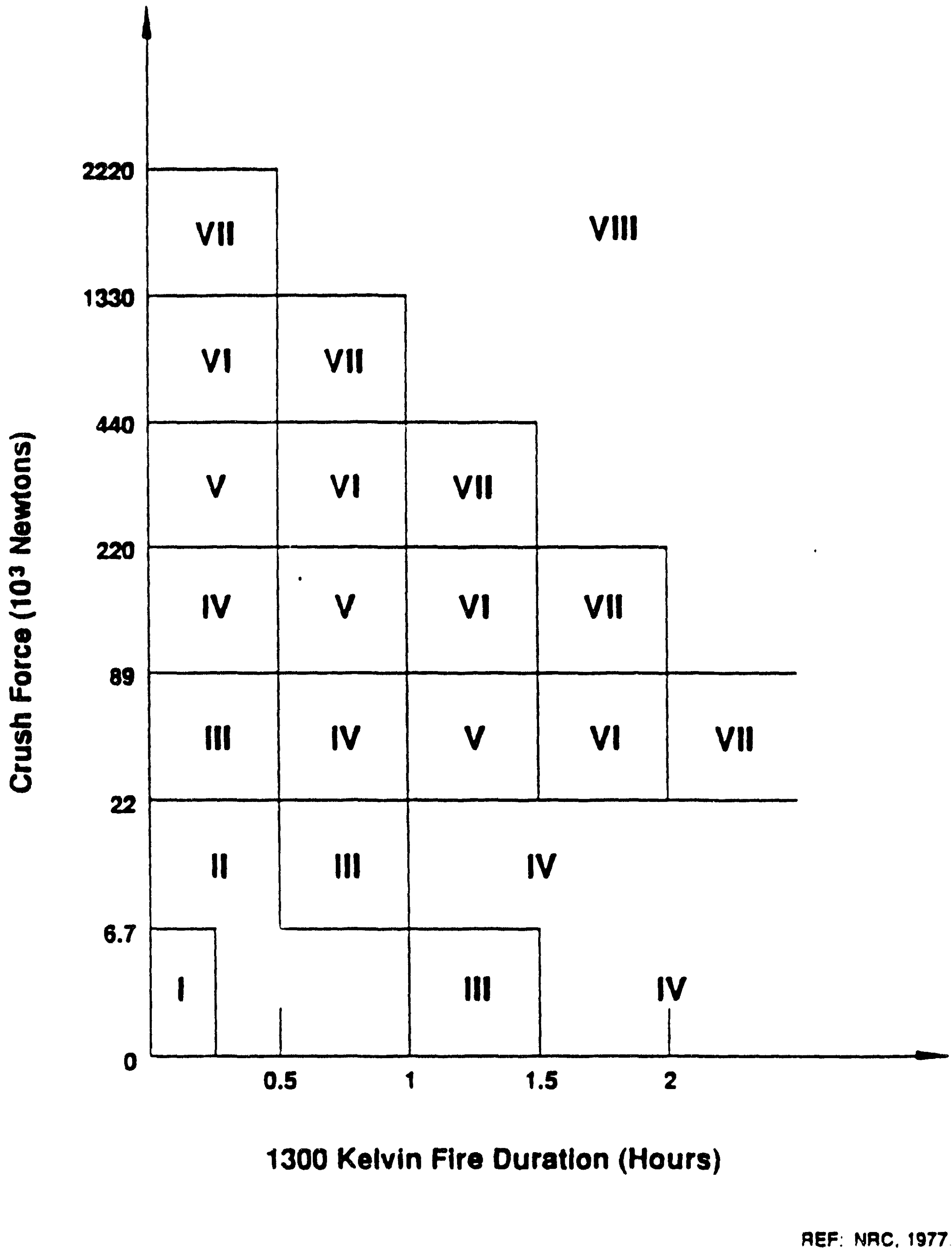

Figure C-1. Truck Incident Severity Category Classification Scheme

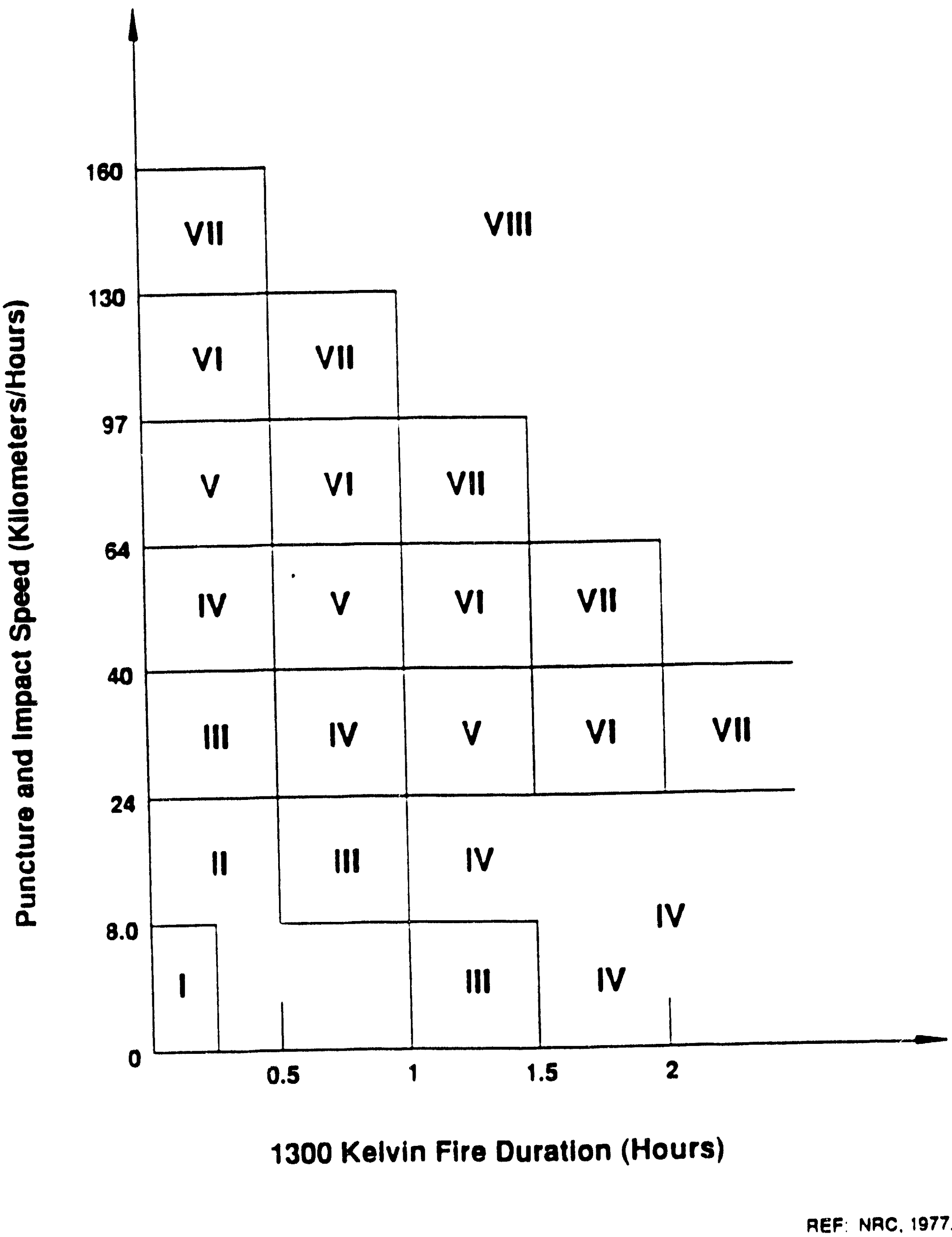

Figure C-2. Railroad Incident Severity Category Classification Scheme

Table C-4. Fractional Occurrences for Truck Incidents by Incident Severity Category and Population Density Zone

Incident Severity Category	Fractional Occurrences	Fractional Occurrences According to Population Density Zones		
		Rural	Suburban	Urban
I	.55	.1	.1	.8
II	.36	.1	.1	.8
III	.07	.3	.4	.3
IV	.016	.3	.4	.3
V	.0028	.5	.3	.2
VI	.0011	.7	.2	.1
VII	8.5×10^{-5}	.8	.1	.1
VIII	1.5×10^{-5}	.9	.05	.05

Table C-5. Fractional Occurrences for Train Incidents by Incident Severity Category and Population Density Zone

Incident Severity Category	Fractional Occurrences	Fractional Occurrences According to Population Density Zones		
		Rural	Suburban	Urban
I	.50	.1	.1	.8
II	.30	.1	.1	.8
III	.18	.3	.4	.3
IV	.018	.3	.4	.3
V	.0018	.5	.3	.2
VI	1.3×10^{-4}	.7	.2	.1
VII	8.5×10^{-6}	.8	.1	.1
VIII	1.5×10^{-6}	.9	.05	.05

(or resultant animal products) prior to consumption by the public.

This analysis uses the release fractions developed in the WIPP SEIS (Appendix D, pp. D-66 to D-81) (DOE, 1990a). They are summarized in Tables C-6 and C-7. The release fraction analysis determined how much radioactive material could be potentially released to the environment in a respirable, airborne form for accident severity categories III through VIII. Larger particle sizes (greater than 10 microns aerodynamic diameter) are not analyzed, as they tend to be eliminated by the body and consequently are not significant in estimating health effects. Consistent with the WIPP SEIS analyses and based on data and analyses presented in NUREG-0170 (NRC, 1977), the NRC Modal Study (NUREG/CR-4829) (NRC, 1987) and SAND 80-2124 (Wolff, 1984), a catastrophic failure (e.g., gaping hole, container severed in half) of a Type B package is not a credible event for transportation incidents and is not addressed in this report.

Based on the foregoing inputs and considerations, RADTRAN was used to determine incident-free transportation doses (in person-rem) and accident risk/doses (in person-rem) per shipment by waste category (CH-TRU or RH-TRU), waste origin site, and transportation mode. The predicted accident risk incorporates the spectrum of incident severities, and their associated probabilities of occurrence, in each of the population settings (urban, suburban, rural). RADTRAN output also provides predicted population dose consequences by incident severity category and population setting. Based on the analysis presented in Section C.1, all three TRUPACT-IIs in a truck shipment and a maximum of six transportation packages (CH-TRU or RH-TRU) in a train shipment are postulated to experience accident conditions more severe than certification test conditions and potentially fail. The computer code TICLD (Transportation Individual Center Line Dose) was used in conjunction with RADTRAN 4 to calculate maximum individual doses from transportation accidents in which radioactive material is released. TICLD incorporates a Gaussian dispersion model.

Health effect impacts from predicted doses may be expressed in terms of excess latent fatalities by multiplying the dose by a dose-to-risk conversion factor. Values for dose-to-risk conversion factors have been estimated by numerous national and international bodies. The estimated values have evolved over time, varying from approximately 2.8E-04 per person-rem (BEIR, 1980) to approximately 8.0E-04 per person-rem (BEIR, 1990) and reflect the uncertainties associated with extrapolating observable cancer risks at relatively high dose rates to lower dose rate exposures. For low doses/low dose-rates, most current estimates are in the range of 3 to 5.0E-04 latent fatalities per person-rem. This analysis uses a dose-to-risk conversion factor of 5.0E-04 latent fatalities per person-rem for the general population and is believed to encompass the primary radionuclides of interest (high linear-energy-transfer [high LET] radiation) (NRC, Preamble to Standards for Protection Against Radiation, 56 FR 23363, May 21, 1991). A dose-to-risk conversion factor of 4.0E-04 latent cancer fatalities per person-rem is used for workers, with the difference attributable to the presence of children in the general population.

Table C-6. CH-TRU Waste Transportation Release Fractions[a,b]

Impact Release Fraction + Thermal Release Fraction = Total Respirable Release Fraction			
Incident Severity Category	Impact Release Fraction	Thermal Release Fraction	Total Respirable Release Fraction
Truck			
I	0E+0	0E+0	0E+0
II	0E+0	0E+0	0E+0
III	0E+0	8E-9	8E-9
IV	0E+0	2E-7	2E-7
V	8E-5	2E-7	8E-5
VI	2E-4	2E-7	2E-4
VII	2E-4	2E-7	2E-4
VIII	2E-4	2E-7	2E-4
Train[c]			
I	0E+0	0E+0	0E+0
II	0E+0	0E+0	0E+0
III	0E+0	2E-8	2E-8
IV	0E+0	7E-7	7E-7
V	8E-5	7E-7	8E-5
VI	2E-4	7E-7	2E-4
VII	2E-4	7E-7	2E-4
VIII	2E-4	7E-7	2E-4

[a] From Table D.3.21 of the WIPP SEIS (DOE, 1990a).
[b] Assumes all packages in shipment behave the same.
[c] Release fractions for regular train or dedicated train shipments.

Table C-7. RH-TRU Waste Transportation Release Fractions[a,b]

Impact Release Fraction + Thermal Release Fraction = Total Respirable Release Fraction			
Incident Severity Category	Impact Release Fraction	Thermal Release Fraction	Total Respirable Release Fraction
Truck			
I	0E+0	0E+0	0E+0
II	0E+0	0E+0	0E+0
III	0E+0	6E-9	6E-9
IV	0E+0	2E-7	2E-7
V	1E-4	2E-7	1E-4
VI	1E-4	2E-7	1E-4
VII	2E-4	2E-7	2E-4
VIII	2E-4	2E-7	2E-4
Train[c]			
I	0E+0	0E+0	0E+0
II	0E+0	0E+0	0E+0
III	0E+0	2E-8	2E-8
IV	0E+0	7E-7	7E-7
V	1E-4	7E-7	1E-4
VI	1E-4	7E-7	1E-4
VII	2E-4	7E-7	2E-4
VIII	2E-4	7E-7	2E-4

[a] From Table D.3.22 of the WIPP SEIS (DOE, 1990a).
[b] Assumes all packages in shipment behave the same.
[c] Release fractions for regular train or dedicated train shipments.

C.1.3 Radiological Analysis Results

Radiological doses associated with truck and train incident-free shipments are expressed in dose equivalents (rem or person-rem). Radiological doses associated with transportation incidents are expressed in 50-year Committed Effective Dose Equivalents (CEDE) (person-rem) and take into consideration continuing exposures to body organs after the initial intake of radionuclides through internal pathways. Table C-8 presents calculated incident-free doses and accident dose risks per shipment for each facility that ships TRU waste to the WIPP. Per-shipment values are given for truck, regular train, and dedicated train options. Table C-9 provides calculated annual doses resulting from TRU waste shipments to the WIPP during the disposal phase. Table C-10 summarizes cumulative incident-free doses and accident dose risks for shipments to the WIPP over the lifetime of the facility. Table C-11 presents cumulative maximum individual doses resulting from incident-free transportation to the WIPP over the lifetime of the facility.

Table C-12 summarizes predicted incident consequences for very severe accidents in an urban community by waste category (CH-TRU or RH-TRU) and transportation option (truck, regular train, or dedicated train). Incident doses presented are for the maximum calculated consequences for a single accident, considering all shipment origin sites and applicable transportation options. Furthermore, consequences are determined on the basis that all packages in a truck shipment (maximum of three) and up to six packages in a train shipment may be subjected to an accident environment exceeding package certification test conditions (see Section C.1). Predicted consequences are further identified as being either representative or maximum values. Representative doses result from a scenario in which emergency response actions occur in sufficient time to mitigate the initial accident sequence, with a postulated release and resulting consequence comparable to a category III severity accident. Chapter 6.0 describes the extensive emergency response capabilities for responding to an accident. Maximum doses result from a very unlikely scenario in which emergency response actions are delayed until after the initial accident sequence is completed (several hours), with a postulated release and resulting consequence comparable to a category VIII severity accident. Considering the comparative nature of this study, it is unnecessary to develop absolute probabilities of occurrence for both scenario categories. Calculated population doses range from: (1) 1.3 to 750,000 person-rem for truck shipments, (2) 1.5 to 1,500,000 person-rem for regular train shipments, and (3) 1.5 to 4,500,000 person-rem for dedicated train shipments. The range of these incident doses are primarily driven by the amount of material-at-risk and potentially available for release for each transportation option and the nature of the waste (CH-TRU or RH-TRU) involved in the accident. Health effects resulting from the above exposures are estimated to range from: (1) 0.0007 to 380 latent cancer fatalities for truck shipments, (2) 0.0008 to 750 latent cancer fatalities for regular train shipments, and (3) 0.0008 to 2,300 latent cancer fatalities for dedicated train shipments. Individual doses are also presented in Table C-12 by transportation option and scenario category. No early fatality consequences are predicted by RADTRAN.

