APPENDIX D
RADIOLOGICAL TRANSPORTATION ANALYSIS METHODOLOGY

D.1 SHIPMENT SCENARIOS

D.1.1 Proposed Action for Transportation

The Modern Pit Facility (MPF) Alternative, as described in Chapter 3, includes transportation as a major component. Aged plutonium pit assemblies would be shipped from Department of Energy (DOE) Pantex Plant in Amarillo, Texas to the MPF site under consideration. Enriched uranium (EU) parts would be disassembled from the pit assemblies and shipped to the Y-12 National Security Complex (Y-12) near Oak Ridge, Tennessee. The reworked EU parts would then be shipped back to MPF. The pit assemblies would be returned to Pantex. During startup, and potentially at other infrequent times, plutonium metal would be shipped from either the Savannah River Site (SRS) or Los Alamos National Laboratory (LANL) to the MPF site.

Both transuranic (TRU) waste and low-level waste (LLW) would be generated at the MPF site. It would have to be disposed at another location if facilities at the MPF site were not available. DOE's Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico would be the destination for TRU waste from all potential MPF sites. Three potential MPF sites, LANL, Nevada Test Site (NTS), and SRS, have LLW disposal facilities. Neither WIPP nor Pantex have such disposal capacity and would have to ship LLW to NTS.

A matrix depicting the origins, destinations, and materials shipped is provided in Table D.1.1–1. The matrix also includes shipments under the No Action and TA-55 Upgrade Alternatives, which are subsets of those for the MPF Alternative.

Table D.1.1–1. Origins, Destinations, and Material Shipped Under the MPF Alternative

Shipment Type	SRS	Pantex	LANL	NTS	Carlsbad Site
SRS Plutonium in	SRS ⇒ SRS	SRS ⇒ Pantex	SRS ⇒ LANL	SRS ⇒ NTS	SRS ⇒ Carlsbad Site
LANL Plutonium in	LANL ⇒ SRS	LANL ⇒ Pantex	LANL ⇒ LANL	LANL ⇒ NTS	LANL ⇒ Carlsbad Site
Pits in	Pantex ⇒ SRS	Pantex ⇒ Pantex	Pantex ⇒ LANL	Pantex ⇒ NTS	Pantex ⇒ Carlsbad Site
EU in	Y-12 ⇒ SRS	Y-12 ⇒ Pantex	Y-12 ⇒ LANL	Y-12 ⇒ NTS	Y-12 ⇒ Carlsbad Site
EU out	SRS ⇒ Y-12	Pantex ⇒ Y-12	LANL ⇒ Y-12	NTS ⇒ Y-12	Carlsbad Site ⇒ Y-12
Pits out	SRS ⇒ Pantex	Pantex ⇒ Pantex	LANL ⇒ Pantex	NTS ⇒ Pantex	Carlsbad Site ⇒ Pantex
TRU waste out	SRS ⇒ WIPP	Pantex ⇒ WIPP	LANL ⇒ WIPP	NTS ⇒ WIPP	Carlsbad Site ⇒ WIPP
LLW out	SRS ⇒ SRS	Pantex ⇒ NTS	LANL ⇒ LANL	NTS ⇒ NTS	Carlsbad Site ⇒ NTS

D.1.2 Materials Shipped

The materials shipped are described as follows.

SRS plutonium/LANL plutonium: Whether from SRS or LANL, this material is plutonium metal that is primarily plutonium-239, but contains other plutonium isotopes in small amounts. It is used for start-up testing and will be infrequently shipped in currently undefined quantities. Because of the relatively small volume of material and lack of specific data on the shipments, analysis of this material is limited to a determination of person-miles for a single shipment, as described in Section D.2.

pits: Pits are the feed and product stream of the MPF. A pit is actually an assembly of plutonium metal with EU parts. The plutonium is primarily plutonium-239, and the uranium is primarily uranium-235. A single shipment of pits contains approximately 110 kilograms (kg) (243 pounds [lb]) of plutonium and 450 kg (992 lb) of uranium. Under each of the MPF capacity options of 125, 250, and 450 pits per year (ppy), there will be 7, 14, and 25 roundtrip shipments per year, respectively.

