RISKS OF TRANSPORTATION ALONG VARIOUS ROUTES TO THE NEVADA TEST SITE

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INTRODUCTION

Residents of Southern Nevada have expressed interest in the risks posed by transportation of radioactive materials to the Nevada Test Site for disposal. Residents of the urban sections of Clark County, in particular, are concerned because the trucks carrying this material pass through fairly densely populated areas on both primary and secondary highways.   Excellent studies by the Desert Research Institute (Miller, et al, 2005; 2007) measured the external radiation doses from these trucks and provided a benchmark for estimating the doses sustained by the population along the transportation routes. The studies did not, however, assess the doses to the population in the event of anaccident involving these trucks. The present study estimates doses to the population along these routes and to various individual receptors, both for routine, incident-free transportation and for transportation accidents.

STUDY METHODS

RADTRAN

The program and code RADTRAN was used to estimate transportation risks (Neuhauser, et al, 2000; Weiner et al, 2006). RADTRAN estimates doses from routine, incident-free transportation by modeling the radioactive cargo as a sphere moving at the speed of the vehicle; the external dose rate at one meter from the cargo (the transport index, or TI) is modeled as a virtual radiation source at the center of this sphere. Doses from transportation accidents that do not involve releases of ionizing radiation also use this model. Accidents in which radioactive material is assumed to be released are modeled by Gaussian dispersion and deposition of released material. Details of these models may be found in Neuhauser et al (2000) and Weiner et al (2006). RADTRAN 5.6 with the input file generator RADCAT 2.3 was used for this study.

RADTRAN input data are shown in Tables 1, 2 and 3. All transportation was by truck. Table 1 Shows the parameters related to population, crew, accidents, vehicle speeds, etc.

Table 1.   Parameters used in calculating incident-free doses.

Parameter	Parameter Value	Comments and Reference
Package		
Package type	Type A	
Package dimension	See Table 2	INEL04SMC002. 0001; NFSI1000000002, 3
External Dose rate (TI)	See Table 2	INEL04SMC002. 0001; NFSI1000000002, 3
Fraction of emitted radiation that is gamma	1.00 (0.99998)	Calculated from inventory and ICRP38 (1983)
Fraction of emitted radiation that is neutrons	2×10^{-5}	
Crew		
Number of crew	2	
Distance from source to crew	3.1 m	
Dose to truck crew during travel	2 mrem/hr	This is the regulatory maximum.
Truck Speeds		Insurance Institute for Highway Safety, as cited by the U.S. Bureau of Transportation Statistics, State Transportation Statistics 2005, Table 2-9 (www.bts.gov)
Rural	113 km/hr[a]	
Suburban	113 km/hr	
Urban	105 km/hr; Clark Co: 97 km/hr	
Traffic accident rate	3.6×10^{-6}/vehicle-km	Nevada data, State Transportation Statistics, U.S. Bureau of Transportation Statistics, 2005, Table 2-1 (www.bts.gov)
Traffic fatality rate	1.27×10^{-8}/vehicle-km	
Number of people per vehicle sharing route	2	
Minimum and maximum distances to exposed resident population along the route	30 to 800 m	
Population densities (persons per km²)		
Rural	See Table 3	
Suburban	See Table 3	
Urban	See Table 3	
One-way traffic count (vehicles per hour) on Nevada highways		
Clark Co. Rural	3640	From The Transportation Health and Safety Calculation Package, DOE, 2002. The traffic counts for counties other than Clark Co are the average for the state (excluding Clark Co.) because there were not enough data for each of the other counties.
Clark Co. Suburban	1230	
Clark Co. Urban	3160	
Other Nevada Rural	148	
Other Nevada Suburban	311	
Other Nevada Urban	2010	

[a] 1 km = 0.6217 mi.

Table 2 shows the parameters related to the cargo section of the vehicle.

Table 2.   Cargo parameters used in calculating incident-free doses.

| Shipment ID | Material | Vehicle (Cargo) Dimensions (m) | | TI(mrem/hr |
		Length	Crew View[a]	
INL08001	unknown	8.41	3.66	0.001
INL08002	unknown	6.06	3.14	0.50
INL08003	unknown	6.06	3.14	0.01
NFL08041	caustic	8.41	3.66	0.01
NFL08042	caustic	8.41	3.66	1.00
NFL08043	raffinate	8.41	3.66	0.01
POL08131	scrap metal	8.41	3.66	0.01
POL08132	scrap metal	8.41	3.66	0.10
POL08133	scrap metal	8.41	3.66	0.01
POL08134	scrap metal	8.41	3.66	0.01
PORTLP0001002	wet solid ,HEPA filters	6.10	3.14	0.10
NFS100000000302	stabilized caustic	6.10	3.56	2.80
NFS100000000201	stabilized raffinate	6.10	3.56	10.00

Table 3. Radionuclide inventories in curies for each package shipped.

Shipment ID	NP237	PA234M	PU238	PU239	TC99	TH231	TH234	U232	U234	U235	U236	U238	AM241	PA231	RA226
INL08001	5.65E-10	8.57E-05	8.57E-11	1.28E-10	4.89E-08	1.08E-06	8.57E-05	1.50E-07	1.54E-05	1.08E-06	5.00E-07	8.57E-05	8.86E-10		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.07E-01	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-05	1.07E-01	2.70E-11		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
INL08002	1.20E-06	1.07E-01	6.60E-06	8.54E-07	1.75E-04	1.30E-03	1.07E-01	1.84E-04	5.26E-02	1.30E-03	1.34E-03	1.07E-01	6.23E-06		
INL08002	1.76E-06	1.57E-01	9.69E-06	1.25E-06	2.56E-04	1.92E-03	1.57E-01	2.70E-04	7.74E-02	1.92E-03	1.97E-03	1.57E-01	9.14E-06		
NFL08041									3.62E-02	7.41E-04	8.81E-03	2.22E-05			
NFL08042									2.81E-02	5.73E-04	6.81E-03	1.72E-05			
NFL08043	6.57E-04		4.86E-06		3.11E-03				1.15E-02			2.62E-03		2.38E-03	2.86E-03
POL08131					1.49E-03				1.93E-04	6.67E-06		4.04E-05			
POL08132					1.15E-03				2.48E-04	8.58E-06		5.19E-05			
POL08133					1.67E-03				5.57E-04	1.93E-05		1.17E-04			
POL08134					1.88E-03				3.13E-04	1.08E-05		6.64E-05			
PORTLP0001002					2.19E-04				2.56E-04	1.48E-05		2.28E-04			
NFS100000000302									7.97E-02	1.64E-03	1.94E-02	5.50E-05			
NFS100000000201	6.80E-06		7.20E-06						5.40E-03		1.25E-03	9.80E-06		1.13E-03	1.33E-03

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