Table C-8. Radiological Doses per Shipment for TRU Waste to the WIPP[a,b]

	Incident-Free Doses per Shipment (person-rem)		Accident Dose Risk per Shipment (person-rem)
CH Waste			
Truck			
Facility	**Worker[c]**	**Public**	**Public**
Idaho National Engineering Laboratory	6.16E-2	1.48E-1	6.83E-4
Rocky Flats Plant	1.06E-3	2.49E-3	3.40E-3
Hanford Reservation	1.49E-1	5.98E-1	1.20E-3
Savannah River Site	9.98E-2	2.28E-1	1.81E-2
Los Alamos National Laboratory	3.33E-2	1.80E-1	9.52E-3
Oak Ridge National Laboratory	1.33E-1	7.05E-1	6.93E-3
Nevada Test Site	1.73E-3	4.22E-3	2.01E-4
Argonne National Laboratory-East	2.32E-2	5.39E-3	8.98E-4
Lawrence Livermore National Laboratory	2.20E-3	5.19E-3	1.76E-3
Mound Laboratory	2.49E-3	5.77E-3	2.96E-3
RH Waste			
Truck			
Idaho National Engineering Laboratory	1.14E-1	3.34E-1	4.31E-2
Hanford Reservation	1.49E-1	4.37E-1	6.78E-2
Los Alamos National Laboratory	3.33E-2	9.63E-2	4.35E-2
Oak Ridge National Laboratory	8.19E-2	1.21E-1	1.09E+0
Argonne National Laboratory-East	9.17E-2	1.34E-1	3.88E-3

[a] Calculations based on three TRUPACT-IIs or one RH-72B cask per truck and six TRUPACT-IIs or two RH-72Bs per railcar.
[b] Radiological doses per shipment are a function of the Transport Index (see Appendix A).
[c] Transportation crew

Table C-8. Radiological Doses per Shipment for TRU Waste to the WIPP[a,b], Continued

	Incident-Free Doses per Shipment (person-rem)		Accident Dose Risk per Shipment (person-rem)
CH Waste			
Regular Train			
Facility	**Worker[c]**	**Public**	**Public**
Idaho National Engineering Laboratory	2.03E-2	3.83E-2	6.29E-4
Rocky Flats Plant	3.42E-4	7.39E-4	2.90E-3
Hanford Reservation	9.10E-2	1.45E-1	1.08E-3
Savannah River Site	3.57E-2	6.28E-2	2.03E-2
Los Alamos National Laboratory	[d]	[d]	[d]
Oak Ridge National Laboratory	8.99E-2	1.56E-1	1.02E-2
Nevada Test Site	[d]	[d]	[d]
Argonne National Laboratory-East	3.37E-4	9.00E-4	4.73E-4
Lawrence Livermore National Laboratory	5.11E-4	1.00E-3	1.69E-3
Mound Laboratory	6.05E-4	1.16E-3	2.60E-3
RH Waste			
Regular Train			
Idaho National Engineering Laboratory	4.89E-2	6.78E-2	4.61E-
Hanford Reservation	7.06E-2	8.25E-2	7.26E-0
Los Alamos National Laboratory	[d]	[d]	
Oak Ridge National Laboratory	4.82E-2	6.15E-2	1.86E+
Argonne National Laboratory-East	2.37E-2	4.67E-2	2.29E-

[a] Calculations based on three TRUPACT-IIs or one RH-72B per truck and six TRUPACT-IIs or two RH-72Bs per railcar.
[b] Radiological doses per shipment are a function of the Transport Index (see Appendix A).
[c] Transportation crew
[d] Rail shipments will not occur from these sites.

Table C-8. Radiological Doses per Shipment for TRU Waste to the WIPP[a,b], Concluded

	Incident-Free Doses per Shipment (person-rem)		Accident Dose Risk Per Shipment (person-rem)
CH Waste			
Dedicated Train			
Facility	Worker[c]	Public	Public
Idaho National Engineering Laboratory	5.08E-2	6.34E-2	6.29E-4
Rocky Flats Plant	7.57E-4	1.45E-3	2.90E-3
Hanford Reservation	7.00E-2	7.39E-2	1.08E-3
Savannah River Site	5.60E-2	1.15E-1	2.03E-2
Los Alamos National Laboratory	[d]	[d]	[d]
Oak Ridge National Laboratory	4.78E-2	1.08E-1	1.02E-2
Nevada Test Site	[d]	[d]	[d]
Argonne National Laboratory-East	1.01E-3	1.68E-3	4.73E-4
Lawrence Livermore National Laboratory	1.26E-3	2.20E-3	1.69E-3
Mound Laboratory	1.28E-3	2.18E-3	2.60E-3
RH Waste			
Dedicated Train			
Idaho National Engineering Laboratory	4.07E-2	3.74E-2	1.38E-1
Hanford Reservation	5.43E-2	4.20E-2	2.18E-01
Los Alamos National Laboratory	[d]	[d]	[d]
Oak Ridge National Laboratory	3.71E-2	6.13E-2	5.57E+0
Argonne National Laboratory-East	3.08E-2	3.76E-2	6.83E-3

[a] Calculations based on three TRUPACT-IIs or one RH-72B per truck and six TRUPACT-IIs or two RH-72Bs per railcar.
[b] Radiological doses per shipment are a function of the Transport Index (see Appendix A).
[c] Transportation crew
[d] Rail shipments will not occur from these sites.

Table C-9. Annual Radiological Doses for TRU Waste Shipments to the WIPP during the Disposal Phase (person-rem)[a,b]

Facility	Number of Shipments	Incident-Free Doses		Accident Dose Risk
		Worker[c]	Public	Public
CH Waste				
Truck				
Idaho National Engineering Laboratory	382	2.35E+1	5.65E+1	2.61E-1
Rocky Flats Plant	21	2.23E-2	5.23E-2	7.14E-2
Hanford Reservation	784	1.17E+2	4.69E+2	9.41E-1
Savannah River Site	233	2.33E+1	5.31E+1	4.22E+0
Los Alamos National Laboratory	101	3.36E+0	1.82E+1	9.62E-1
Oak Ridge National Laboratory	10	1.33E+0	7.05E+0	6.93E-2
Nevada Test Site	6	1.04E-2	2.53E-2	1.21E-3
Argonne National Laboratory-East	2	4.64E-2	1.08E-2	1.80E-3
Lawrence Livermore National Laboratory	5	1.10E-2	2.60E-2	8.80E-3
Mound Laboratory	2	4.98E-2	1.15E-2	5.92E-3
RH Waste				
Truck				
Idaho National Engineering Laboratory	11	1.25E+0	3.67E+0	4.74E-1
Hanford Reservation	362	5.39E+1	1.58E+2	2.45E+1
Los Alamos National Laboratory	5	1.67E-1	4.82E-1	2.18E-1
Oak Ridge National Laboratory	86	7.04E+0	1.04E+1	9.37E+1
Argonne National Laboratory-East	5	4.59E-1	6.70E-1	1.94E-2

[a] The annual exposures assume that shipments occur over a 20-year disposal phase.
[b] In some instances one full shipment occurs every two years; it is assumed that every facility ships at lea once per year.
[c] Transportation crew.

Table C-9. Annual Radiological Doses for TRU Waste Shipments to the WIPP during the Disposal Phase (person-rem)[a,b], Continued

Facility	Number of Shipments	Incident-Free Doses		Accident Dose Risk
		Worker[c]	Public	Public
CH Waste				
Regular Train				
Idaho National Engineering Laboratory	191	3.88E+0	7.32E+0	1.20E-1
Rocky Flats Plant	11	3.76E-3	8.13E-3	3.19E-2
Hanford Reservation	98	8.92E+0	1.42E+1	1.06E-1
Savannah River Site	116	4.14E+0	7.28E+0	2.35E+0
Los Alamos National Laboratory[d]	101	3.36E+0	1.82E+1	9.62E-1
Oak Ridge National Laboratory	5	4.50E-1	7.80E-1	5.10E-2
Nevada Test Site[d]	6	1.04E-2	2.53E-2	1.80E-3
Argonne National Laboratory-East	1	3.37E-4	9.00E-4	4.73E-4
Lawrence Livermore National Laboratory	2	1.02E-3	2.00E-3	3.38E-3
Mound Laboratory	1	5.11E-4	1.00E-3	1.69E-3
RH Waste				
Regular Train				
Idaho National Engineering Laboratory	5	2.41E-1	3.39E-1	2.31E-1
Hanford Reservation	181	1.28E+1	1.49E+1	1.31E+01
Los Alamos National Laboratory[d]	5	1.67E-1	4.82E-1	2.18E-1
Oak Ridge National Laboratory	43	2.07E+0	2.64E+0	8.00E+1
Argonne National Laboratory-East	3	7.11E-2	1.40E-1	6.87E-3

[a] The annual exposures assume that shipments occur over a 20-year disposal phase.
[b] In some instances one full shipment occurs every two years; it is assumed that every facility ships at least once per year.
[c] Transportation crew.
[d] Rail shipments will not occur from these sites. The truck data are included to provide a maximum case.

Table C-9. Annual Radiological Doses for TRU Waste Shipments to the WIPP during the Disposal Phase (person-rem)[a,b], Concluded

Facility	Number of Shipments	Incident-Free Doses		Accident Dose Risk
		Worker[c]	Public	Public
CH Waste				
Dedicated Train				
Idaho National Engineering Laboratory	64	3.25E+0	4.06E+0	4.08E-2
Rocky Flats Plant	4	3.03E-3	5.80E-3	1.16E-2
Hanford Reservation	33	2.31E+0	2.44E+0	3.56E-2
Savannah River Site	39	2.18E+0	4.49E+0	7.92E-1
Los Alamos National Laboratory[d]	101	3.36E+0	1.82E+1	9.62E-1
Oak Ridge National Laboratory	2	9.56E-2	2.16E-1	2.04E-2
Nevada Test Site[d]	6	1.04E-2	2.53E-2	1.21E-3
Argonne National Laboratory-East	1	1.01E-3	1.68E-3	4.73E-4
Lawrence Livermore National Laboratory	1	1.26E-3	2.20E-3	1.69E-3
Mound Laboratory	1	1.28E-3	2.18E-3	2.60E-3
RH Waste				
Dedicated Train				
Idaho National Engineering Laboratory	2	8.14E-2	7.48E-2	2.76E-1
Hanford Reservation	60	3.26E+0	2.52E+0	1.31E+01
Los Alamos National Laboratory[d]	5	1.67E-1	4.82E-1	2.18E-1
Oak Ridge National Laboratory	14	5.19E-1	8.58E-1	7.80E+1
Argonne National Laboratory-East	1	3.08E-2	3.76E-2	6.83E-3

[a] The annual exposures assume that shipments occur over a 20-year disposal phase.
[b] In some instances one full shipment occurs every two years; it is assumed that every facility ships at least once per year.
[c] Transportation crew.
[d] Rail shipments will not occur from these sites. The truck data are included to provide a maximum case.

Table C-10. Cumulative Radiological Doses for TRU Waste Shipments to the WIPP over the Lifetime of the WIPP Facility (person-rem)

Facility	Number of Shipments	Incident-Free Doses		Accident Dose Risk
		Worker[a]	Public	Public
CH Waste				
Truck				
Idaho National Engineering Laboratory	7639	4.71E+2	1.13E+3	5.22E+0
Rocky Flats Plant	408	4.32E-1	1.02E+0	1.39E+0
Hanford Reservation	3920	5.84E+2	2.34E+3	4.70E+0
Savannah River Site	4658	4.65E+2	1.06E+3	8.43E+1
Los Alamos National Laboratory	2016	6.71E+1	3.63E+2	1.92E+1
Oak Ridge National Laboratory	206	2.74E+1	1.45E+2	1.43E+0
Nevada Test Site	110	1.90E-1	4.64E-1	2.21E-2
Argonne National Laboratory-East	49	1.14E+0	2.64E-1	4.40E-2
Lawrence Livermore National Laboratory	91	2.00E-1	4.72E-1	1.54E-1
Mound Laboratory	48	1.20E-1	2.77E-1	1.42E-1
CH-TRU Subtotal	19,145	1.62E+3	5.04E+3	1.16E+2
RH Waste				
Truck				
Idaho National Engineering Laboratory	218	2.49E+1	7.28E+1	9.40E+0
Hanford Reservation	7244	1.08E+3	3.17E+3	4.91E+2
Los Alamos National Laboratory	105	3.50E+0	1.01E+1	4.75E+0
Oak Ridge National Laboratory	1723	1.41E+2	2.08E+2	1.88E+3
Argonne National Laboratory-East	99	9.08E+0	1.33E+1	3.84E-1
RH-TRU Subtotal	9,389	1.26E+3	3.30E+3	1.94E+3
Total	28,534	2.89E+3	8.43E+3	2.06E+3

[a]Transportation crew

Table C-10. Cumulative Radiological Doses for TRU Waste Shipments to the WIPP over the Lifetime of the WIPP Facility (person-rem), Continued

CH Waste				
Regular Train				
Facility	**Number of Shipments**	**Incident-Free Doses**		**Accident Dose Risk**
		Worker[b]	**Public**	**Public**
Idaho National Engineering Laboratory	3820	7.75E+1	1.46E+2	2.40E+0
Rocky Flats Plant	204	6.98E-2	1.51E-1	5.92E-1
Hanford Reservation	1960	1.78E+2	2.84E+2	2.12E+0
Savannah River Site	2329	8.31E+1	1.46E+2	4.73E+1
Los Alamos National Laboratory[a]	2016	6.71E+1	3.63E+2	1.92E+1
Oak Ridge National Laboratory	103	9.26E+0	1.61E+1	1.05E+0
Nevada Test Site[a]	110	1.90E-1	4.64E-1	2.21E-2
Argonne National Laboratory-East	25	8.43E-3	2.25E-2	1.18E-2
Lawrence Livermore National Laboratory	46	2.35E-2	4.60E-2	7.77E-2
Mound Laboratory	24	1.45E-2	2.78E-2	6.24E-2
CH-TRU Subtotal	10,637	4.15E+2	9.56E+2	7.28E+1
RH Waste				
Regular Train				
Idaho National Engineering Laboratory	109	5.25E+0	6.70E+0	5.02E+0
Hanford Reservation	3622	2.56E+2	2.99E+2	2.63E+2
Los Alamos National Laboratory[a]	105	3.50E+0	1.01E+1	4.57E+0
Oak Ridge National Laboratory	862	4.15E+1	5.30E+1	1.60E+3
Argonne National Laboratory-East	50	1.19E+0	1.94E-1	1.15E-1
RH-TRU Subtotal	4748	3.08E+2	3.69E+2	1.87E+3
Total	15,385	7.23E+2	1.33E+3	1.94E+3

[a] Rail shipments will not occur from these sites. The cumulative doses from truck shipment from these facilities are included in this option.
[b] Transportation crew.

Table C-10. Cumulative Radiological Doses for TRU Waste Shipments to the WIPP over the Lifetime of the WIPP Facility (person-rem), Concluded

Facility	Number of Shipments	Incident-Free Doses		Accident Dose Risk
		Worker[a]	Public	Public
CH Waste				
Dedicated Train				
Idaho National Engineering Laboratory	1274	6.47E+1	8.08E+1	8.01E-1
Rocky Flats Plant	68	5.15E-2	9.86E-2	1.97E-1
Hanford Reservation	654	4.58E+1	4.83E+1	7.06E-1
Savannah River Site	777	4.35E+1	8.94E+1	1.58E+1
Los Alamos National Laboratory[b]	2016	6.71E+1	3.63E+2	1.92E+1
Oak Ridge National Laboratory	35	1.67E+0	3.78E+0	3.57E-1
Nevada Test Site[b]	110	1.90E-1	4.64E-1	2.21E-2
Argonne National Laboratory-East	9	9.09E-3	1.51E-2	4.26E-3
Lawrence Livermore National Laboratory	16	2.02E-2	3.52E-2	2.70E-2
Mound Laboratory	8	1.02E-2	1.74E-2	2.08E-2
CH-TRU Subtotal	4967	2.23E+2	5.86E+2	3.71E+1
RH Waste				
Dedicated Train				
Idaho National Engineering Laboratory	37	1.51E+0	1.38E+0	5.11E+0
Hanford Reservation	1208	6.56E+1	5.07E+1	2.63E+2
Los Alamos National Laboratory[b]	105	3.50E+0	1.01E+1	4.57E+0
Oak Ridge National Laboratory	288	1.07E+1	1.77E+1	1.60E+3
Argonne National Laboratory-East	17	5.24E-1	6.39E-1	1.16E-1
RH-TRU Subtotal	1655	8.18E+1	8.05E+1	1.87E+3
Total	6622	3.05E+2	6.66E+2	1.91E+3

[a] Rail shipments will not occur from these sites. The cumulative doses from truck shipment from these facilities are included in this option.
[b] Transportation crew

Table C-11. Estimated Maximum Incident-Free Doses to Individuals (rem)

SITE	Truck Shipments							
	Worker					Public		
	Crew Member			Other				
	In-Transit	Stops	Total	Departure Inspections	State Inspections	Sharing Route	Adjacent to Route	Stops
Contact-Handled								
Idaho National Engineering Laboratory			1.00E + 1*	5.73E-1	4.68E + 0	1.60E-3	1.26E-3	3.82E-1
Rocky Flats Plant	1.06E-1	4.60E-2	1.62E-1	1.00E-3	8.16E-3	5.00E-6	2.23E-6	6.67E-4
Hanford Reservation			1.00E + 1*	4.10E + 0	3.28E + 1	2.09E-2	6.31E-3	2.73E + 0
Savannah River Site			1.00E + 1*	3.46E-1	3.17E + 0	1.70E-3	8.66E-4	2.64E-1
Los Alamos National Laboratory			1.00E + 1*	1.02E + 0	8.10E + 0	1.01E-2	2.22E-3	6.72E-1
Oak Ridge National Laboratory			1.00E + 1*	1.31E-1	1.08E + 0	1.31E-2	2.86E-4	6.73E-2
Nevada Test Site	6.19E-2	2.42E-2	7.61E-2	3.00E-4	2.20E-3	5.00E-6	6.01E-7	2.00E-4
Argonne National Laboratory-East	2.32E-2	9.81E-3	3.30E-2	1.00E-4	9.80E-4	5.00E-6	2.68E-7	6.67E-5
Lawrence Livermore National Laboratory	5.60E-2	2.41E-2	7.91E-2	2.60E-4	1.82E-3	5.00E-6	4.87E-7	1.67E-4
Mound Laboratory	2.49E-2	1.06E-2	3.54E-2	1.00E-4	9.60E-4	5.00E-6	2.62E-7	6.67E-5
Subtotal					4.97E + 1		1.09E-2	4.14E + 0
Remote-Handled								
Idaho National Engineering Laboratory			1.00E + 1*	1.11E-1	8.81E-1	1.01E-2	1.18E-4	7.41E-2
Hanford Reservation			1.00E + 1*	3.04E + 0	2.43E + 1	8.40E-3	3.27E-3	2.03E + 0
Los Alamos National Laboratory	8.26E-1	1.14E + 0	1.98E + 0	4.28E-2	3.69E-1	8.55E-3	4.82E-5	2.86E-2
Oak Ridge National Laboratory			1.00E + 1*	1.89E-1	1.52E + 0	2.20E-3	2.03E-4	1.26E-1
Argonne National Laboratory-East	2.29E + 0	1.20E + 0	3.49E + 0	1.23E-2	9.70E-2	2.46E-3	1.31E-6	8.17E-3
Subtotal					2.72E + 1		3.66E-3	2.27E + 0
TOTAL					7.69E + 1		1.46E-2	6.41E + 0

*Total individual crew member doses will be administratively controlled to 1 rem per year, giving a maximum ten-year career dose of 10 rem. Because doses will be administratively controlled, a breakout of individual crew doses for in-transit travel and stops is not provided.