EU: The EU parts from disassembled pits are shipped to the Y-12 National Security Complex (Y-12) for processing and returned to the MPF. A single shipment of EU contains approximately 630 kg (1,389 lb) of uranium.

TRU waste: Processing of plutonium pits produces contact-handled TRU waste, primarily americium-241. Under the MPF capacity options of 125, 250, and 450 ppy, there will be 74, 93, and 142 shipments per year of TRU waste, respectively.

LLW: This waste would consist of job control waste and decontamination wastes. The radioisotopes would primarily be transuranics, but their concentrations would be sufficiently low to classify the waste as LLW. Under the MPF capacity options of 125, 250, and 450 ppy, there will be 136, 217, and 331 shipments per year of LLW, respectively.

D.1.3 Packaging

For purposes of this analysis, the National Nuclear Security Administration (NNSA) used two general package types: Type A and Type B. A Type A package is designed to protect and retain their contents under normal transport conditions and must maintain sufficient shielding to limit radiation exposure to handling personnel. These packages are used to transport LLW. A Type B package is used to transport material with the highest radioactivity levels and to protect and retain their contents under transportation accident conditions.

DOE adopts Nuclear Regulatory Commission standards for Type B packages, which include certification of packages against stringent testing standards (10 CFR 71). The testing or other analysis must certify that the contents of the package will not be released under the following tests:

Free Drop: The cask drops 9 meters (m) (30 feet [ft]) onto a flat, horizontal, unyielding surface so that it strikes at its weakest point.

Puncture: The cask drops 102 centimeters (cm) (40 inches [in]) onto a 15-cm (6-in) diameter steel bar at least 20 cm (8 in) long. The bar strikes the cask at its most vulnerable spot.

Fire: After the impact tests, the cask is totally engulfed in an 808 ^{o}C (1,475 ^{o}F) thermal environment for 30 minutes. The cask is then completely submerged under at least 102 cm (40 in) of water for 8 hours. Undamaged packages must withstand more severe immersion tests.

There are numerous designs of Type B packages that the NNSA uses for transporting radioactive materials. The NNSA would select packages that are appropriate for the purpose and contents for which it would be used. Most likely, plutonium pits would use one kind of Type B package and EU parts would use another. The NNSA would use the Transuranic Package Transporter (TRUPACT-II) for contact-handled TRU waste shipments. The TRUPACT-II is a large casks that can contain 14 208-L (55-gal) drums. It includes armor, impact limiters, and thermal insulation and is shipped up to three to a truck.

Type B packages for pits and EU are shipped in specially designed Safe Secure Trailers/Safeguards Transports (SST/SGT). The SST/SGT contains enhanced structural and security features that are classified. They operate under operational security procedures and emergency plans that include armed escort, satellite tracking, and advanced communications.

D.2 ROUTING AND DEMOGRAPHICS

NNSA used the computer code TRAGIS (Transportation Routing Analysis Geographic Information System) (Johnson and Michelhaugh 2000) to determine representative routes for the transportation indicated in Table D.1.1–1. Designed by Oak Ridge National Laboratory, TRAGIS gives routes from an origin to destination based on user-selected criteria. The NNSA selected criteria consistent with transport of radioactive material by preferred routes as described in 49 CFR 397, Subpart D, i.e., highway route-controlled quantities.

TRAGIS provides route information such as nodes, segments, miles per segment, miles per state, miles per highway type, miles per population density category, population within 800 m (0.5 mi) of the route, and other parameters of interest. Some of the output is specifically designed for direct input into the RADTRAN computer code (see Section D.3).

TRAGIS runs were performed for the unique origin-destination pairs indicated in Table D.1.1–1. Pairs with origin the same as the destination were eliminated. Duplicates and pairs already represented by a reverse-direction pair were also eliminated. Unique TRAGIS runs reduced to those in Table D.2–1.