Table C-11. Estimated Maximum Incident-Free Doses to Individuals (rem), Continued

SITE	Regular Train Shipments							
	Transportation Worker						Public	
	Crew Member			Other				
	In-Transit	Stops	Total	Yard Crew	Departure Inspections	State Inspections	Adjacent to Route	Stops
Contact-Handled								
Idaho National Engineering Laboratory	1.27E+0	2.05E-3	1.27E+0	4.84E-1	5.66E-1	2.18E+0	1.72E-3	2.00E-1
Rocky Flats Plant	5.35E-3	4.05E-5	5.39E-3	6.67E-4	9.00E-4	3.06E-3	2.43E-6	2.82E-4
Hanford Reservation	4.24E+0	3.50E-2	4.28E+0	3.46E+0	4.10E+0	1.50E+1	1.23E-2	1.43E+0
Savannah River Site	2.08E+0	1.15E-3	2.08E+0	3.33E-1	3.98E-1	1.50E+0	1.19E-3	1.38E-1
Los Alamos National Laboratory[b]			1.00E+1[a]	N/A	1.02E+0	8.10E+0	2.22E-3	6.72E-1
Oak Ridge National Laboratory	2.39E-1	7.63E-3	2.47E-1	1.11E-1	1.31E-1	3.96E-1	4.06E-4	4.72E-2
Nevada Test Site[b]	5.19E-2	2.42E-2	7.61E-2	N/A	3.00E-4	2.20E-3	6.01E-7	2.00E-4
Argonne National Laboratory-East	6.74E-4	6.91E-5	7.43E-4	6.67E-5	1.00E-4	3.75E-4	2.98E-7	3.45E-5
Lawrence Livermore National Laboratory	1.99E-3	8.41E-5	2.07E-3	1.33E-4	2.50E-4	6.90E-4	5.47E-7	6.35E-5
Mound Laboratory	6.20E-4	4.49E-5	6.65E-4	6.67E-5	1.00E-4	3.80E-4	2.86E-7	3.31E-5
Subtotal				4.39E+0		2.72E+1	1.78E-2	2.49E+0
Remote-Handled								
Idaho National Engineering Laboratory	2.88E-1	2.12E-2	3.10E-1	1.31E-1	1.11E-1	6.44E-1	2.75E-4	5.93E-2
Hanford Reservation	3.29E+0	2.17E-2	3.31E+0	3.96E+0	3.04E+0	1.78E+1	7.61E-3	1.64E+0
Los Alamos National Laboratory[b]	8.26E-1	1.14E+0	1.98E+0	N/A	4.28E-2	3.59E-1	4.82E-5	2.86E-2
Oak Ridge National Laboratory	1.10E+0	1.91E-3	1.11E+0	2.47E-1	1.89E-1	1.11E+0	4.75E-4	1.02E-1
Argonne National Laboratory-East	1.42E-1	6.63E-3	1.49E-1	1.92E-2	1.23E-2	7.20E-2	3.08E-6	6.62E-3
Subtotal				4.35E+0		2.00E+1	8.41E-3	1.84E+0
TOTAL				8.74E+0		4.72E+1	2.62E-3	4.33E+0

[a]Total individual crew member doses will be administratively controlled to 1 rem per year, giving a maximum ten-year career dose of 10 rem. Because doses will be administratively controlled, a breakout of individual crew doses for in-transit travel and stops is not provided.
[b]These sites do not currently have rail access. Truck transportation doses are reported.

Table C-11. Estimated Maximum Incident-Free Doses to Individuals (rem), Concluded

SITE	Dedicated Train Shipments							
	Transportation Worker						Public	
	Crew Member			Other				
	In-Transit	Stops	Total	Yard Crew	Departure Inspections	State Inspections	Adjacent to Route	Stops
Contact-Handled								
Idaho National Engineering Laboratory	3.17E+0	8.88E-5	3.17E+0	1.77E-1	5.66E-1	2.38E+0	1.72E-3	7.31E-3
Rocky Flats Plant	3.55E-3	4.17E-6	3.56E-3	5.20E-4	9.00E-4	7.96E-3	2.42E-6	2.44E-5
Hanford Reservation	2.51E+0	1.52E-3	2.51E+0	1.28E+0	4.10E+0	1.71E+1	1.24E-2	5.23E-2
Savannah River Site	1.20E+0	4.97E-5	1.20E+0	1.22E-1	3.96E-1	1.64E+0	1.19E-3	5.02E-3
Los Alamos National Laboratory[b]			1.00E+1[a]	N/A	1.02E+0	8.10E+0	2.22E-3	6.72E-1
Oak Ridge National Laboratory	5.09E-2	3.20E-4	5.12E-2	4.85E-2	1.31E-1	6.73E-1	4.13E-4	1.76E-3
Nevada Test Site[b]	5.19E-2	2.42E-2	7.61E-2	N/A	3.00E-4	2.20E-3	6.01E-7	2.00E-4
Argonne National Laboratory-East	2.02E-3	7.12E-6	2.03E-3	1.73E-4	1.00E-4	1.05E-3	3.20E-7	3.23E-6
Lawrence Livermore National Laboratory	2.45E-3	8.67E-6	2.46E-3	1.74E-4	2.50E-4	1.87E-3	5.70E-7	5.74E-6
Mound Laboratory	1.31E-3	4.62E-6	1.32E-3	1.73E-4	1.00E-4	9.36E-4	2.85E-7	2.87E-6
Subtotal				1.63E+0		2.99E+1	1.79E-2	7.39E-1
Remote-Handled								
Idaho National Engineering Laboratory	9.60E-2	8.41E-4	9.68E-2	5.25E-2	1.11E-1	6.56E-1	2.80E-4	2.01E-3
Hanford Reservation	2.53E+0	8.59E-4	2.53E+0	1.31E+0	3.04E+0	1.78E+1	7.61E-3	5.47E-2
Los Alamos National Laboratory[b]	8.26E-1	1.14E+0	1.98E+0	N/A	4.28E-2	3.59E-1	4.82E-5	2.85E-2
Oak Ridge National Laboratory	2.77E-1	7.55E-5	2.77E-1	8.03E-2	1.89E-1	1.11E+0	4.75E-4	3.42E-3
Argonne National Laboratory-East	6.16E-2	2.63E-4	6.19E-2	8.40E-3	1.23E-2	7.34E-2	3.13E-5	2.25E-4
Subtotal				1.45E+0		2.00E+1	8.45E-3	8.89E-2
TOTAL				3.08E+0		4.99E+1	2.63E-2	8.28E-1

[a]Total individual crew member doses will be administratively controlled to 1 rem per year, giving a maximum ten-year career dose of 10 rem. Because doses will be administratively controlled, a breakout of individual crew doses for in-transit travel and stops is not provided.
[b]These sites do not currently have rail access. Truck transportation doses are reported.

Table C-12. Consequence Comparison for TRU Waste Shipments Involved in Very Severe Accidents[a,b]

Transportation Option	Likely Incident Doses With Emergency Response[c] (person-rem; rem)	Possible Incident Doses With Delayed Emergency Response[d] (person-rem; rem)
CH-TRU Waste		
Truck	1.3E+0 (population dose) 3.2E-3 (maximum individual) 2.6E-5 (individual @ 1,000m)	3.2E+4 (population dose) 8.1E+1 (maximum individual) 6.6E-1 (individual @ 1,000m)
Regular Train	1.5E+0 (population dose) 4.4E-3 (maximum individual) 3.6E-5 (individual @ 1,000m)	1.5E+4 (population dose) 4.4E+1 (maximum individual) 3.6E-1 (individual @ 1,000m)
Dedicated Train	1.5E+0 (population dose) 4.4E-3 (maximum individual) 3.6E-5 (individual @ 1,000m)	1.5E+4 (population dose) 4.4E+1 (maximum individual) 3.6E-1 (individual @ 1,000m)
RH-TRU Waste		
Truck	2.2E+1 (population dose) 1.1E-1 (maximum individual) 9.4E-4 (individual @ 1,000m)	7.5E+5 (population dose) 3.8E+3 (maximum individual) 3.1E+1 (individual @ 1,000m)
Regular Train	1.5E+2 (population dose) 7.6E-1 (maximum individual) 6.3E-3 (individual @ 1,000m)	1.5E+6 (population dose) 7.6E+3 (maximum individual) 6.3E+1 (individual @ 1,000m)
Dedicated Train	4.5E+2 (population dose) 2.3E+0 (maximum individual) 1.9E-2 (individual @ 1,000m)	4.5E+6 (population dose) 2.3E+4 (maximum individual) 1.9E+2 (individual @ 1,000m)

[a] Based on RADTRAN 4 and TICLD calculated consequences for a postulated accident in an urban community.
[b] Incident doses presented are the maximum calculated consequences for each transportation option, considering all shipment origin sites.
[c] Emergency response actions occur in sufficient time to mitigate the initial accident sequence, with a postulated release and resulting consequence comparable to a category III severity accident.
[d] Emergency response actions are delayed until after the initial accident sequence is over, with a postulated release and resulting consequence comparable to a category VIII severity accident.

C.2 Hazardous Chemical Impacts

This section discusses potential chemical impacts from transporting TRU waste.

C.2.1 Hazardous Chemical Data Sources

The following documents were used to characterize TRU-mixed waste:

- *U.S. Department of Energy Interim Mixed Waste Inventory Report: Waste Streams, Treatment Capacities and Technologies* (DOE, 1993b)
- *Waste Isolation Pilot Plant, Resource Conservation and Recovery Act (RCRA) Part B Permit Application*, (DOE, 1993c)
- *Waste Isolation Pilot Plant, TRUPACT-II List of Chemical Compounds in each Content Code in TRUCON* (DOE, 1989b)

These three documents supported identification of the physical and chemical matrix of mixed TRU waste and provided a means to determine chemical nominal concentrations.

The following documents were used to obtain concentration limit parameters:

- *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices* (ACGIH, 1992)
- *Emergency Response Planning Guidelines* (AIHA, 1991)
- *29 CFR 1910.1000, Subpart Z – Toxic and Hazardous Substances;* Section 1910.1000, *Air Contaminants*
- *Emergency Planning for Extremely Hazardous Substances - Technical Guidance for Hazard Analysis* (EPA, 1987)
- *Toxic Chemical Hazard Classification and Risk Acceptance Guidelines for Use in DOE Facilities* (Craig et al., 1993)

C.2.2 Hazardous Chemical Analysis Methodology

The scope of this report is limited to the analysis of the transportation impacts from the gate of the shipment origin site to the gate of the WIPP facility. During this transportation segment, no handling of waste containers occurs, and hazardous chemical components of the waste are completely contained within the shipment package (i.e., TRUPACT-II or RH-72B). Because of the integrity and leak tightness of these Type B packages, it is concluded that the shipment of hazardous materials presents an insignificant hazard to workers and the public under incident-free transportation conditions. As discussed in Section C.1, while it is very unlikely that an accident will breach a Type B package, such an accident is credible and would have the potential of releasing hazardous chemicals to the environment.

An initial screening analysis was performed to identify potential chemicals for analysis under accident conditions. Table C-1 of the WIPP RCRA Part B Permit Application (DOE, 1993c) and the *TRUPACT-II List of Chemical Compounds in Each Content Code in TRUCON* (DOE, 1989b) were reviewed to identify chemicals found in CH-TRU waste streams for Idaho National Engineering Laboratory, Hanford, Rocky Flats Plant, and Savannah River Site. Waste streams from these sites are currently projected to constitute 87 percent of the CH-TRU waste to be emplaced at the WIPP. Chemicals were retained as candidates for analysis if an airborne concentration limit could be found for the chemical of interest. Concentration limits considered included:

- The EPA list of extremely hazardous substances having levels of concern (LOCs)
- OSHA permissible exposure limit (PEL) values
- American Industrial Hygiene Association Emergency Response Planning Guideline (ERPG) values
- American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLVs)

Following the initial screening analysis, chemicals were further ranked as to their potential health significance using a relative hazard value. The relative hazard value for each chemical was determined by dividing the hazard value for a given chemical by the maximum hazard value for all the chemicals in the respective table. The hazard value was calculated as the fraction (concentration) of the chemical in the waste matrix divided by the airborne concentration limit of the subject chemical. Thus, the higher a chemical concentration in a waste matrix or the lower its airborne concentration limit, the greater its potential hazard. ERPG-2 (Emergency Response Planning Guides-2) values were selected as the primary airborne concentration limit. ERPG values are intended for use as planning tools for assessing the adequacy of accident prevention and containment measures undertaken for chemical releases, for transportation emergency planning, and for the developing community emergency response plan (AIHA, 1989).

An ERPG-2 is defined as the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action (AIHA 1989). This is an appropriate exposure level for the public and is consistent with the recommendations in the DOT *1990 Emergency Response Guidebook* (DOT 1990).

Because there are few ERPG-2 values developed, a hierarchy of alternative values must be used. The hierarchy selected is presented in Table C-13 and is taken from

Table C-13. Hierarchy of Alternative Concentration-Limit Parameters

Primary Guideline	Hierarchy Group	Hierarchy of Alternative Guidelines	Source of Concentration Parameter
ERPG-3	1	EEGL (30-min) IDLH	AIHA NAS NIOSH
ERPG-2	2	EEGL (60-min) LOC PEL-C TLV-C TLV-TWA x 5	AIHA NAS EPA 29 CFR 1910.1000 ACGIH ACGIH
ERPG-1	3	PEL-STEL TLV-STEL TLV-TWA x 3	AIHA 29 CFR 1910.1000 ACGIH ACGIH
PEL-TWA	4	TLV-TWA SPEGL (60-min) CEGL	29 CFR 1910.1000 ACGIH NAS NAS

EEGL - Emergency Exposure Guidance Level
LOC - Level of Concern
PEL-C - Permissible Exposure Limit-Ceiling
TLV-C - Threshold Limit Value-Ceiling
TLV-TWA x 5 - Threshold Limit Value - Time Weighted Average

Toxic Chemical Hazard Classification and Risk Acceptance Guidelines for Use in D.O.E. Facilities (Craig et al., 1993). As this table shows, where ERPG-2 values were not available, Emergency Exposure Guidance Levels (EEGL, 60-min) were then used. If these were not developed for the chemical of concern, a Level of Concern (LOC) was used, and so on.

It is expected that metals would disperse differently than the other compounds in the waste matrix. As such, metals were evaluated separately from the other compounds.

Chemical concentrations were estimated using Table C-1 of the WIPP RCRA Part B Permit Application (DOE, 1993c) and the *TRUPACT-II List of Chemical Compounds in Each Content Code in TRUCON* (DOE, 1989b). These documents provide concentration values for chemicals in the various waste matrices. Chemicals were typically reported as either dominant (>10 weight percent), minor (1-10 weight percent), trace (<1 weight percent), trace 1 (< 0.1 weight percent) trace 2 [low parts per million [ppm] range], or trace 3 (<1 ppm by weight). The following concentration values were assigned for each category (percent by weight):

Dominant (D) - 0.3
Minor (M) - 0.10
Trace (T) - 0.01
Trace 1 (T1) - 0.001
Trace 2 (T2) - 0.0001
Trace 3 (T3) - no chemicals passing the initial screening were in this category.

The analysis used the highest reported nominal concentration for a given chemical, with the exception of cadmium, due to the variability of its concentration in the waste forms considered (maximum reported value is "D," value utilized is "M"). The results of the chemical relative hazard value are presented in Tables C-14 and C-15. All substances having a relative hazard value within 1 percent of the maximum relative risk value were retained for final analysis. The 20 chemicals that fell within 1 percent of the maximum hazard value are presented in Table C-16.

The chemical hazards assessment performed was based on a very severe shipment accident for each of the transportation options addressed in this report (truck, regular train, dedicated train). Maximum impacts were evaluated by assuming a severity VIII category accident and associated releases. The level of hazard was evaluated by comparing maximum airborne chemical concentration for a member of the public with ERPG-2 based concentration limits. ERPG-2 values are developed based on an anticipated 1-hour exposure. To address a postulated 2-hour exposure, the ERPG-2 value was halved to provide an adjusted ERPG-2 value. This is a more stringent exposure level for comparing 2-hour release concentration values with calculated chemical airborne concentrations. This comparison was accomplished by dividing the maximum calculated receptor concentrations for each chemical by the adjusted ERPG-2 value. Ratios smaller than unity indicate that exposures fall within health-based reference levels. Additionally, the individual chemical ratios were summed and compared to unity. This provides an indication of potential cumulative

Table C-14. Initial Screening Analyses of Chemical Constituents in CH-TRU Waste (Metals)

Chemical Name	CAS Number	Quantity Code	Fraction in Waste Matrix	ERPG-2 (ppm)	ERPG-2 Source	Hazard Value	Relative Hazard Value
Aluminum, as Al (welding fumes)	7429-90-5	D	0.3	25.00	a	1.20E-02	2.80E-03
Barium	7440-39-3	T	0.01	0.5	a	2.00E-02	4.66E-03
Barium sulfate	7727-43-7	M	0.1	5.50	a	1.82E-02	4.24E-03
Beryllium	7440-41-7	T	0.01	0.01	c	1.00E+00	2.33E-01
Cadmium (fume)	7440-43-9	D	0.3	0.07	b	4.29E+00	9.99E-01
Calcium oxide	1305-78-8	T	0.01	11	a	9.09E-04	2.12E-04
Chromium III compounds, as Cr		T	0.01	1.2	a	8.33E-03	1.94E-03
Chromium VI compounds, as Cr		T	0.01	0.1	a	1.00E-01	2.33E-02
Copper (fume)	7440-50-8	M	0.10	0.4	a	2.50E-01	5.83E-02
Fluorides, as F	Varies with compound	T	0.01	1.74	a	5.75E-03	1.34E-03
Lead	7439-92-1	D	0.3	0.09	a	3.33E+00	7.77E-01
Magnesium (oxide fume)	1309-48-4	T	0.01	30.5	a	3.28E-04	7.64E-05
Mercury (inorganic)	7439-97-6	T	0.01	0 01	b	1.00E+00	2.33E-01
Nickel	7440-02-0	T	0.01	21	d	4.76E-04	1.11E-04
Platinum	7440-06-4	M	0.1	0.5	a	2.00E-01	4.66E-02
Silver	7440-22-4	T	0.01	0 1	a	1.00E-01	2.33E-02
Tantalum	7440-22-4	T	0.01	3.5	a	2.86E-03	6.66E-04
Tungsten (sol. compounds as W)	7440-33-7	M	0.1	0.5	a	2.00E-01	4.66E-02
Uranium	7440-61-1	T	0.01	0.1	a	1.00E-01	2.33E02
Zinc (oxide fume)	1314-13-2	T	0.01	9.50	a	1.05E-03	2.45E-04
Zirconium	7440-67-7	T	0.01	6.5	a	1.54E-03	3.59E-04

a. TLV-TWA X5; b. PEL-C; c. ERPG-2; d. LOC

Table C-15. Initial Screening Analyses of Chemical Constituents in CH-TRU Waste (Non-Metals)

Chemical Name	CAS Number	Quantity Code	Fraction in Waste Matrix	ERPG-2 (ppm)	ERPG-2 Source	Hazard Value	Relative Hazard Value
Acetic acid	64-19-7	T1	0.001	50	a	2.00E-05	6.67E-05
Acetone	67-64-1	T	0.01	8500	c	1.18E-06	3.92E-06
Bromine	7726-95-6	T	0.01	1	c	1.00E-02	3.33E-02
n-Butanol (butyl alcohol)	71-36-3	T	0.01	50	b	2.00E-04	6.67E-04
Calcium hydroxide	1305-62-0	T	0.01	8.5	a	1.18E-03	3.92E-03
Carbon tetrachloride	56-23-5	D	0.3	25	b	1.20E-02	4.00E-02
Cellulose	9004-34-6	D	0.3	25	a	1.20E-02	4.00E-02
Chloroform	67-66-3	D	0.3	100	e	3.00E-03	1.00E-02
Chlorosulfonic acid	7790-94-5	T	0.01	2.1	c	4.76E-03	1.59E-02
Cyclohexane	110-82-7	T	0.01	1500	a	6.67E-06	2.22E-05
1,2-Dichloroethane (ethylene dichloride)	107-06-2	T1	0.001	100	b	1.00E-05	3.33E-05
Dichloromethane (methylene chloride)	75-09-2	T	0.01	1000	b	1.00E-05	3.33E-05
Ethanol	64-17-5	T	0.01	5000	a	2.00E-06	6.67E-06
Ethyl benzene	100-41-4	T2	0.0001	500	a	2.00E-07	6.67E-07
Ethyl ether	60-29-7	T	0.01	2000	a	5.00E-06	1.67E-05
Formic acid	64-18-6	T	0.01	25	a	4.00E-04	1.33E-03
Glycerin	56-81-5	T	0.01	13.5	e	7.41E-04	2.47E-03
Hexane	110-54-3	T	0.01	250	e	4.00E-05	1.33E-04
Hydrazine	302-01-2	T	0.01	0.8	c	1.25E-02	4.17E-02
Hydrogen peroxide	7722-84-1	T	0.01	7.2	d	1.39E-03	4.63E-03
Isopropanol (isopropyl alcohol)	67-63-0	T	0.01	2000	a	5.00E-06	1.67E-05

a: TLV-TWA X5; b: PEL-C; c: ERPG-2; d: LOC; e: EEGL (60-min)

Table C-15. Initial Screening Analyses of Chemical Constituents in CH-TRU Waste (Non-Metals), Concluded

Chemical Name	CAS Number	Quantity Code	Fraction in Waste Matrix	ERPG-2 (ppm)	ERPG-2 Source	Hazard Value	Relative Hazard Value
Methanol (methyl alcohol)	67-56-1	T	0.01	200	e	5.00E-05	1.67E-04
Methyl ethyl ketone (2-butanone)	78-93-3	T	0.01	1000	a	1.00E-05	3.33E-05
Methyl isobutyl ketone (hexone)	108-10-1	T	0.01	250	a	4.00E-05	1.33E-04
Methylene chloride	75-09-2	T	0.01	1000	b	1.00E-05	3.33E-05
Naphtha (naphthalene)	91-20-3	T	0.01	50	a	2.00E-04	6.67E-04
Nonane	111-84-2	T	0.01	1000	a	1.00E-05	3.33E-05
Nitric acid	7697-37-2	T	0.01	10	d	1.00E-03	3.33E-03
Oxalic acid	144-62-7	T	0.01	1.5	a	6.67E-03	2.22E-02
Pentane	109-66-0	T	0.01	3000	a	3.33E-06	1.11E-05
Phosphoric acid	7664-38-2	T	0.01	1.5	a	6.67E-03	2.22E-02
Sodium hydroxide	1310-73-2	T	0.01	1.2	b	8.33E-03	2.78E-02
Sulfuric acid	7664-93-9	T	0.01	10	c	1.00E-03	3.33E-03
1,1,2,2,-Tetrachloroethane	79-34-5	T1	0.001	5	a	2.00E-04	6.67E-04
Tetrachloroethylene	127-18-4	T	0.01	200	b	5.00E-05	1.67E-04
Toluene	108-88-3	T	0.01	250	a	4.00E-05	1.33E-04
Tributyl phosphate	126-73-8	D	0.3	1	a	3.00E-01	1.00E+00
1,1,1,-Trichloroethane (methyl chloroform)	71-55-6	D	0.3	1750	a	1.71E-04	5.71E-04
Trichloroethylene	79-01-6	T	0.01	200	b	5.00E-05	1.67E-04
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	M	0.1	5000	a	2.00E-05	6.67E-05
Trimethylbenzene	25551-13-7	M	0.1	125	a	8.00E-04	2.67E-03
Xylene	1330-20-7	D	0.3	200	e	1.50E-03	5.00E-03

a: TLV-TWA X5; b: PEL-C; c: ERPG-2; d: LOC; e: EEGL (60-min)

Table C-16. Selection of Chemical Constituents in CH-TRU Waste for Further Analysis

Chemical Name	CAS Number	Quantity Code	Fraction in Waste Matrix	ERPG-2 (ppm)	ERPG-2 Source	Hazard Value	Relative Hazard Value
Beryllium	7440-41-7	T	0.01	0.01	c	1.00E+00	2.33E-01
Bromine	7726-95-6	T	0.01	1	c	1.00E-02	3.33E-02
Cadmium (fume)	7440-43-9	D	0.3	0.07	b	4.29E+00	9.99E-01
Carbon tetrachloride	56-23-5	D	0.3	25	b	1.20E-02	4.00E-02
Cellulose	9004-34-6	D	0.3	25	a	1.20E-02	4.00E-02
Chloroform	67-66-3	D	0.3	100	d	3.00E-03	1.00E-02
Chlorosulfonic acid	7790-94-5	T	0.01	2.1	c	4.76E-03	1.59E-02
Chromium VI compounds, as Cr		T	0.01	0.1	a	1.00E-01	2.33E-02
Copper (fume)	7440-50-8	M	0.10	0.4	a	2.50E-01	5.83E-02
Hydrazine	302-01-2	T	0.01	0.8	c	1.25E-02	4.17E-02
Lead	7439-92-1	D	0.3	0.09	a	3.33E+00	7.77E-01
Mercury (inorganic)	7439-97-6	T	0.01	0.01	b	1.00E+00	2.33E-01
Oxalic acid	144-62-7	T	0.01	1.5	a	6 67E 03	2.22E 02
Platinum	7440-06-4	M	0.1	0.5	a	2.00E-01	4.66E-02
Phosphoric acid	7664-38-2	T	0.01	1.5	a	6.67E-03	2.22E-02
Silver	7440-22-4	T	0.01	0.1	a	1.00E-01	2.33E-02
Sodium hydroxide	1310-73-2	T	0.01	1.2	b	8.33E-03	2.78E-02
Tributyl phosphate	126-73-8	D	0.3	1	a	3.00E-01	1.00E+00
Tungsten (sol. compounds as W)	7440-33-7	M	0.1	0.5	a	2.00E-01	4.66E-02
Uranium	7440-61-1	T	0.01	0.1	a	1.00E-01	2.33E-02

a. TLV-TWA X5; b. PEL-C; c. ERPG-2; d. LOC effects for exposure to multiple chemicals even though it does not take into consideration possible synergistic effects among the chemicals.

Airborne chemical concentrations for the maximally exposed member of the public were determined using the Gaussian Plume equation of Pasquill as modified by Gifford (1961) for ground-level concentrations at the centerline of the plume:

$$\chi = [Q/(\pi\, \sigma_y \sigma_z\, \mu)]\ \exp\ [-.5\ (H/\sigma_z 0)^2],$$

where

χ = contaminant airborne concentration at x meters downwind, mg/m^3
Q = contaminant release rate, mg/m^3
μ = mean wind speed, m/sec
σ_y = horizontal dispersion coefficient, m
σ_z = vertical dispersion coefficient, m
H = effective release height, m.

The above equation does not incorporate plume depletion effects from particulate settlement (by gravitational or chemical effects) and thus will overstate air concentrations and resulting inhalation exposures. Additionally, each accident was postulated to occur during a period having very stable atmospheric meteorological conditions (Pasquill Stability Class F, wind speed of 1 m/sec). Use of these unfavorable meteorological conditions introduce additional conservatisms into the analysis.

The following short-term dispersion coefficients (Slade, 1968) were incorporated in the Gaussian Plume-Dispersion equation:

$\sigma_y = 0.02\ (x)^{.89}$
$\sigma_z = 0.05\ (x)^{.61}$
x = downwind distance, m

The effective height (H) of the accident plume was estimated as approximately 21 meters. This takes into consideration the buoyancy rise associated with the thermal effects from the accident. Thermal effects (e.g., hydrocarbon fuel fire) are expected to play a major role in any loss of containment scenario. The buoyancy rise was determined using a heat emission of 8.3E+04 $watts/m^2$, based on hydrocarbon fuel fire tests (Gregory et al., 1987).

Quantities of hazardous constituents released during the maximum accident were determined using the following assumptions and bases:

- A severity category VIII accident occurs, resulting in a breach of multiple packages, and involves both impact and thermal release mechanisms as discussed in Section C.1.

- Based on the analysis presented in Section C.1, all three TRUPACT-IIs in a truck shipment and up to six TRUPACT-IIs in a train shipment are postulated to experience accident conditions more severe than certification test conditions and potentially fail.

- The material-at-risk and potentially available for release for a postulated accident is 309 cubic feet (8.75 cubic meters) for CH-TRU truck shipments and 617 cubic feet (17.5 cubic meters) for CH-TRU regular train and dedicated train shipments. This is based on an individual TRUPACT-II package capacity of 102 cubic feet (2.9 cubic meters).

- The CH-TRU waste matrix has a density of 37 lb/ft^3 (600 kg/m^3). This is based on limited data presented in the *Interim Mixed Waste Inventory Report* (DOE, 1993b), which identifies applicable waste form densities ranging from 0.1 lb/ft^3 (64 kg/m^3) to 63.9 lb/ft^3 (1,023 kg/m^3).

- Chemicals released as respirable particulate matter will have a release fraction of 0.0002 to the environment, as determined for the radiological analysis.

- Chemicals released as vapors will have a release fraction dependent on their vapor pressure at the internal temperature conditions of the TRUPACT-II.

- The fraction of a TRU waste shipment containing the hazardous chemicals of interest was determined on a system-wide-average basis.

The *Interim Mixed Waste Inventory Report* (DOE, 1993b) (Chapter 4.0, Table 4-1, and site waste profile sheets) was used to estimate the fraction of CH-TRU waste volume (or shipment) for which each hazardous constituent of interest is present.

Based on the relative shipment capacity of the TRUPACT-II and RH-72B (2.9 m^3 versus 0.89 m^3) and the chemical characterization data presented in the *Interim Mixed Waste Inventory Report* (DOE, 1993b), it is concluded that hazardous consituent accident analyses for CH-TRU waste shipments are bounding for RH-TRU waste shipments.

C.2.3 Hazardous Chemical Analysis Results

Results of the chemical hazard assessment are presented in Table C-17. The comparison of predicted receptor concentrations with adjusted ERPG-2 values is accomplished by dividing the calculated receptor concentration by the adjusted ERPG-2 value. Ratios smaller than unity indicate that exposures fall within health-based reference levels. For the truck shipment option, it is seen that individual and combined chemical exposure ratios are less than unity; thus, the maximum exposure

Table C-17. Comparison of Maximum Calculated Chemical Airborne Concentrations with Emergency Response Guidelines for a Severe Accident[a]

CH-TRU Truck Shipment								
Chemical	Release Form	Release Fraction[b]	Fraction of Waste Chemical is Present	Chemical Fraction in Waste Matrix	Quantity Released (mg)	Receptor Concentration[c] (mg/m³)	Adjusted ERPG-2 Value (mg/m³)	Receptor Concen. Adj. ERPG-2
Beryllium	Particulate	2.0E-04	2.1E-01	1.0E-02	2.2E+03	3.4E-05	2.5E-03	1.4E-02
Bromine	Vapor	5.0E.01	6.6E-02	1.0E-02	1.7E+07	2.7E-01	3.3E+00	8.2E-02
Cadmium	Particulate Vapor	2.0E-04 1.6E-02	1.9E-01 1.9E-01	3.0E-01 3.0E-01	2.0E+04 1.6E+06	3.1E-04 2.5E-02	1.5E-01 1.5E-01	2.1E-03 1.7E-01
Carbon tetrachloride	Vapor	5.0E-01	1.3E-01	3.0E-01	1.0E+08	1.6E+00	7.9E+01	2.0E-02
Cellulose	Particulate	2.0E-02	9.1E-02	3.0E-01	2.9E+06	4.5E-02	2.5E+01	1.8E-03
Chloroform	Vapor	5.0E-01	6.0E-03	3.0E-01	4.7E+06	7.4E-02	2.4E+02	3.1E-04
Chlorosulfonic acid	Vapor	5.0E-01	1.8E-01	1.0E-02	4.7E+06	7.4E-02	5.0E+00	1.5E-02
Chromium VI compounds	Particulate	2.0E-04	1.9E-01	1.0E-02	2.0E+03	3.1E-05	1.3E-01	2.4E-04
Copper	Particulate	2.0E-04	1.9E-01	1.0E-01	2.0E+04	3.1E-04	5.0E-01	6.2E-04
Hydrazine	Vapor	5.0E-01	1.3E-01	1.0E-02	3.4E+06	5.3E-02	5.5E-01	9.7E-02
Lead	Particulate	2.0E-04	1.9E-01	3.0E-01	6.0E+04	9.3E-04	3.8E-01	2.5E-03
Mercury	Vapor	5.0E-01	3.6E-02	1.0E-02	9.4E+05	1.5E-02	5.0E-02	2.9E-01
Oxalic acid	Vapor	5.0E-01	1.8E-01	1.0E-02	4.7E+06	7.4E-02	2.5E+00	2.9E-02
Platinum	Particulate	2.0E-04	2.8E-01	1.0E-01	2.9E+04	4.6E-04	2.5E+00	1.8E-04
Phosphoric acid	Particulate	2.0E-04	6.0E-03	1.0E-02	6.6E+01	1.0E-06	2.5E+00	4.1E-07
Silver	Particulate	2.0E-04	1.5E-01	1.0E-02	1.6E+03	2.5E-05	2.5E-01	9.8E-05
Sodium hydroxide	Particulate	2.0E-04	1.6E-01	1.0E-02	1.7E+03	2.6E-05	1.0E+00	2.6E-05
Tributyl phosphate	Vapor	5.0E-01	2.4E-02	3.0E-01	1.9E+07	2.9E-01	5.5E+00	5.4E-02
Tungsten	Particulate	2.0E-04	1.9E-01	1.0E-01	2.0E+04	3.1E-04	2.5E+00	1.2E-04
Uranium	Particulate	2.0E-04	1.5E-01	1.0E-02	1.6E+03	2.5E-05	5.0E-01	4.9E-05
						TOTAL		7.8E-01

[a] Assumes a severity category VIII accident.
[b] See text for basis for release fractions.
[c] The receptor is the maximum exposed member of the public with downwind dispersion characteristics bas on a wind speed of 1 meter/sec and Pasquill Stability Class F.