Table D.2–1. Unique TRAGIS Runs

ID No.	Origin-Destination Pair	Material Shipped
1	LANL ⇔ SRS	Plutonium metal
2	Pantex ⇔ SRS	Pits; plutonium metal
3	Y-12 ⇔ SRS	EU
4	LANL ⇔ Pantex	Pits; plutonium metal
5	Y-12 ⇔ Pantex	EU
6	Y-12 ⇔ LANL	EU
7	SRS ⇔ NTS	Plutonium metal
8	LANL ⇔ NTS	Plutonium metal
9	Pantex ⇔ NTS	Pits; LLW
10	Y-12 ⇔ NTS	EU
11	SRS ⇔ Carlsbad Site/WIPP	Plutonium metal; TRU
12	LANL ⇔ Carlsbad Site/WIPP	Plutonium metal; TRU
13	Pantex ⇔ Carlsbad Site/WIPP	Pits; TRU
14	Y-12 ⇔ Carlsbad Site	EU
15	NTS ⇔ WIPP	TRU; LLW

Note: WIPP and Carlsbad Site were modeled as the same location.

The following tabulations provide the resulting RADTRAN input data for each unique TRAGIS run.

LANL Û SRS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	29.7	860.5	5,902.2	
People/km^2	11.5	332.2	2,278.8	
Distance				
Miles	1,241.2	430.6	64.5	1,736.1
Kilometers	1,997.5	692.9	103.8	2,794.0
Percentages	71.5	24.8	3.7	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168 GA 226,097 NM 84,915 OK 80,578 SC 4,642 TN 185,926 TX 39,756			
Total Population within 800-m (0.5-mi)Buffer Zone:				**699,082**

Pantex Û SRS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	34.96	861.0	5,882.0	
People/km^2	13.4	332.4	2,271.0	
Distance				
Miles	918.2	385.9	50.1	1,354.1
Kilometers	1,477.6	621.1	80.5	2,179.1
Percentages	67.8	28.5	3.7	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168 GA 226,097 OK 80,578 SC 4,642 TN 185,926 TX 2,186			
Total Population within 800-m (0.5-mi) Buffer Zone:				**576,597**

Y-12 Û SRS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	48.8	920.9	5,917.6	
People/km^2	18.9	355.6	2,284.8	
Distance				
Miles	188.4	170.8	22.8	382.0
Kilometers	303.3	274.8	36.7	614.7
Percentages	49.3	44.7	6.0	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	GA 226,097 SC 4,642 TN 34,368			
Total Population within 800-m (0.5-mi) Buffer Zone:				**264,408**

LANL Û Pantex

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	16.2	835.5	5,972.2	
People/km^2	6.2	322.6	2,305.9	
Distance				
Miles	342.1	46.6	14.4	403.0
Kilometers	550.5	74.9	23.2	648.6
Percentages	84.9	11.6	3.6	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	NM 84,915 TX 38,420			
Total Population within 800-m (0.5-mi) Buffer Zone:				**123,335**

Y-12 Û Pantex

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	33.5	776.2	5,788.5	
People/km^2	13.0	299.7	2,235.0	
Distance				
Miles	811.7	252.3	26.1	1,090.1
Kilometers	1,306.3	406.0	42.1	1,754.2
Percentages	74.5	23.1	2.4	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168 OK 80,578 TN 168,225 TX 2,186			
Total Population within 800-m (0.5-mi) Buffer Zone:				**328,157**

Y-12 Û LANL

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	28.5	788.2	5,853.9	
People/km^2	11.0	304.3	2,260.2	
Distance				
Miles	1,134.7	296.9	40.6	1,472.1
Kilometers	1,826.1	477.8	65.3	2,369.1
Percentages	77.1	20.2	2.8	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168 NM 84,915 OK 80,578 TN 168,225 TX 39,756			
Total Population within 800-m (0.5-mi) Buffer Zone:				**450,642**

SRS Û NTS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	28.9	864.4	6,105.2	
People/km^2	11.2	333.7	2,357.2	
Distance				
Miles	1,987.3	554.8	82.7	2,624.8
Kilometers	3,198.1	892.9	133.1	4,224.1
Percentages	75.7	21.1	3.2	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 287			
	GA 226,097			
	IL 37,937			
	IA 9,881			
	KY 13,961			
	MO 185,917			
	NE 59,486			
	NV 74,850			
	SC 4,642			
	TN 99,201			
	UT 159,595			
	WY 32,573			
Total Population within 800-m (0.5-mi) Buffer Zone:				**904,426**

LANL Û NTS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	17.9	861.3	6,261.4	
People/km^2	6.9	332.6	2,417.5	
Distance				
Miles	860.7	98.7	17.6	977.1
Kilometers	1,385.2	158.8	28.4	1,572.5
Percentages	88.1	10.1	1.8	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AZ 36,032			
	CA 15,433			
	NV 61,906			
	NM 76,780			
Total Population within 800-m (0.5-mi) Buffer Zone:				**190,151**

Pantex Û NTS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	16.9	897.6	6,153.3	
People/km^2	6.5	346.6	2,375.8	
Distance				
Miles	1,063.2	104.0	23.0	1,190.3
Kilometers	1,711.1	167.4	37.0	1,915.5
Percentages	89.3	8.7	1.9	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AZ 36,032			
	CA 15,433			
	NV 61,906			
	NM 83,907			
	TX 38,420			
Total Population within 800-m (0.5-mi) Buffer Zone:				**235,698**

Y-12 Û NTS

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	24.0	814.2	5,959.3	
People/km^2	9.3	314.3	2,300.9	
Distance				
Miles	1,861.6	354.3	49.2	2,265.0
Kilometers	2,995.8	570.3	79.1	3,645.1
Percentages	82.2	15.6	2.2	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR 77,168			
	AZ 36,032			
	CA 15,433			
	NM 83,907			
	NV 61,906			
	OK 80,578			
	TN 168,225			
	TX 39,756			
Total Population within 800-m (0.5-mi) Buffer Zone:				**563,005**

SRS Û WIPP

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	34.0	815.1	5,632.2	
People/km^2	13.1	314.7	2,174.6	
Distance				
Miles	1,072.5	401.1	39.4	1,512.8
Kilometers	1,726.0	645.5	63.4	2,434.6
Percentages	70.9	26.5	2.6	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AL 67,186			
	GA 155,168			
	LA 53,453			
	MS 47,944			
	NM 1,150			
	SC 4,642			
	TX 186,722			
Total Population within 800-m (0.5-mi) Buffer Zone:				**516,265**

LANL Û WIPP

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	15.2	727.5	4,948.3	
People/km^2	5.9	280.9	1,910.5	
Distance				
Miles	347.2	23.1	3.1	373.5
Kilometers	558.8	37.2	5.0	601.0
Percentages	93.0	6.2	0.8	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	NM 29,512			
Total Population within 800-m (0.5-mi) Buffer Zone:				**29,512**

Pantex Û WIPP

RADTRAN Input Data	Rural		Suburban	Urban	Totals
Weighted Population					
People/mi^2	12.1		961.7	5,317.1	
People/km^2	4.7		371.3	2,052.9	
Distance					
Miles	419.8		20.3	6.9	447.0
Kilometers	675.6		32.7	11.1	719.4
Percentages	93.9		4.5	1.5	
Basis (people/mi^2)	<139		139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	NM TX	19,291 38,420			
Total Population within 800-m (0.5-mi) Buffer Zone:					**57,711**

Y-12 Û WIPP

RADTRAN Input Data	Rural		Suburban	Urban	Totals
Weighted Population					
People/mi^2	32.4		851.1	5,879.8	
People/km^2	12.5		328.6	2,270.2	
Distance					
Miles	1,018.4		319.3	41.3	1,379.0
Kilometers	1,638.9		513.9	66.4	2,219.3
Percentages	73.8		23.2	3.0	
Basis (people/mi^2)	<139		139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AR NM TN TX	63,457 1,150 168,225 248,611			
Total Population within 800-m (0.5-mi) Buffer Zone:					**481,443**

NTS Û WIPP

RADTRAN Input Data	Rural	Suburban	Urban	Totals
Weighted Population				
People/mi^2	16.6	879.1	6,148.9	
People/km^2	6.4	339.4	2,374.1	
Distance				
Miles	1,084.0	100.6	20.8	1,205.3
Kilometers	1,744.4	161.9	33.4	1,939.8
Percentages	89.9	8.3	1.7	
Basis (people/mi^2)	<139	139-3,326	>3,326	
Population within 800-m (0.5-mi) Buffer Zone by state:	AZ 36,032 CA 15,433 NV 61,906 NM 97,394			
Total Population within 800-m (0.5-mi) Buffer Zone:				**210,765**

Based on these data, it is possible to construct a ranking of relative impacts for the various sites with respect to the infrequent plutonium shipments that were not analyzed. The results are presented in Table D.2–2. SRS and LANL logically tied for least impact because they are suppliers of the plutonium metal. Rankings are listed by total person-miles and then re-ranked by selecting only the nearest plutonium supplier.