Table C-17. Comparison of Maximum Calculated Chemical Airborne Concentrations with Emergency Response Guidelines for a Severe Accident, Concluded

CH-TRU Train Shipment								
Chemical	Release Form	Release Fraction[b]	Fraction of Waste Chemical is Present	Chemical Fraction in Waste Matrix	Quantity Released (mg)	Receptor Concentration[c] (mg/m^3)	Adjusted ERPG-2 Value (ms/m^3)	Recep. Conc. Adj. ERPG-2
Beryllium	Particulate	2.0E-04	2.1E-01	1.0E-02	4.4E+03	6.9E-05	2.5E-03	2.8E-02
Bromine	Vapor	5.0E-01	6.6E-02	1.0E-02	3.5E+06	5.4E-02	3.3E+00	1.6E-02
Cadmium	Particulate Vapor	2.0E-04 1.6E-02	1.9E-01 1.9E-01	1.0E-01 1.0E-01	4.0E+04 3.2E+06	6.2E-04 5.0E-02	1.5E-01 1.5E-01	4.2E-03 3.3E-01
Carbon tetrachloride	Vapor	5.0E-01	1.3E-01	3.0E-01	2.1E+08	3.2E+00	7.9E+01	4.0E-02
Cellulose	Particulate	2.0E-02	9.1E-02	3.0E-01	5.7E+06	8.9E-02	2.5E+01	3.6E-03
Chloroform	Vapor	5.0E-01	6.0E-03	3.0E-01	9.5E+06	1.5E-01	2.4E+02	6.1E-04
Chlorosulfonic acid	Vapor	5.0E-01	1.8E-01	1.0E-02	9.5E+06	1.5E-01	5.0E+00	3.0E-02
Chromium VI compounds	Particulate	2.0E-04	1.9E-01	1.0E-02	4.0E+03	6.2E-05	1.3E-01	4.8E-04
Copper	Particulate	2.0E-04	1.9E-01	1.0E-01	4.0E+04	6.2E-04	5.0E-01	1.2E-03
Hydrazine	Vapor	5.0E-01	1.3E-01	1.0E-02	6.8E+06	1.1E-01	5.5E-01	1.9E-01
Lead	Particulate	2.0E-04	1.9E-01	3.0E-01	1.2E+05	1.9E-03	3.8E-01	4.9E-03
Mercury	Vapor	5.0E-01	3.6E-02	1.0E-02	1.9E+06	2.9E-02	5.0E-02	5.8E-01
Oxalic acid	Vapor	5.0E+-01	1.8E-01	1.0E-02	9.5E+06	1.5E-01	2.5E+00	5.9E-02
Platinum	Particulate	2.0E-04	2.8E-01	1.0E-01	5.9E+04	9.2E-04	2.5E+00	3.7E-04
Phosphoric acid	Particulate	2.0E-04	6.0E-03	1.0E-02	1.3E+02	2.1E-06	2.5E+00	8.2E-07
Silver	Particulate	2.0E-04	1.5E-01	1.0E-02	3.2E+03	4.9E-05	2.5E-01	2.0E-04
Sodium hydroxide	Particulate	2.0E-04	1.6E-01	1.0E-02	3.4E+03	5.2E-05	1.0E+00	5.2E-05
Tributyl phosphate	Vapor	5.0E-01	2.4E-02	3.0E-01	3.8E+07	5.9E-01	5.5E+00	1.1E-01
Tungsten	Particulate	2.0E-04	1.9E-01	1.0E-01	4.0E+04	6.2E-04	2.5E+00	2.5E-04
Uranium	Particulate	2.0E-04	1.5E-01	1.0E-02	3.2E+03	4.9E-05	5.0E-01	9.8E-05
						TOTAL		1.56E+00

Assumes a severity category VIII accident.
See text for basis for release fractions.
The receptor is the maximum exposed member of the public with downwind dispersion characteristics based on a wind speed of 1 meter/sec and Pasquill Stability Class F.

to a member of the public is acceptable and is within health-based reference levels. For the train options (same hazard levels), whereas the individual chemical exposure ratios are less than unity, the combined chemical exposure ratios are slightly greater than unity. Considering the conservatisms in the analysis as previously cited, with no credit taken for thermal destruction of volatile organic compounds, and the small margin by which unity is exceeded, it may be concluded that the maximum exposure to a member of the public for the train options also falls within health-based reference levels and is acceptable.

C.3 Nonradiological/Nonchemical Impacts

This section discusses nonradiological and nonchemical impacts of transporting TRU waste to the WIPP. These impacts are the same as those resulting from transporting nonnuclear and nonhazardous materials and involve traumatic injuries and fatalities from transportation accidents and latent health effects from vehicle emissions. Nonradiological and nonchemical impacts are independent of the characteristics of the cargo.

There are two types of nonradiological and nonchemical impacts associated with projected TRU waste shipments. These are risks resulting from normal transportation and risks resulting from transportation accidents. Normal risks include the health risks in vehicles during waste shipments. Transportation accident risks include injuries and fatalities resulting from shipments that are totally unrelated to radiological and hazardous chemical risks resulting from projected accidents.

The methodology presented in the SEIS (DOE, 1990a) was used to estimate the range of nonradiological and nonchemical risks. The risks of adverse urban area pollutant health effects and accident-related injuries and fatalities were calculated on a per-shipment basis and a cumulative basis from unit risk factors described by Sandia National Laboratories (Cashwell et al., 1986). These data (see Table C-18) were based on heavy truck and Class A rail statistics from the DOT Research and Special Programs Administration.

Table C-18. Nonradiological and Nonchemical Unit Risk Factors[a]

Mode	Zone	LCF/Mile[b]	Injuries/Mile[b]	Fatalities/Mile[b]
Truck	Rural	0	1.33E-6	1.09E-7
	Suburban	0	6.32E-7	2.69E-8
	Urban	1.6E-7	6.16E-7	1.54E-8
Rail	Rural	0	4.78E-7	4.54E-8
	Suburban	0	4.78E-7	4.54E-8
	Urban	2.1E-7	4.78E-7	4.54E-8

[a] Air pollutant unit consequence factors.
[b] LCF - Latent cancer fatalities.

Estimates of per-shipment risk include the probability of adverse urban area pollutant health effects and accident-related injuries and fatalities of a single TRU waste shipment (round trip) to the WIPP. Cumulative risk estimates were determined by multiplying per-shipment risks by average annual shipments. The estimated total number of shipments, truck and both rail cases, are summarized in Appendix B.

Calculated per-shipment nonradiological and nonchemical risks for CH-TRU and RH-TRU shipments to the WIPP are summarized in Table C-19. These risks include the impact of the return trip by either truck or rail from the WIPP to the generator or storage facility. Each travel mode alternative assumes the uniform maximum use of that mode by all facilities. Therefore, the mode alternatives are labeled as 100-percent truck and maximum rail, for those facilities that have access to rail. Los Alamos National Laboratory and the Nevada Test Site do not have access to rail, and, thus, truck mode risks for these two facilities are listed with the maximum rail risks for the purpose of estimating the cumulative risk.

Total cumulative nonradiological and nonchemical CH-TRU and RH-TRU transportation risks are summarized in Table C-20 for the 20-year disposal phase.

Table C-19. Nonradiological/Nonchemical Per-Shipment Risk

		TRUCK			TRAIN		
		Incident Case			Incident Case		
Facility	Zone	Normal Transportation LCF	Injuries	Fatalities	Normal Transportation LCF	Injuries	Fatalities
INEL	Rural	0.00E+0	3.34E-3	2.74E-4	0.00E+0	1.52E-3	1.44E-4
	Suburban	0.00E+0	1.42E-4	6.03E-6	0.00E+0	1.16E-4	1.10E-5
	Urban	4.80E-6	1.85E-5	4.62E-7	7.98E-6	1.82E-5	1.73E-6
RFP	Rural	0.00E+0	1.61E-3	1.32E-4	0.00E+0	8.31E-4	7.89E-5
	Suburban	0.00E+0	8.22E-5	3.50E-6	0.00E+0	8.22E-5	7.81E-6
	Urban	4.80E-6	1.85E-5	4.62E-7	9.24E-6	2.10E-5	2.00E-6
HANFORD	Rural	0.00E+0	4.42E-3	3.62E-4	0.00E+0	2.03E-3	1.93E-4
	Suburban	0.00E+0	1.72E-4	7.32E-6	0.00E+0	1.45E-4	1.38E-5
	Urban	6.40E-6	2.46E-5	6.16E-7	1.01E-5	2.26E-5	2.18E-6
SRS	Rural	0.00E+0	3.89E-3	3.19E-4	0.00E+0	1.35E-3	1.28E-4
	Suburban	0.00E+0	3.75E-4	1.60E-5	0.00E+0	3.49E-4	3.31E-5
	Urban	9.60E-6	3.70E-5	9.24E-7	2.52E-5	5.74E-5	5.45E-6
LANL	Rural	0.00E+0	9.58E-4	7.85E-5		a	
	Suburban	0.00E+0	3.79E-5	1.61E-6			
	Urban	2.24E-6	8.62E-6	2.16E-7			
ORNL	Rural	0.00E+0	3.51E-3	2.88E-4	0.00E+0	1.14E-3	1.08E-4
	Suburban	0.00E+0	2.38E-4	1.01E-5	0.00E+0	3.18E-4	3.02E-5
	Urban	6.40E-6	2.46E-5	6.16E-7	1.93E-5	4.40E-5	4.18E-6
NTS	Rural	0.00E+0	3.02E-3	2.47E-4		a	
	Suburban	0.00E+0	6.70E-5	2.85E-6			
	Urban	5.12E-6	1.97E-5	4.93E-7			
ANL-E	Rural	0.00E+0	3.29E-3	2.70E-4	0.00E+0	1.11E-3	1.05E-4
	Suburban	0.00E+0	2.63E-4	1.12E-5	0.00E+0	1.23E-4	1.17E-5
	Urban	5.76E-6	2.22E-5	5.54E-7	7.14E-6	1.63E-5	1.54E-6
LLNL	Rural	0.00E+0	2.59E-3	2.83E-4	0.00E+0	1.41E-3	1.34E-4
	Suburban	0.00E+0	1.19E-4	5.06E-6	0.00E+0	1.24E-4	1.18E-5
	Urban	1.47E-5	5.67E-5	1.42E-6	1.22E-5	2.77E-5	2.63E-6
MOUND	Rural	0.00E+0	3.51E-3	2.87E-4	0.00E+0	1.34E-3	1.27E-4
	Suburban	0.00E+0	2.78E-4	1.18E-5	0.00E+0	2.12E-4	2.02E-5
	Urban	7.36E-6	2.83E-5	7.08E-7	1.39E-5	3.15E-5	3.00E-6

a Rail shipments do not occur from these facilities.

Table C-20. Total Cumulative Nonradiological/Nonchemical Transportation Risks

Facility	Zone	Number of Shipments	Normal Transportation LCF	Injuries	Fatalities
CH TRUCK					
INEL	Rural	7639	0.00E+0	2.55E+1	2.10E+0
	Suburban		0.00E+0	1.08E+0	4.61E-2
	Urban		3.67E-2	1.42E-1	3.53E-3
RFP	Rural	408	0.00E+0	6.57E-1	5.39E-2
	Suburban		0.00E+0	3.35E-2	1.43E-3
	Urban		1.96E-3	7.55E-3	1.88E-4
HANFORD	Rural	3920	0.00E+0	1.73E+1	1.54E+0
	Suburban		0.00E+0	6.74E-1	2.87E-2
	Urban		2.51E-2	9.64E-2	2.41E-3
SRS	Rural	4658	0.00E+0	1.81E+1	1.54E+0
	Suburban		0.00E+0	1.75E+0	7.27E-2
	Urban		4.47E-2	1.72E-1	4.30E-3
LANL	Rural	2016	0.00E+0	1.93E+0	1.59E-1
	Suburban		0.00E+0	7.64E-2	1.25E-3
	Urban		4.52E-3	1.74E-2	4.35E-4
ORNL	Rural	206	0.00E+0	7.23E-1	5.93E-2
	Suburban		0.00E+0	4.90E-2	2.08E-3
	Urban		1.32E-3	5.07E-3	1.27E-4
NTS	Rural	110	0.00E+0	3.32E-1	2.72E-2
	Suburban		0.00E+0	7.37E-3	3.14E-4
	Urban		5.63E-4	2.17E-3	5.42E-5
ANL-E	Rural	49	0.00E+0	1.61E-1	1.32E-2
	Suburban		0.00E+0	1.29E-2	5.49E-4
	Urban		2.82E-4	1.09E-3	2.71E-5
LLNL	Rural	91	0.00E+0	2.36E-1	2.58E-2
	Suburban		0.00E+0	1.08E-2	4.60E-4
	Urban		1.34E-3	5.16E-3	1.29E-4
MOUND	Rural	48	0.00E+0	1.68E-1	1.38E-2
	Suburban		0.00E+0	1.33E-2	5.66E-4
	Urban		3.53E-4	1.36E-3	3.40E-5
Subtotal			1.17-1	6.92+1	4.01E+0

Table C-20. Total Cumulative Nonradiological/Nonchemical Transportation Risks, Continued

		DISPOSAL PHASE			
Facility	Zone	Number of Shipments	Normal Transportation LCF	Injuries	Fatalities
RH TRUCK					
INEL	Rural	218	0.00E+0	7.28E-1	5.97E-2
	Suburban		0.00E+0	3.10E-2	1.31E-3
	Urban		1.05E-3	4.03E-3	1.01E-4
HANFORD	Rural	7244	0.00E+0	3.20E+1	2.62E+0
	Suburban		0.00E+0	1.25E+0	5.30E-2
	Urban		4.64E-2	1.78E-1	4.46E-3
ORNL	Rural	1723	0.00E+0	6.27E+0	5.13E-1
	Suburban		0.00E+0	4.12E-1	1.76E-2
	Urban		1.05E-2	4.03E-2	1.01E-3
ANL-E	Rural	99	0.00E+0	3.39E-1	2.78E-3
	Suburban		0.00E+0	2.62E-2	1.12E-3
	Urban		5.70E-4	2.20E-3	5.48E-5
LANL	Rural	105	0.00E+0	1.01E-1	8.24E-3
	Suburban		0.00E+0	3.98E-3	1.69E-4
	Urban		2.35E-4	9.05E-4	2.27E-5
Subtotal			5.88E-2	4.14E+1	3.29E+0
TOTAL			1.75E-1	1.10E+2	7.30E+0

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3 of 3

Table C-20. Total Cumulative Nonradiological/Nonchemical Transportation Risks, Continued

			Regular Train DISPOSAL PHASE		
Facility	Zone	Number of Shipments	Normal Transportation LCF	Injuries	Fatalities
CH TR.ˑIN					
INEL	Rural	3820	0.00E+0	5.81E+0	5.50E-1
	Suburban		0.00E+0	4.43E-1	4.20E-2
	Urban		3.05E-2	6.95E-2	6.61E-3
RFP	Rural	204	0.00E+0	1.70E-1	1.61E-2
	Suburban		0.00E+0	1.68E-2	1.59E-3
	Urban		1.88E-3	4.28E-3	4.08E-4
HANFORD	Rural	1960	0.00E+0	3.98E+0	3.78E-1
	Suburban		0.00E+0	2.84E-1	2.70E-2
	Urban		1.98E-2	4.49E-2	4.27E-3
SRS	Rural	2329	0.00E+0	3.14E+1	2.98E-1
	Suburban		0.00E+0	8.13E+0	7.71E-2
	Urban		5.87E-1	1.34E-1	1.27E-2
LANL	Rural	2016	0.00E+0	1.93E+0	1.58E-1
	Suburban		0.00E+0	7.64E-2	3.25E-3
	Urban		4.52E-3	1.74E-2	4.35E-4
ORNL	Rural	103	0.00E+0	1.17E-1	1.11E-2
	Suburban		0.00E+0	3.28E-2	3.11E-3
	Urban		1.99E-3	4.53E-3	4.31E-4
NTS	Rural	110	0.00E+0	3.32E-1	2.72E-2
	Suburban		0.00E+0	7.37E-3	3.14E-4
	Urban		5.63E-4	2.17E-3	5.42E-5
ANL-E	Rural	25	0.00E+0	2.78E-2	2.63E-3
	Suburban		0.00E+0	3.08E-3	2.93E-4
	Urban		1.79E-4	4.08E-4	3.85E-5
LLNL	Rural	46	0.00E+0	6.49E-2	6.16E-3
	Suburban		0.00E+0	5.70E-3	5.43E-4
	Urban		5.61E-4	1.27E-3	1.21E-4

Table C-20. Total Cumulative Nonradiological/Nonchemical Transportation Risks, Continued