Table D.2–2. Ranking of Relative Impacts for Plutonium Metal Shipments

Ranking By Total Person Miles			
MPF site	**Person-miles from SRS**	**Person-miles from LANL**	**Total person-miles**
1. LANL	788,000	0	788,000
1. SRS	0	788,000	788,000
2. Pantex	659,000	130,000	789,000
3. Carlsbad Site	585,000	214,000	800,000
4. NTS	1,040,000	211,000	1,250,000

Ranking by Person-Miles to Nearest Supplier		
MPF site	**Nearest supplier**	**Person-miles from nearest supplier**
1. LANL	LANL	0
1. SRS	SRS	0
2. Pantex	LANL	130,000
3. NTS	LANL	211,000
4. Carlsbad Site	LANL	214,000

D.3 INCIDENT-FREE ANALYSIS

NNSA used RADTRAN 5 (Neuhauser and Kanipe 2000) to calculate collective dose from incident-free transportation of radioactive materials by truck. RADTRAN was developed and is maintained by Sandia National Laboratories. It is capable of analyzing both incident-free and accident impacts for highway, rail, ship and barge, and air transport. For incident-free analysis, the code calculates collective doses to persons along the route (e.g., residents), persons sharing the route, persons at stops, and drivers. Important inputs to RADTRAN are the demographic and route data described in Section D.2, the dose rate from the truck, and other parameters.

For incident-free analysis, a principal RADTRAN input is the radiation dose rate one meter from the truck. To determine dose rates from the truck, the NNSA made assumptions about the packages and the truck loading configuration and then used the computer code Microshield (Grove Engineering 1996) to determine doses. For pits, the NNSA selected the gross characteristics of the FL package, a Type B package certified for transport of pits. For EU shipments, the NNSA selected the gross characteristics of the 6M package, also a Type B package certified for the purpose. Contact-handled TRU waste was assumed to be packaged in the TRUPACT-II cask, three to a truck. LLW was assumed to be placed in a Type A 208 L (55-gal) drum, loaded 80 to a truck. For all four materials, actual shipments might involve different but similar packaging.

Microshield calculations of arrays of pit and EU packages placed into SST/SGTs yielded very low dose rates. For conservatism, the NNSA selected a larger dose rate to model, 1 mrem/hr. Years of experience shipping weapons-related fissile materials have demonstrated that the 1 mrem/hr dose rate is not likely to be exceeded. Dose rates for TRU waste were not calculated but taken from the WIPP SEIS (DOE 1997b). LLW was assumed to be 1 mrem/hr based on information in the Waste Management Programmatic EIS (PEIS) (DOE 1997a). The shielding analyses made many simplifying, but conservative, assumptions to arrive at dose rates for analysis that would be higher than those actually encountered.

Individual RADTRAN runs needed for the analysis are indicated in Table D.3–1. (Except for the dose rate, Table D.3–1 also applies to accident analyses.) Results of the shielding analysis are also provided. The index numbers correspond to the TRAGIS runs for the relevant origin-destination pair. The plutonium metal analyses were not performed because of their small contribution to the overall analysis.

Results of the incident-free analysis for a single, one-way shipment are provided in Table D.3–2. They are keyed to the run numbers provided in Table D.2–1. These results can be aggregated into values for the three alternatives, three capacity options, and for the five sites as described in Section D.5 and reported in Sections 5.2.12, 5.3.12, 5.4.12, 5.5.12, and 5.6.12.

Table D.3–1. RADTRAN Runs and Dose Rates for Incident-Free Analysis

No.	Origin-Destination	Material	Dose Rate
1	LANL ⇔ SRS	Plutonium metal	No Run
2a	Pantex ⇔ SRS	Pits	1
2b	SRS ⇒ Pantex	Plutonium metal	No Run
3	Y-12 ⇔ SRS	EU	1
4a	LANL ⇔ Pantex	Pits	1
4b	LANL ⇒ Pantex	Plutonium metal	No Run
5	Y-12 ⇔ Pantex	EU	1
6	Y-12 ⇔ LANL	EU	1
7	SRS ⇒ NTS	Plutonium metal	No Run
8	LANL ⇒ NTS	Plutonium metal	No Run
9a	Pantex ⇔ NTS	Pits	1
9b	Pantex ⇒ NTS	LLW	1
10	Y-12 ⇔ NTS	EU	1
11a	SRS ⇒ Carlsbad Site	Plutonium metal	No Run
11b	SRS ⇒ WIPP	TRU waste	4
12a	LANL ⇒ Carlsbad Site	Plutonium metal	No Run
12b	LANL ⇒ WIPP	TRU waste	4
13a	Pantex ⇔ Carlsbad Site	Pits	1
13b	Pantex ⇒ WIPP	TRU waste	4
14	Y-12 ⇒ Carlsbad Site	EU	1
15a	NTS ⇒ WIPP	TRU waste	4
15b	Carlsbad Site ⇒ NTS	LLW	1

Table D.3–2. Results of Incident-Free RADTRAN Runs (Person-Rem) for a Single Shipment

RADTRAN Run No.	Public Collective Dose				Worker Collective Dose	Total Dose
	Stops	Sharing Route	Along Route	Total Public	Drivers	
1	-	-	-	-	-	-
2a	6.7×10^{-3}	1.6×10^{-2}	2.2×10^{-3}	2.5×10^{-2}	1.6×10^{-2}	4.1×10^{-2}
2b	-	-	-	-	-	-
3	1.4×10^{-3}	6.7×10^{-3}	1.0×10^{-3}	9.1×10^{-3}	5.4×10^{-3}	1.4×10^{-2}
4a	1.4×10^{-3}	3.7×10^{-3}	2.7×10^{-4}	5.3×10^{-3}	4.1×10^{-3}	9.5×10^{-3}
4b	-	-	-	-	-	-
5	5.4×10^{-3}	9.9×10^{-3}	1.3×10^{-3}	1.7×10^{-2}	1.2×10^{-2}	2.9×10^{-2}
6	6.7×10^{-3}	1.4×10^{-2}	1.6×10^{-3}	2.2×10^{-2}	1.6×10^{-2}	3.8×10^{-2}
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9a	5.4×10^{-3}	7.6×10^{-3}	6.5×10^{-4}	1.4×10^{-2}	1.2×10^{-2}	2.5×10^{-2}
9b	6.3×10^{-3}	8.9×10^{-3}	7.6×10^{-4}	1.6×10^{-2}	2.5×10^{-2}	4.1×10^{-2}
10	1.2×10^{-2}	1.8×10^{-2}	1.9×10^{-3}	3.2×10^{-2}	2.4×10^{-2}	5.5×10^{-2}
11a	-	-	-	-	-	-
11b	2.3×10^{-2}	4.3×10^{-2}	6.1×10^{-3}	7.2×10^{-2}	3.8×10^{-2}	1.1×10^{-1}
12a	-	-	-	-	-	-
12b	7.7×10^{-3}	4.6×10^{-3}	3.5×10^{-4}	1.3×10^{-2}	7.3×10^{-3}	2.0×10^{-2}
13a	2.7×10^{-3}	2.3×10^{-3}	1.4×10^{-4}	5.2×10^{-3}	4.1×10^{-3}	9.2×10^{-3}
13b	7.7×10^{-3}	6.6×10^{-3}	4.0×10^{-4}	1.5×10^{-2}	8.8×10^{-3}	2.3×10^{-2}
14	8.1×10^{-3}	1.4×10^{-2}	1.8×10^{-3}	2.4×10^{-2}	1.6×10^{-2}	3.9×10^{-2}
15a	1.9×10^{-2}	2.1×10^{-2}	1.8×10^{-3}	4.2×10^{-2}	2.5×10^{-2}	6.6×10^{-2}
15b	7.9×10^{-3}	8.5×10^{-3}	7.2×10^{-4}	1.7×10^{-2}	2.6×10^{-2}	4.3×10^{-2}

"-" = no RADTRAN run needed.