			Regular Train		
Facility	Zone	Number of Shipments	Normal Transportation LCF	Injuries	Fatalities
MOUND	Rural	24	0.00E+0	3.22E-2	3.05E-3
	Suburban		0.00E+0	5.09E-3	4.85E-4
	Urban		3.34E-4	7.56E-4	7.20E-5
Subtotal			6.48E-1	5.32E+1	1.63E+0
RH TRAIN					
INEL	Rural	109	0.00E+0	1.66E-1	1.57E-2
	Suburban		0.00E+0	1.26E-2	1.20E-3
	Urban		8.70E-4	1.98E-3	1.89E-4
HANFORD	Rural	3622	0.00E+0	7.35E+0	6.99E-1
	Suburban		0.00E+0	5.25E-1	5.00E-2
	Urban		3.66E-2	8.16E-2	7.90E-3
ORNL	Rural	862	0.00E+0	9.83E-1	9.31E-2
	Suburban		0.00E+0	2.74E-1	2.60E-2
	Urban		1.62E-2	3.79E-2	3.60E-3
ANL-E	Rural	50	0.00E+0	5.55E-2	5.25E-3
	Suburban		0.00E+0	6.15E-3	5.85E-4
	Urban		3.57E-4	8.15E-4	7.70E-5
LANL	Rural	105	0.00E+0	1.00E-1	8.23E-3
	Suburban		0.00E+0	3.98E-3	1.69E-4
	Urban		2.52E-4	2.52E-5	2.43E-5
Subtotal			5.43E-2	9.60E+0	9.11E-1
TOTAL			7.02E-1	6.28E+1	2.54E+0

Table C-20. Total Cumulative Nonradiological/Nonchemical Transportation Risks, Continued

		Dedicated Train			
Facility	Zone	Number of Shipments	Normal Transportation LCF	Injuries	Fatalities
CH TRAIN					
INEL	Rural	1274	0.00E+0	1.94E+0	1.83E-1
	Suburban		0.00E+0	1.48E-1	1.40E-2
	Urban		1.02E-2	2.32E-2	2.20E-3
RFP	Rural	68	0.00E+0	5.65E-2	5.37E-3
	Suburban		0.00E+0	5.59E-3	5.31E-4
	Urban		6.28E-4	1.43E-3	1.36E-4
HANFORD	Rural	554	0.00E+0	1.33E+0	1.26E-1
	Suburban		0.00E+0	9.48E-2	9.03E-3
	Urban		6.61E-3	1.50E-2	1.43E-3
SRS	Rural	777	0.00E+0	1.05E+0	9.95E-2
	Suburban		0.00E+0	2.71E-1	2.57E-2
	Urban		1.96E-2	4.46E-2	4.23E-3
LANL	Rural	2016	0.00E+0	1.93E+0	1.58E-1
	Suburban		0.00E+0	7.64E-2	3.25E-3
	Urban		4.52E-3	1.74E-2	4.35E-4
ORNL	Rural	35	0.00E+0	3.99E-2	3.78E-3
	Suburban		0.00E+0	1.11E-2	1.06E-3
	Urban		6.76E-4	1.54E-3	1.46E-4
NTS	Rural	110*	0.00E+0	3.32E-1	2.72E-2
	Suburban		0.00E+0	7.37E-3	3.14E-4
	Urban		5.63E-4	2.17E-3	5.42E-5
ANL-E	Rural	9	0.00E+0	9.99E-5	9.45E-4
	Suburban		0.00E+0	1.11E-3	1.05E-4
	Urban		6.43E-5	1.47E-4	1.39E-5
LLNL	Rural	16	0.00E+0	2.26E-2	2.14E-3
	Suburban		0.00E+0	1.98E-3	1.89E-4
	Urban		1.95E-4	4.43E-4	4.21E-5

Table C-20. Total Cumulative Nonradiological/Nonchemical Transportation Risks, Concluded

		Dedicated Train			
Facility	Zone	Number of Shipments	Normal Transportation LCF	Injuries	Fatalities
MOUND	Rural	8	0.00E+0	1.07E-2	1.02E-3
	Suburban		0.00E+0	1.70E-3	1.62E-4
	Urban		1.11E-4	2.52E-4	2.40E-5
Subtotal			4.32E-2	8.44E+0	6.70E-1
RH TRAIN					
INEL	Rural	37	0.00E+0	5.62E-2	5.33E-3
	Suburban		0.00E+0	4.29E-3	4.07E-4
	Urban		2.95E-4	6.73E-4	6.40E-5
HANFORD	Rural	1208	0.00E+0	2.45E+0	2.33E-1
	Suburban		0.00E+0	1.75E-1	1.67E-2
	Urban		1.22E-2	2.73E-2	2.63E-3
ORNL	Rural	288	0.00E+0	3.28E-1	3.11E-2
	Suburban		0.00E+0	9.16E-2	8.70E-3
	Urban		5.56E-3	1.27E-2	1.20E-3
ANL-E	Rural	17	0.00E+0	1.89E-2	1.79E-3
	Suburban		0.00E+0	2.09E-3	1.99E-4
	Urban		1.21E-4	2.77E-4	2.62E-5
LANL	Rural	105	0.00E+0	1.00E-1	8.23E-3
	Suburban		0.00E+0	3.98E-3	1.69E-4
	Urban		2.52E-4	2.52E-5	2.43E-5
Subtotal			1.84E-2	3.27E+0	3.10E-1
TOTAL			6.16E-2	1.17E+1	9.80E-1

APPENDIX D

EMERGENCY RESPONSE:

STATES TRAINING AND EDUCATION PROGRAM (STEP), FIELD EXERCISES, AND STATE EMERGENCY RESPONSE CAPABILITIES

APPENDIX D

D.0 STATES TRAINING AND EDUCATION PROGRAM (STEP) COURSE OUTLINES

D.0.1 *First Responder Course Outline*

I. INTRODUCTION
- A. Course Introduction
- B. Overall Objectives
- C. Course Materials
- D. Definition of First Responder

II. SITE OVERVIEW
- A. Mission
  1. Test Phase
  2. Life of Project
- B. WIPP Site
  1. Surface Facilities
  2. Underground Layout
- C. Decommissioning

III. WASTE ACCEPTANCE
- A. Definition of "Transuranic" and "Mixed Waste"
- B. TRUPACT-II Transuranic Package Transporter Overview
- C. Standard Waste Box Packages
- D. Test Bins
- E. Interim Storage Methods Presently in Use
- F. Radioactive Materials Package Content Verification

IV. INTRODUCTION TO RADIATION
- A. Radiation Overview (VIDEO)
- B. Radiation Definitions
- C. Radiation Effects and Consequences
- D. Protection Factors for the First Responder

V. TRANSPORTATION
- A. Transuranic Waste Generator Site Locations
- B. Highway Route Selection
- C. Radioactive Material Shipping Statistics
- D. Radioactive Material Package Accident Data
- E. WIPP Transportation Shipping Paper Information
- F. Vehicle Placarding
- G. Radioactive Material Package Labels
- H. TRANSCOM Transportation Tracking and Communication System

VI. PACKAGE DESIGN
   A. Description of TRUPACT-II Transuranic Package Transporter
   B. TRUPACT-II Transporter Testing (VIDEO)
   C. Certification Testing
   D. Remote-Handled Waste Packaging

VII. EMERGENCY RESPONSE
   A. Emergency Response Guides Used for WIPP-Related Incidents
   B. U.S. Department of Energy (DOE) Radiological Assistance Team (RAT) Operations
   C. DOE Regions and Notification Procedures

VIII. FIRST RESPONDER ACTIONS
   A. Medical
   B. Fire Fighting
   C. Law Enforcement
   D. Questions and Answers

D.0.2 *First Responder Refresher Course Outline*

I. INTRODUCTION
   A. Course Introduction
   B. Overall Objectives
   C. Course Materials
   D. Definition of First Responder

II. WASTE ACCEPTANCE
   A. Definition of "Transuranic" and "Mixed Waste"
   B. TRUPACT-II Transuranic Package Transporter Overview
   C. Standard Waste Box Packages
   D. Test Bins
   E. Interim Storage Methods Presently in Use
   F. Radioactive Materials Package Content Verification

III. INTRODUCTION TO RADIATION
   A. Radiation Definitions
   B. Radiation Effects and Consequences
   C. Protection Factors for the First Responder

IV. TRANSPORTATION
   A. Transuranic Waste Generator Site Locations
   B. Highway Route Selection
   C. Radioactive Material Shipping Statistics
   D. Radioactive Material Package Accident Data
   E. WIPP Transportation Shipping Paper Information
   F. Vehicle Placarding
   G. Radioactive Material Package Labels

H. TRANSCOM Transportation Tracking and Communication System

V. EMERGENCY RESPONSE
   A. Emergency Response Guides Used for WIPP-Related Incidents
   B. U.S. Department of Energy (DOE) Radiological Assistance Team (RAT) Operations
   C. DOE Regions and Notification Procedures

VI. FIRST RESPONDER ACTIONS
   A. Medical
   B. Fire Fighting
   C. Law-Enforcement
   D. Questions and Answers

D.0.3 *Command-and-Control Course Outline*

Day One

I - VIII. FIRST RESPONDER COURSE (See First Responder Course Outline)

Day Two

IX. COMMAND AND CONTROL
   A. Review of Day One - First Responder Actions
   B. Overview of the Incident Command System (VIDEO)
   C. Function of the Incident Command System (ICS)
   D. Integration of Responding Agencies to a Radioactive Materials Incident
   E. Command and Communications
   F. Mitigation and Cleanup of a WIPP Incident
   G. Implementing the ICS (VIDEO)

X. EXERCISE SCENARIOS USING TABLE TOP MODELS

XI. CONCLUSION
   A. Questions and Answers

D.0.4 *Mitigation Course Outline*

I. OVERVIEW
   A. The WIPP Mission
   B. Transuranic Waste
   C. Contact-Handled and Remote-Handled Waste

II. TRANSPORTATION ISSUES
   A. Route Selection
   B. Regulation and Compliance

C. Carrier Requirements
D. TRANSCOM

III. PACKAGE AND CONTENTS
A. Certification Requirements
B. TRUPACT-II Specifications
C. Waste Composition by Generator Site
D. Quality Assurance Requirements

IV. HEALTH PHYSICS ISSUES
A. Internal and External Hazards
B. Biological Consequences of Plutonium
C. Treatment Methods for Internal Depositions
D. Alpha Monitoring Techniques
E. Risk and Accident Analysis

V. EMERGENCY RESPONSE ROLES AND RESPONSIBILITIES
A. Local
B. State
C. The DOE as Shipper and Responder

VI. CONCLUSION

D.0.5 *Train-the-Trainer Course Outline*

Day One

I. FIRST RESPONDER COURSE (See First Responder Course Outline)

Day Two

II. TRAIN-THE-TRAINER SPECIFIC
A. Nuclear Waste Primer
1. Charts and Graphs
2. Pictures of Transporters
3. Pictures of Waste Storage
4. Maps of Proposed Waste Storage Sites
B. Student Packet
1. Student Handout
2. Radiation - A Fact of Life
3. WIPP Fact Sheets
C. 35mm Slide Set
Explanation of 20 slides and their uses
D. Lesson Plans
E. Question and Answer Period
F. Conclusion

D.0.6 *Medical Management Course Outline*

I. INTRODUCTION
   A. Course Introduction
   B. WIPP Overview

II. PHYSICS AND RADIOBIOLOGY
   A. The Physics of Transuranic Waste
   B. Radiobiology of Contamination with Alpha Emitters

III. RADIATION INJURY
   A. Contamination Potential from a WIPP Accident
   B. Decontamination for Victim with External Contamination
   C. Techniques for Treating an Internally Contaminated Patient
   D. Techniques for Contamination Control in Hospitals

IV. RADIOLOGICAL MONITORING
   A. General Radiological Monitoring
   B. Monitoring of Contaminated Victims

V. "WALK THROUGH" EXERCISE
   A. Selected Course Participants Demonstrate, Under Guidance of Instructors, Use of Protective Clothing and Sampling
   B. Demonstration of Clothing Removal and Decontamination of Victim

VI. SUPERVISED EXERCISES
   A. Hospital Emergency Response Team Exercises Response Plan
   B. No-Fault Critique by Instructors

VII. CONCLUSION

D.0.7 *Kit Course Outline*

I. INTRODUCTION
   A. Course Introduction
   B. Overall Objectives
   C. Course Materials

II. KIT CONTENTS/FAMILIARIZATION

III. USE OF SUIT AND RESPIRATORS
   A. Anticontamination Suit
   B. Respirator
   C. Donning and Doffing
   D. Bagging Contaminated Clothing and Equipment

IV. EXERCISE
    A. Donning and Doffing
    B. Questions and Answers

D.1 STEP Courses Held since 1988

The STEP courses held by DOE since 1988 are presented in Table D-1.

Table D-1. STEP Courses Held since 1988

STATE	First Responder	First Responder Refresher	Command-and-Control	Mitigation	Train-the-Trainer	Medical Management
Colorado						
1988	329		160	17		
1989	240		95			129
1990	61	23	28	17	24	
1991	123	28	26			21
1992	54	13	36		11	
1993						
TOTAL	**807**	**64**	**345**	**34**	**35**	**150**
Idaho						
1988	109		26	15		
1989	66	34				16
1990	28		28		7	
1991	84	32	47			9
1992	50	13	28		6	14
1993						
TOTAL	**337**	**79**	**129**	**15**	**13**	**39**
New Mexico					<u>Kit Course</u>	
1988	665		242	8	*	
1989	206	70	60			179
1990	162		27		10	6
1991	183	29	42		132	102
1992	377		193		67	208
1993					132	
TOTAL	**1,593**	**99**	**564**	**8**	**341**	**495**

*New Mexico, as the host state for WIPP, was given a special 2-hour course covering equipment use. New Mexico did not request the "Train-the-Trainer" course.

Table D-1. STEP Courses Held since 1988, Continued

STATE	First Responder	First Responder Refresher	Command-and-Control	Mitigation	Train-the-Trainer	Medical Management
Oregon*						
1988						
1989						
1990	46					
1991						
1992						
1993						
TOTAL	**46**					
*Oregon is not one of the corridor states designated for the original Test Phase, but requested that two sample classes be taught in 1990.						
Utah						
1988	199		21	16		
1989	32	80			9	14
1990						
1991	50	27	16			25
1992	12	1	7			
1993						
TOTAL	**293**	**108**	**44**	**16**	**9**	**39**
Wyoming						
1988	323		236	43	3	
1989	58	142				32
1990	8	33	20			
1991	160	73	43			38
1992	10					
1993	76					
TOTAL	**635**	**248**	**299**	**43**	**3**	**70**

Table D-1. STEP Courses Held since 1988, Continued

STATE*	First Responder	First Responder Refresher	Command-and-Control	Mitigation	Train-the-Trainer	Medical Management
Alabama						
1988						
1989	231			9	15	
1990						
1991						
1992						
1993						
TOTAL	**231**			**9**	**15**	
Georgia						
1988						
1989	394			14	50	
1990						
1991						
1992						
1993						
TOTAL	**394**			**14**	**50**	
Louisiana						
1988						
1989	171			17	29	
1990						
1991						
1992						
1993						
TOTAL	**171**			**17**	**29**	
Mississippi						
1988						
1989	152			20	34	
1990						
1991						
1992						
1993						
TOTAL	**152**			**20**	**34**	

*Training conducted because the original plans called for shipment to be made from the Savannah River Site early in the program. WIPP shipments will not be made in the southern or midwestern states until at least 1999.

Table D-1. STEP Courses Held since 1988, Concluded

STATE*	First Responder	First Responder Refresher	Command-and-Control	Mitigation	Train-the-Trainer	Medical Management
South Carolina						
1988						
1989	23			17	13	
1990						
1991						
1992						
1993						
TOTAL	**23**			**17**	**13**	
Texas						
1988						
1989	280		133	51		
1990						
1991**	58		27			40
1992						
1993						
TOTAL	**338**		**160**	**51**		**40**

*Training conducted because the original plans called for shipment to be made from the Savannah River Site early in the program. WIPP shipments will not be made in the southern or midwestern states until at least 1999.

**Training conducted in Texas in 1991, in anticipation of possible routing of shipments to the WIPP through El Paso from INEL and RFP.

D.2 TRANSAX Field Exercise Example

D.2.1 TRANSAX 1992 Scenario

A TRUPACT-II transporter is traveling south to the Waste Isolation Pilot Plant (WIPP) in New Mexico from the Idaho National Engineering Laboratory (INEL) when it is forced from Interstate 15 and down Exit #89 by a speeding southbound vehicle. As the TRUPACT-II transporter is proceeding down the off-ramp, a van with seven occupants, apparently not seeing the TRUPACT-II transporter, pulls away from the shoulder on the east side of the ramp and into the path of the oncoming transporter. The two vehicles collide.

The force of the collision pushes the van across the grassy median where it overturns and ejects five of its seven occupants. The accident victims are scattered amidst the wreckage. A natural-gas-line-casing vent is located adjacent to the wreckage. A small fire breaks out north of the power pole and natural-gas-line-casing vent.

Attempting to avoid the collision, the TRUPACT-II transporter veers to the right, bounces heavily over uneven ground, strikes a power pole and careens across Riverton Road. Ultimately it comes to rest on the southwest side of Riverton Road. The fuel tank on the left side of the transporter ruptures and fuel is leaking from the tank.

The heaving, breaking, and torquing of the trailer frame over rough terrain causes the second and third TRUPACT-II containers to be released from the trailer. Container #2 lands upright in the median. It appears to have only superficial scuff damage, but a power line has fallen across it. Container #3 lands on its side on the southwest side of Riverton Road. It sustains damage to its outer skin. Some of the damage appears to extend to the underside. Container #1 remains on the transporter trailer and appears to be undamaged.

The TRUPACT-II transporter drivers notify the WIPP CMR via TRANSCOM immediately, then confirm their notification by calling the WIPP Central Monitoring Room (CMR) using the cellular telephone located in the transporter's cab. In response to the fire and the smell of leaking fuel, the drivers evacuate the tractor cab with fire extinguishers and shipping papers, but without their radiation monitoring equipment. Just prior to evacuating, they ask the CMR to make the remainder of their required notifications.

D.2.2 Organizations Attending TRANSAX 1992

- Shoshone-Bannock Tribes
    - Police Department
    - Dispatch Center
    - Fire Department
    - Quick Response Unit (QRU)

- State of Idaho
    - State Emergency Operations Center (SEOC)
    - State Emergency Response Commission (SERC)
    - State Police (ISP)
    - Transportation Department (ITD)
    - Department of Health and Welfare (DHW)
        - Division of Environmental Quality (DEQ)
        - INEL Oversight Program
        - Emergency Medical Services (EMS)

- Bingham County
  - Disaster Services
  - Sheriff's Office
  - Blackfoot Fire and Ambulance

- Hospitals
  - Bingham Memorial Hospital
  - Bannock Regional Medical Center
  - Pocatello Regional Medical Center

- Private Companies
  - Idaho Power Company
  - Intermountain Gas Company

- U.S. Department of Energy (DOE)
  - DOE Headquarters (DOE/HQ)
    - DOE Headquarters EOC
    - EM Duty Officer and Operational Emergency Management Team (OEMT)
  - DOE Operations Office, Idaho (DOE/ID) (Shipper)
    - Warning Communications Center (WCC)
    - Emergency Operations Center (EOC)
    - Radiological Assistance Team (RAT)
    - Emergency Information Center (EIC)
  - DOE Operations Office, Albuquerque (DOE/AL)
    - Operations Center (ALOC)
    - Emergency Operations Center (EOC)
  - Waste Isolation Pilot Plant Project Integration Office
    - Senior DOE/AL Official
  - Waste Isolation Pilot Plant Project Site Office
    - WIPP Central Monitoring Room (CMR)
    - WIPP Emergency Operations Center (EOC)
    - WIPP Information Center

- DOE Contractors
  - Contract carrier
  - Incident/Accident Response Team (IART)

- TRANSCOM Control Center (TCC)

- DOE Operations Office, Oak Ridge (DOE/OR)
  - Emergency Operations Center (limited to communications)

D.2.3 TRANSAX 1992 Schedule

September 16, 1992

TIMELINE

Time (MDT)	Event/Expected Response
6:00 AM	TRUPACT-II transporter leaves INEL.
8:00 AM	TRUPACT-II transporter is forced off I-15 by a southbound car and proceeds down the Exit #89 off-ramp. The transporter collides with a van on the off-ramp. The TRUPACT-II drivers notify the WIPP CMR via TRANSCOM. Fire and the smell of fuel force the drivers to leave the tractor.
8:01 AM	TCC contacts WIPP CMR to verify receipt of driver's message and confirms accident has occurred.
8:03 AM	WIPP CMR notifies local law enforcement agency. TCC notifies DOE/ALOC.
8:04 AM	Citizen phones 911 - Bingham County Emergency Dispatch - concerning an accident. A local resident phones Idaho Power Company about the power outage. ALOC begins call out procedures. ALOC notifies AL Duty Officer, who then notifies the WPIO Duty Officer and the Office of Emergency Plans and Operations (OEPO) Duty Officer.
8:05 AM	A Fort Hall patrol officer arrives at the accident scene and notifies Fort Hall Dispatch to call to the scene the Quick Response Unit (QRU), the Fort Hall Fire and Ambulance, the Fort Hall Patrol Captain, and law enforcement backup. WIPP CMR contacts DOE/ALOC concerning the TRUPACT-II accident. TCC notifies INEL Traffic Manager (Shipper).

DOE/ALOC contacts DOE/HQ, and DOE/ID WCC.

8:06 AM — Fort Hall Dispatch notifies the QRU, Fort Hall Fire and Ambulance, and Fort Hall Patrol Captain, and requests backup. Dispatch also notifies the Idaho State Police, State Hazmat Team, 911 (Bingham County), Fort Hall Community Response Coordinator, State EMS Communications Center, and INEL WCC.

8:08 AM — ISP Dispatch dispatches closest available Patrol Unit and WIPP Unit to the scene.

TCC notifies DOE/HQ EOC Coordinator.

8:09 AM — The State EMS Communications Center pages the Idaho DEQ Field Office, EPA, and then begins other required notifications.

8:10 AM — Fort Hall Patrol Captain arrives and takes command of the incident and establishes exclusion zones. Incident Commander directs dispatch to call his Logistics Officer, Idaho Power Company, Intermountain Gas Company, the Blackfoot Fire and Ambulance, and the Fort Hall Public Information Officer.

Idaho State DEQ Duty Officer calls the State Communications Center, assumes the role of Communications Moderator, is briefed, and classifies the incident as "Significant-Radiological." The Communications Moderator directs the EMS Operator to make the notifications required for a radiological incident and to set up a Conference Bridge.

WIPP CMR notifies DOE/ID WCC (Shipper).

TCC notifies DOE/OR EOC.

8:11 AM — ISP Patrol Officer arrives and reports to the Incident Commander and, as requested, establishes traffic control.

8:12 AM — Fort Hall QRU arrives and with the Incident Commander's concurrence, begins to establish a medical command system to set up a medical staging area, renders first aid, sets medical priorities, and determines hospital destinations.

TCC notifies DOE/OR Transportation Manager.

8:13 AM — Fort Hall Fire Department and Ambulance Service and Blackfoot Fire and Ambulance arrive and report to the Incident Command Post.

8:14 AM	WIPP CMR contacts the State Communications Center and tribal authorities as back-up notification of the event.
	Additional law enforcement units arrive.
	DOE/ID RCO directs notification, assembly of the RAP Team and recommends to the ID Duty Officer that the INEL EOC be partially activated.
	DOE/ID sends an advance RAT to the scene.
	TCC notifies WPSO Traffic Manager (Receiver) in Carlsbad.
8:16 AM	DOE/HQ EOC contacts the EM Duty Officer and establishes a conference call with DOE/AL.
8:18 AM	ITD arrives on scene.
8:20 AM	Logistics Officer arrives on scene and reports to the Incident Commander.
	Idaho Power Company arrives on scene and confirms that the fallen line is de-energized.
8:21 AM	EM Duty Officer initiates a conference call to various DOE offices including EM-56 and EM-1. EM-56 recommends that EM-1 direct establishment of an Operational Emergency Management Team (OEMT). After consultation with the Secretary, EM-1 concurs and the EM Duty Officer is directed to activate an EM OEMT.
8:25 AM	Intermountain Gas Company representative arrives on scene, confirms that there is a vent for a pipe casing at the accident scene and that the pipeline is not damaged.
8:30 AM	State Communications starts to establish a Conference Bridge. Incident Commander relates status on scene, including resources, to the Conference Bridge.
	ID RCO directs deployment of the RAP Team and initiates notification of DOE/HQ and to the AL EOC based on requirements in DOE Order 5530.3. Call based on the off-site deployment of the RAP Team.
8:32 AM	Conference Bridge participants determine that INEL Oversight Office personnel in Idaho Falls should be dispatched to the scene to assist with radiological assessment. Incident Commander concurs.

8:35 AM	Fort Hall Public Information Officer arrives at the Incident Command Post and is briefed by the Incident Commander. Bingham County Public Information Officer arrives at the scene and is briefed by the Fort Hall PIO.
	INEL EOC Public Affairs Officer confirms location of TRUPACT-II incident, issues pre-approved press release after classification review to media, Albuquerque EOC.
8:36 AM	Media and members of the general public begin calling the INEL Public Affairs Office for information about the accident. Calls are referred to EOC Public Affairs representative.
8:38 AM	EOC Public Affairs Officer notifies JPIC manager to activate rumor control function only.
8:40 AM	Mock media arrive at the scene, approach officers who are controlling the scene. They are escorted to a holding area and introduced to the PIOs.
8:45 AM	ISP WIPP Officers arrive on scene and report to the Incident Commander.
	DOE/AI assigns a Tier II response.
	DOE/ALOC notifies DOE/WPIO of possible need for recovery equipment.
	IART is notified by AL EOC through WIPP CMR to respond to the scene. AL notifies Ross Aviation, AL Communication Group, and WPIO to prepare to go to Carlsbad and incident scene. When AL Communication Group and WPIO arrive in Carlsbad, IART tells contract carrier to deploy crane, welders, replacement tractor and recovery flatbed. At this time, contract carrier contacts a crane company, welder, recovery flatbed, tractor and replacement tractor to replace damaged tractor.
	DOE/AL declares a Site Area Emergency based on two TRUPACT-II containers off the trailer, with one visibly damaged and having unknown radiological conditions and initiates a 5000.3A call to DOE/HQ.
8:50 AM	Southeast Area Field Officer (BDS) arrives and reports to Incident Commander. Sightseers and media aircraft are circling overhead. Incident Commander contacts Conference Bridge and requests the airspace be closed. ITD offers to clear airspace through the Bureau of Aeronautics.

9:00 AM	State Hazmat Response Team arrives and reports to the staging area. The Incident Commander is informed.
9:20 AM	All victims have departed to area hospitals.
9:30 AM	DOE/ID RAP Team arrives and reports to the staging area. The Incident Commander is informed. DOE RAP Team Leader (acting DOE Senior Official) communicates with the Incident Commander.
10:00 AM	INEL Oversight personnel arrive and report to the staging area. The Incident Commander is informed.
10:30 AM	**THE FIRST PHASE OF THE EMERGENCY RESPONSE IS OVER. THERE IS A BREAK FOR 15 MINUTES.**
10:45 AM	IART arrives and begins assessment of TRUPACT-II containers.
	Recovery resources, arranged by contract carrier, arrive at the staging area to be deployed at the IART direction.
11:00 AM	IART and contract carrier begin recovery procedures.
11:05 AM	Recovery proceeds according to the TRUPACT-II Recovery Guide.
2:00 PM	ISP reinspects the WIPP trailer(s), tractor(s), and containers before they resume interstate travel.
2:45 PM	**THE TRANSAX '92 EXERCISE IS TERMINATED.**

D.2.4 TRANSAX 1992 Exercise Response -- September 16, 1992

Nine months of preparation culminated in the TRANSAX '92 exercise conducted on September 16, 1992, on the Fort Hall (Idaho) Reservation. The exercise was a full-scale, full-participation field event. The exercise began at 8:00 AM and continued until 4:00 PM. The U.S. Department of Energy fielded a control group formal evaluation team. State, tribal, and local participants fielded their own combined control and evaluation organization.

Prestaging was held to a minimum. Responders were prestaged only if their response time would not fit the exercise window or if fulfilling an objective necessitated it. Where prestaging was necessary, response time was tested prior to the September exercise.

The participating organizations exercised their notification and communication networks and protocols, a key component of which was the DOE TRANSCOM satellite tracking and communications system located at Oak Ridge, Tennessee.

On-scene, the Fort Hall Police Department's Patrol Captain established an incident command structure to manage the incident, appointing and exercising his operations, logistics, safety, and public information officers. The Patrol Captain shared his role as Incident Commander with the Idaho State Police District V Commander.

The Shoshone-Bannock Tribes, Idaho State Police, Bingham County, and DOE/ID fielded public information officers. Public information and rumor control systems at DOE/ID, WIPP, and DOE/AI were activated. The emergency event presented considerable challenge to these systems in the form of mock media on scene, questions from a simulated public and national media located in an off-site control cell, a videotape of a simulated news report which seriously misrepresented the incident, and the real local media.

Bannock Regional Medical Center, Bingham Memorial Hospital, and Pocatello Regional Medical Center received and treated potentially radiologically contaminated patients at their hospitals.

Idaho Power Company and Intermountain Gas Company dispatched personnel to investigate their respective facilities, which included a downed power line and a gas-pipeline-casing vent located at the accident scene.

The Fort Hall Reservation, State Bureau of Disaster Services, Bingham County, DOE Headquarters, DOE/AL, DOE/ID, and DOE/WIPP activated their Emergency Operations Centers (EOCs).

D.2.5 Accomplishments

The TRANSAX '92 Final Report summed up the program results as follows:

- Local participants were enabled to work with and increase understanding of existing DOE transportation emergency response and recovery systems.
- Involved organizations enhanced their emergency response capabilities.
- Systems and procedures were tested.
- Competence to provide an effective, integrated response to a radiological transportation emergency was successfully demonstrated.
- During the course of the TRANSAX '92 Program, the Shoshone-Bannock Tribes built and demonstrated a first response capability, and developed skill in using the Incident Command System.
- The State of Idaho Hazardous Materials Incident Command & Response Support Plan was undergoing revision during the TRANSAX '92 Program. The program supplied a testing ground for some of the proposed revisions and helped to

identify the state's INEL Oversight Program Office as a valuable radiological assessment resource during an emergency incident.

- Bingham Memorial received radiological training through the REAC/TS program and gained hands-on experience. Two regional hospitals along the INEL-to-WIPP shipping corridor applied and tested their skills.

- The State Emergency Medical Services Communications Center tested and improved its procedures.

- The DOE field-tested its TRUPACT-II recovery system and personnel, including the TRANSCOM system, and the TRUPACT-II Incident/Accident Response Team (IART), as well as the TRUPACT-II emergency response procedures contained in the *TRUPACT-II Recovery Guide* (DOE, 1991e), the *Radiological Assistance Team Procedures for TRUPACT-II Transportation Incidents* (DOE,1991a), and the *Emergency Response and Recovery Roles and Responsibilities for TRUPACT-II Transportation Incidents* (DOE,1991b).

D.3 WIPPTREX Field Exercise Example

D.3.1 WIPPTREX 93-1 Scenario

The TRUPACT-II transportation vehicle is traveling Interstate 80 en route to the WIPP site. It is lunch time and the TRUPACT-II transportation vehicle drivers exit the highway to get something to eat at the restaurant near the interstate exit. As the TRUPACT-II transportation vehicle turns onto State Highway 130, a common delivery van, moving at a high rate of speed, runs a red light, enters the frontage road, and crashes into the middle of the TRUPACT-II transportation vehicle. The rear doors of the delivery van, inadequately secured, fly open, scattering packages all over, including under the rear axle of the TRUPACT-II transportation vehicle. The TRUPACT-II transportation vehicle cannot avoid all of the packages that have been scattered. Several are crushed before the driver can bring the vehicle to a complete stop. Some of the packages contain radioactive material.

Within seconds, a local police officer approaches the accident, initiating pursuit after having seen the van run the red light. The officer stops and radios dispatch for backup.

The driver of the delivery van is injured, pinned inside the vehicle, and unconscious. The drivers of the TRUPACT-II transportation vehicle are uninjured. A good samaritan stops to render first aid to the injured van driver.

The driver of the TRUPACT-II transportation vehicle tries to initiate notification procedures, but cannot because of communication transmission difficulties. [Note: This is an exercise anomaly to allow evaluation of local notification procedures.] The co-driver gets out of the vehicle, assists the good samaritan in providing first aid to the injured driver, and waits for arrival of the ambulance/fire department.

The first driver of the TRUPACT-II transporter gets out of the vehicle to assess any damage and notices the package behind the rear axle of the trailer. The package has been crushed, has a radioactive shipping label, and is leaking. It appears that the package was crushed by the right wheels of the rear axle, and that the vehicle ran through the dispersed material. There is no apparent structural damage to the TRUPACT-II transportation vehicle, and only minor surface scratches to the TRUPACT-II container that was struck.

A sheriff's deputy traveling in the opposite direction witnesses the accident. He crosses the median, approaches from behind the TRUPACT-II transportation vehicle, and calls dispatch for assistance.

D.3.2 WIPPTREX 93-1 Schedule for April 13-14, 1993

<u>Tuesday, April 13, 1993</u>

9:00 AM - Noon	Evaluator Training

<u>Wednesday, April 14, 1993</u>

8:00 AM - 8:30 AM	Briefing for Observers and Media Representatives
8:30 AM - 8:45 AM	Observers transported to exercise location
9:00 AM - 2:00 PM	WIPPTREX Exercise
2:30 PM - 3:30 PM	Debriefing/Critique for exercise participants
4:00 PM - 5:00 PM	Evaluators Meeting

D.3.3 Organizations Attending WIPPTREX 93-1

- City of Laramie
    - Police Department
    - Fire Department
    - Emergency Medical Services (EMS)
    - City of Laramie and Albany County Joint Disaster Center
- Albany County
    - Disaster Services
    - Sheriff's Office
    - Ivinson Memorial Hospital

- State of Wyoming
  - Governor's Office
  - Public Service Commission
  - Emergency Management Agency
  - Department of Transportation
  - Highway Patrol
  - Highway Patrol Dispatch
  - Health Department (HD)
  - Department of Environmental Quality (DEQ)
  - Radiological Response Team
  - University of Wyoming

- U.S. Department of Energy (DOE)
  - Albuquerque Operations Office (DOE/AL)
  - Waste Isolation Pilot Plant (WIPP)
  - Idaho Operations Office (DOE/ID)
  - Idaho National Engineering Laboratory
  - Rocky Flats Plant

- U.S. Department of Energy Contractors
  - Contract carrier - Drivers
  - TRANSCOM (Transportation Tracking and Communication System) contractor
  - Westinghouse Waste Isolation Division (WID)

D.3.4 WIPPTREX 93-1 Timeline

Evaluator/Controller information in brackets [ ].