D.4 ACCIDENT ANALYSIS

The NNSA used RADTRAN 5 for the accident analysis and employed the conservative methodology of NUREG 0170, *Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes* (NRC 1977). The method considers eight categories of potential accidents with severity levels based on increasing levels of impact, crush, fire, and puncture. As done for many other RADTRAN analyses of radioactive materials transport, the NNSA has selected parameters for the eight categories consistent with NUREG 0170 and the RADTRAN 5 User Guide. This simple approach with standard inputs based on the materials, packaging, and mode of transport, is appropriate for this programmatic evaluation to distinguish between the five sites.

The results of a RADTRAN accident analysis are based on a sum of the risks over various segments of the transportation route, taking into account differing accident frequencies and severity categories in urban, suburban, and rural population zones. Demographic information is taken from TRAGIS. Accident rates are taken from Saricks and Tompkins (1999) for standard truck transport. Analyses involving SST/SGT transport used actual accident rates that are lower. The final risk output is a product of the collective dose and the probability of the accident occurring, summed over all accident severity categories and population zones. Therefore, although the units of the results are in person-rem, the unitless probability is also a factor in the results.

Results of the RADTRAN runs are provided in Table D.4–1. The results of the RADTRAN runs must be multiplied by the number of shipments per year to give an annual risk value.

Table D.4–1. Results of RADTRAN Accident Runs for a Single Shipment

RADTRAN Run No.	Dose Risk (person-rem)	RADTRAN Run No.	Dose Risk (person-rem)
1	-	9b	4.8×10^{-6}
2a	3.5×10^{-8}	10	2.9×10^{-11}
2b	-	11a	-
3	9.3×10^{-12}	11b	1.5×10^{-4}
4a	6.2×10^{-9}	12a	-
4b	-	12b	2.3×10^{-6}
5	1.8×10^{-11}	13a	4.4×10^{-9}
6	2.2×10^{-11}	13b	6.3×10^{-6}
7	-	14	2.3×10^{-11}
8	-	15a	1.2×10^{-5}
9a	1.6×10^{-8}	15b	3.2×10^{-6}

"-" = no RADTRAN run needed.

NNSA also calculated the traffic accident fatality rate for all radiological transportation associated with the Proposed Action and alternatives. The state-specific miles for each shipment campaign (route mileage time number of trips) was multiplied by state-specific truck accident and fatality rates from Saricks and Tomkins (1999) and the summed for all states. Although the national average accident rate for SST/SGT shipments are much less than that for SST/SGTs, state-specific rates for SST/SGTs are not available. Accordingly, NNSA used commercial truck accident rates for all shipment campaigns. Results are reported in Chapter 5.

D.5 CONSTRUCTION OF ALTERNATIVES

The RADTRAN results presented in Sections D.3 and D.4 must be combined into alternatives, impacts for a given site, and capacity options.

D.5.1 No Action Alternative

Radiological transportation under the No Action Alternative for LANL would include transport of pits from Pantex to LANL, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at LANL. For purposes of transportation analysis, these pits are assumed to arrive in two shipments. Recycle shipments of EU would also be sent and received in two shipments.

Therefore, the No Action Alternative includes:

- 2 roundtrip shipments of pits under RADTRAN run 4a
- 2 roundtrip shipments of EU under RADTRAN run 6
- 20 one-way shipments of TRU waste under RADTRAN run 12b

D.5.2 Modern Pit Facility Alternative

D.5.2.1 Los Alamos Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for LANL would include transport of pits from Pantex to LANL, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at LANL. NNSA's analysis includes options for 125, 250, and 450 ppy. For purposes of transportation analysis, these pits are assumed to arrive in 7, 14, and 25 shipments, respectively. Recycle shipments of EU would be sent and received in 5, 10, and 18 shipments, respectively.

Therefore, for the MPF Alternative at LANL, the following RADTRAN runs would be selected:

- 7, 14, 25 roundtrip shipments of pits under RADTRAN run 4a
- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 6
- 74, 93, 142 one-way shipments of TRU waste under RADTRAN run 12b

D.5.2.2 Nevada Test Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for NTS would include transport of pits from Pantex to NTS, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at NTS. NNSA's analysis includes options for 125, 250, and 450 ppy. For purposes of transportation analysis, these pits are assumed to arrive in 7, 14, and 25 shipments, respectively. Recycle shipments of EU would be sent and received in 5, 10, and 18 shipments, respectively.

Therefore, for the MPF Alternative at NTS, the following RADTRAN runs would be selected:

- 7, 14, 25 roundtrip shipments of pits under RADTRAN run 9a
- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 10
- 74, 93, 142 one-way shipments of TRU waste under RADTRAN run 15a

D.5.2.3 Pantex Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for Pantex would include recycle of EU parts to and from the Y-12 in Oak Ridge, shipment of TRU waste to WIPP, and shipment of LLW to NTS. The pits would already reside at Pantex. NNSA's analysis includes options for processing 125, 250, and 450 ppy. For purposes of transportation analysis, these pits are assumed to result in EU recycle shipments that would be sent and received in 5, 10, and 18 shipments, respectively.

Therefore, for the MPF Alternative at NTS, the following RADTRAN runs would be selected:

- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 5
- 74, 93, 142 one-way shipments of TRU waste under RADTRAN run 13b
- 136, 217, 331 one-way shipments of LLW under RADTRAN run 9b

D.5.2.4 Savannah River Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for SRS would include transport of pits from Pantex to SRS, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at SRS. NNSA's analysis includes options for 125, 250, and 450 ppy for purposes of transportation analysis, these pits are assumed to arrive in 7, 14, and 25 shipments, respectively. Recycle shipments of EU would be sent and received in 5, 10, and 18 shipments, respectively.

Therefore, for the MPF Alternative at SRS, the following RADTRAN runs would be selected:

- 7, 14, 25 roundtrip shipments of pits under RADTRAN run 2a
- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 3
- 74, 93, 142 one-way shipments of TRU waste under RADTRAN run 11b

D.5.2.5 Carlsbad Site Modern Pit Facility Alternative

Radiological transportation under the MPF Alternative for the Carlsbad Site would include transport of pits from Pantex to the Carlsbad Site, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of LLW to NTS. TRU waste would be disposed of at WIPP. The NNSA's analysis includes options for processing 125, 250, and 450 ppy for purposes of transportation analysis, these pits are assumed to arrive in 7, 14, and 25 shipments, respectively, each with 18 packages. Recycle shipments of EU would be sent and received in 5, 10, and 18 shipments, respectively, each with 25 packages.

Therefore, for the MPF Alternative at the Carlsbad Site, the following RADTRAN runs would be selected:

- 7, 14, 25 roundtrip shipments of pits under RADTRAN run 13a
- 5, 10, 18 roundtrip shipments of EU under RADTRAN run 14
- 136, 217, 331 one-way shipments of LLW under RADTRAN run 15b

D.5.3 TA-55 Upgrade Alternative

Radiological transportation under the TA-55 Upgrade Alternative for LANL would include transport of pits from Pantex to LANL, recycle of EU parts to and from the Y-12 in Oak Ridge, return of re-assembled pits to Pantex, and shipment of TRU waste to WIPP. LLW would be disposed of at LANL. For purposes of transportation analysis, these pits are assumed to arrive in five shipments. Recycle shipments of EU would be sent and received in four shipments.

Therefore, for the TA-55 Upgrade Alternative, the following RADTRAN run would be selected:

- 5 roundtrip shipments of pits under RADTRAN run 4a
- 3 roundtrip shipments of EU under RADTRAN run 6
- 55 one-way shipments of TRU waste under RADTRAN run 12b

D.6 Calculation of Latent Cancer Fatalities

In Chapter 5 of this EIS, DOE reports human health effects from transportation of radioactive materials in terms of latent cancer fatalities (LCFs). Consistent with recommendations of the International Commission on Radiological Protection (ICRP 1991), DOE uses factors to convert collective dose in person-rem to numbers of latent cancer fatalities. For workers, the value is 4×10^{-4} LCFs per person-rem and for the general population the value is 5×10^{-4} LCFs per person-rem.