Time (MDT)	Event/Expected Response
9:00 AM	The police officer approaches cautiously, determines wind direction and safe approach, and follows HAZMAT First Responder procedures. The police officer assesses injuries and calls for backup. [Note: Real wind direction to be used.]
9:02 AM	Officer calls for fire department and ambulance support.
9:05 AM	The officer approaches from upwind and makes initial assessment of hazard: • People at/leaving the scene • Company names of involved vehicles

- Container shape and size
- Container markings and colors
- Odor, smoke, vapor, and sound
- Shipping papers and MSDS
- Placards and labels

The police officer establishes contact with a TRUPACT-II transportation driver and is informed of possible contamination from crushed package.

The TRUPACT-II transportation drivers request the officer, through the joint communications center, to make initial notification to WIPP CMR of status of TRUPACT-II transportation vehicle and potential for contamination from radioactive material from crushed package.

Officer should identify type and quantity of radioactive material from shipping papers. Shipping company is "Safe Transport, Inc.".

9:10 AM Deputy/police officer transmits Situation Report:

- Location
- Victim information
- Material identification (name/placard/label)
- Material amount, state, appearance, behavior
- Container type and size
- Wind and exposures

9:12 AM Arrival of ambulances and backup support.
EMTs begin treatment of injured driver.

9:15 AM Communications center notifies Highway Patrol Dispatch Center of involvement of TRUPACT-II shipment, and dispersal of commercial radioactive material, and requests the State's Radiological Response Team (RRT).

DOE/AL establishes communications with DOE/HQ, RAP Regional Coordinating Office, Shipper Office, and WIPP CMR. (This action will be accomplished through a simulation cell.)

Media arrives and questions local officers.

9:16 AM Highway Patrol Dispatch Center makes notifications on checklist and dispatches "WIPP Officer."

9:20 AM	The Wyoming Highway Patrol (WHP) officer arrives, secures the scene, and takes the following actions if not already accomplished:

- Evacuates the hazard area and assemble upwind
- Isolates the area and denies entry
- Establishes physical boundaries
- Posts people where necessary and safe
- Controls sources of ignition, if applicable

Begin emergency containment if possible, employing such techniques as diking.

WIPP CMR begins notifications: [when contacted]

- State authorities
- DOE/Albuquerque Operations Office EOC
- Shipper
- TRANSCOM Communications Center

9:25 AM — DOE/ID and Highway Patrol Dispatch establish line of communication. State is informed by DOE/ID of ETA of regional RAP team to incident site. State informs DOE/ID of ETA of state RRT.

The WHP officer initiates the Incident Command System if not already accomplished:

- Develops an initial plan
- Announces establishment of incident command
- Tells incoming responders what to do
- Sets up an on-scene control point
- Briefs later arriving emergency responders

9:30 AM — DOE/AL activates a Tier I response. DOE/ID activates appropriate RAP team and obtains estimated time of arrival. Team is dispatched initially to ensure integrity of shipment and determine full extent of contamination.

DOE/AL ensures DOE/HQ has been notified and categorizes the incident in accordance with DOE Orders.

Highway Patrol Officer asks DOE/ID for technical advice. Call goes to Exercise Control Cell.

9:40 AM — Ambulance prepares for transportation of injured individual. Precautions are taken in case of contamination of the victim.

****

[Time Compression. DOE RAP Teams and State Radiological Teams will be prepositioned to minimize exercise time due to travel.]

****

10:00 AM	Arrival of state RRT on the scene and briefing by Incident Commander of information available on crushed package (shipping manifest).
10:30 AM	RAP Team arrives and leader establishes communications with the Incident Commander and receives an RRT briefing. The RAP Team leader establishes contact with and briefs the Regional Coordinating Office.
11:00 AM	RAP Team Leader prepares assessment of possible contamination and prepares plan, including whether protective clothing is required, instrumentation, sampling plan, air sampling, etc.
11:05 AM	The State Department of Environmental Quality determines responsibilities for assessment, and carrier cleanup of the radioactive contamination.
	[Carrier is Safe Transportation Inc.]
	[Time Compression]
11:20 AM	Commercial van company representative arrives on scene.
	[Time Compression]
11:30 AM	TRUPACT-II Incident/Accident Response Team (IART) arrives on scene and provides assessment of need for recovery of TRUPACT-II transportation vehicle and identifies resources required with input from RAP Team Leader.
12:00 Noon	State coordinates recovery plan with the DOE and carrier/shipper and notifies all parties of course of action.
12:30 PM	State prepares a final release for the media.
1:00 PM	**EXERCISE TERMINATION.**

D.4 State Emergency Response Capabilities

Table D-2 presents the emergency response capabilities for accidents involving radioactive or hazardous materials for the states through which TRU waste will be transported during the Disposal Phase. Information is presented regarding the state agency; function, composition, and location of emergency response teams; training provided for team members; and applicable plans.

D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Idaho	State Police	Hazmat response	7 along route	Eastern Idaho	b	
	Department of Health and Welfare	Radiological assessment, containment	3 health physicists	Boise	b	Radiological Emergency Response Plan
	Pocatello Fire Department (State-funded)	Hazmat response	18 on team	Pocatello	a applies to 11 on team; b applies to the other 7	
	Bureau of Disaster Services	Oversees emergency response	No team	Boise	b	
Utah	Highway Patrol	Hazmat response	14 on team; 7 along route	Northeast Utah	a	
	Department of Environmental Quality	Radiological assessment, containment	Staff of health physicists	Salt Lake City	b	Radiological Emergency Plan
	Ogden City Fire Department	Hazmat response	12 on team	Ogden	a	

[a]OSHA hazmat training, as specified in 29 CFR 1910 120

[b]Radiation training equivalent to NRC Health Physics course or FEMA Radiological Emergency Response Operations (RERO) course.

D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Wyoming	Radiological Response Team: Emergency Management Agency (Team Leader), Department of Environmental Quality, Department of Health, University of Wyoming	Radiological assessment, containment	Pool of 30	Cheyenne, Laramie, and statewide	b	Radiological Materials Accident Emergency Response Plan
	Highway Patrol (also serves on Rad Response Team)	Hazmat response (accident command)	Unknown	Statewide	a	
Colorado	State Patrol	Emergency response authority on federal, state, and county roads, outside cities	2-person hazmat (26 personnel designated for teams)	Strategically located throughout the state	a & b	
	Department of Health, Radiation Control Division	Technical assistance for radiation incidents, lead state agency	Pool of health physicists	Denver	b	Standard operating procedures

[a]OSHA hazmat training, as specified in 29 CFR 1910.120

[b]Radiation training equivalent to NRC Health Physics course or FEMA Radiological Emergency Response Operations (RERO) course

D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Colorado (Continued)	Dept. of Local Affairs, Office of Emergency Management	Responsible for State Emergency Operations Center (SEOC) activation and maintenance	N/A	Denver metro area	Training varies	State Emergency Operations Plan (SEOP), Haz Mat, Annex, WIPP Appendix
	Dept. of Health, Emergency Management Unit	Coordinates environmental response to WIPP incident	N/A	Denver	a	State Emergency Operations Plan (SEOP), Haz Mat, Annex, WIPP Appendix
	Dept. of Health, Radiation Control Division	Technical assistance for radiation incidents, lead state agency	Staff of health physicists			Standard operating procedures
	Department of Public Safety, Division of Disaster Emergency Services	Coordinates state agencies for a WIPP incident	NA	Denver	Unknown	Colorado Hazardous Materials, Spills, and Releases Response Plan
New Mexico	New Mexico Dept. of Public Safety, State Police	Radioactive and hazmat incidents coordination	Individual officers	Statewide	a	Hazardous Materials Emergency Response Plan
	Environment Dept., Hazardous and Radioactive Materials	Radioactive material assessment	Entire RAD staff of 5 available	Most at Santa Fe	b	

[a]OSHA hazmat training, as specified in 29 CFR 1910.120

[b]Radiation training equivalent to NRC Health Physics course or FEMA Radiological Emergency Response Operations (RERO) course

D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Arizona	Department of Public Safety	Coordinates transportation incidents (except rad.)	15	Statewide	a	Hazardous Materials Response and Recovery Plan
	Radiation Regulatory Agency	Coordinates transportation incidents if rad. involved	Pool of 19 people	Phoenix	b	
	Department of Transportation	Responds to transportation accidents	2	Phoenix	a	
	Department of Environmental Quality, Emergency Response and Recovery Unit	Responds to accidents	4	Phoenix	a	
California	Department of Health Services, Radiological Health Branch	Responsible for radiological assessment and emergency response and for overseeing site recovery for incidents involving radioactive materials	2- to 4-person teams	Statewide	b	Nuclear Emergency/Terrorism Response Plan; Hazardous Materials Incident Contingency Plan; Railroad Accident Prevention and Immediate Deployment Plan

[a]OSHA hazmat training, as specified in 29 CFR 1910.120

[b]Radiation training equivalent to NRC Health Physics course or FEMA Radiological Emergency Response Operations (RERO) course.

D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
California (Continued)	California Highway Patrol (CHP)	State Agency Coordinator for on-highway hazardous materials incidents. On-scene incident commander (for highways under CHP jurisdiction)	Variable depending upon incident	Statewide	a	Nuclear Emergency/Response Plan; Hazardous Materials Incident Contingency Plan
	Office of Emergency Services	Coordinates state emergency response resources, preparedness, planning, mitigation, and recovery activities; communication coordination	NA	3 regional offices in the state	a	Nuclear Emergency/Terrorism Response Plan; Hazardous Material Incident Contingency Plan; and Railroad Accident Prevention and Immediate Deployment Plan

[a]OSHA hazmat training, as specified in 29 CFR 1910.120

[b]Radiation training equivalent to NRC Health Physics course or FEMA Radiological Emergency Response Operations (RERO) course.

D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
California (Continued)	Department of Fish and Game	State Agency Coordinator for off-highway hazardous materials spills. Incident command authority for marine oil spill response	No teams; DFG wardens	Statewide	a	Marine Oil Spill Contingency Plan; State Hazardous Materials Incident Contingency Plan
	Department of Transportation	Identification and removal of all hazardous materials spilled on highways; assists in traffic control	Variable	Statewide	a	Hazardous Materials Incident Contingency Plan

[a]OSHA hazmat training, as specified in 29 CFR 1910.120

[b]Radiation training equivalent to NRC Health Physics course or FEMA Radiological Emergency Response Operations (RERO) course

D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
California (Continued)	Environmental Protection Agency	Assists local health and safety personnel during hazardous materials incidents (excluding radioactive materials); sets criteria for hazardous materials incident recovery and mitigation; provides follow-up investigation and site remediation; can provide technical support, sampling, and lab analysis capabilities	Variable depending on nature of incident	Statewide	a	Hazardous Materials Incident Contingency Plan; Railroad Accident Prevention and Immediate Deployment Plan; Marine Oil Spill Contingency Plan
Nevada	No information received from state; to be added later					

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D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Oregon	Oregon Emergency Management	Emergency response planning, notification, and communication	NA	Salem	Unknown	Oregon Emergency Operations Plan; Oil and Hazardous Materials Emergency Response Plan
	Regional hazmat response teams (state-supported)	Regional emergency response to hazmat incident	6 to 8 people	Teams will be established in eastern Oregon	a	
	Oregon Department of Energy	Lead state agency for transportation incidents involving rad materials	No response team; experts assist via phone	Salem	b	
	Health Division	Lead agency for fixed site rad. incidents, radiological monitoring, supervision of cleanup	Individuals on radiation emergency response team--8 members	Salem, Portland	b	
Washington	Department of Health	Lead agency for rad. assessment	Pool of people for 6 teams	Olympia and other locations	b	

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D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Washington (Continued)	State Patrol	Lead incident command agency, rad. monitoring	All troopers rad. monitoring trained and equipped	Statewide	a	
South Carolina	Department of Health and Environmental Control	Radiological assessment--lead	Pool of 20-40	Columbia and 2 in Aiken	b; a, in part	
Georgia	Environmental Protection Division	Radiological emergency response implementation	Pool of 25 people	Atlanta and some other locations	b	
	Emergency Management Planning Agency	Planning, and coordinating state agencies	NA	Atlanta and field coordinators	Unknown	Guidance for Responding to Transportation Accidents Involving Radioactive Materials
Alabama	Department of Public Health	Lead radiation control agency; serves on State Hazardous Materials Response Team (SHMRT)	Pool of 10	Montgomery	b	
	Emergency Management Agency	Planning and emergency coordination	NA	Montgomery	Unknown	State Emergency Operations Plan

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D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Alabama (Continued)	Department of Public Safety	Coordinates SHMRT	Interagency	Montgomery	a	
	Department of Environmental Management	Serves on SHMRT and coordinates removal of hazardous materials	Unknown	Montgomery	a	
Mississippi	Department of Health, Division of Radiological Health	Lead radiation protection agency	Varies, depending on situations	Jackson	a and b	
	Emergency Management Agency	Response coordination planning	N/A	Jackson	a and b	State emergency operations plans
	Department of Public Safety	Emergency response	Varies	Statewide	a and b	
	Department of Transportation	Emergency response	Varies	Statewide	a	
	Department of Environmental Quality	Emergency response	3	Jackson	a	

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D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Louisiana	Department of Environmental Quality, Radiation Protection Division	Lead radiation protection agency	Pool of 20; 5 teams designated, usually send 2	Baton Rouge and other locations	b	
	Office of Emergency Preparedness	Planning	NA	Baton Rouge	Unknown	
	State Police	Emergency response	Unknown	Statewide	a	
Texas	Department of Health, Bureau of Radiation Control	Lead radiation protection agency	From a pool of >50	Austin and other locations	b	Texas Emergency Management Plan
	Division of Emergency Management	Planning; coordinates state agencies	NA	Austin	Unknown	
Tennessee	Tennessee Emergency	Emergency response training, emergency response plans, coordination of emergency response state agencies, shipment and accident notification point	2 rad specialists, pool of 10 rad. training/haz mat specialists	Nashville Jackson Knoxville	a and b	Fixed Nuclear Facilities Plan, State Emergency Operation Plan, Haz Mat Plan

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D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Tennessee (Continued)	Public Service Communication	Regulation of hazardous material transportation, transportation accident investigation, route coordinator	Pool of up to 30 trained officers	Statewide	a	
Arkansas	Office of Emergency Services	Planning; coordinates state agencies	NA	Little Rock	Unknown	Basic Plan, Emergency Operation Plan, State of Arkansas
	Department of Health, Division of Radiation Control	Responsibility for radiological assessment	Pool of 16; 4 teams	Little Rock and Russellville	b	Radiological annex to state plan
	State Police	Coordinates on-scene response of all hazmat incidents	Unknown	Statewide	a	State police annex to state plan
	Highway and Transportation Department	Assists Health Department in highway accident cleanup	Unknown	Statewide	Unknown	Highway and transportation annex to state plan
Oklahoma	Department of Civil Emergency Management	Plans and coordinates state agencies	NA	Oklahoma City	Unknown	Emergency Operations Plan

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D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Oklahoma (Continued)	Department of Health, Radiation Protection Division	Lead agency for radiological assessment	Pool of experts, 1 team	Oklahoma City	b	
Ohio	Emergency Management Agency	Radiological emergency response	3 teams of 2 people each and backups	Columbus	b	Emergency Rad. Response Plan
	Environmental Protection Agency	Hazmat emergency response	3 people	Dayton	a	
	Fire Marshal	Hazmat emergency response, hazmat equipment application	3 people	Columbus	a	
Indiana	State Department of Health, Division of Industrial Hygiene and Radiological Health	Emergency response for radiological incidents	5 people	Indianapolis	b	1) State Emergency Operations Plan 2) State Ingestion Pathway Plan
	Indiana Area Radiation Emergency Response Committee	Supplements response capabilities of Department of Health	24 radiation experts	Statewide	b (many have)	

[a]OSHA hazmat training, as specified in 29 CFR 1910 120

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D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Indiana (Continued)	Department of Fire and Building Services, Fire Marshal's Office	Coordinates hazmat training for fire departments and county hazmat teams	4 people, specialist level	Indianapolis Fort Wayne Terre Haute	a	State Emergency Operations Plan
	State Emergency Management Agency	Coordinates and supplements response capabilities of department of health	3 people	Indianapolis	b	1) State emergency operations plans 2) State Ingestion Pathway Plan
Illinois	Department of Nuclear Safety (IDNS)	Oversight of radiological control actions, radiological assessment, and mitigation	Pool of >30 rad. experts	2 regional offices	b	Illinois Plan for Radiological Accidents (IPRA)
	State Police	Oversees traffic at accident site, and provides assessment assistance to IDNS	Hazmat teams of 1-6 troopers	At 22 places statewide	a and b	

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D-2. State Emergency Response Capabilities for Radioactive and Hazardous Materials Accidents/Incidents

State	State Agency	Function	Team Composition	Location	Training[a,b]	Plans
Illinois (Continued)	Department of Transportation	May close highways in event of accident	Unknown	9 district offices	Unknown	
Missouri	Department of Natural Resources	Hazmat response	5 people; 2 backups	5 in Jefferson City, 2 in Times Beach	a and b	Department of Natural Resources Hazardous Substances Emergency Response Plan
	Bureau of Radiation Health	Responsible for radiological assessment	6 persons in 2 teams	Mostly Jefferson City	b	
	State Emergency Management Agency	Coordinates emergency response among state agencies	Missouri Nuclear Emergency Assistance Team (many entities)	Diverse locations	b	Missouri Nuclear Emergency Assistance Plan

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