THE ANALYSIS OF LOCAL IMPACT OF THE TRANSPORTATION OF CH WASTE TO WIPP

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ABSTRACT

This paper discusses the method used in assessing the impact of transportation of contact-handled transuranic waste to the Waste Isolation Pilot Plant (WIPP) on the health and safety of the citizens of New Mexico. This analysis used the RADTRAN II computer code developed by Sandia National Laboratories and considers the route specific and source specific characteristics of these waste shipments. The analysis includes the impact of incident-free transportation and potential accident conditions. The analysis projects that the transportation of waste to WIPP will produce less than .0002 latent fatal cancers per year of operation for the 25 years of facility operation.

INTRODUCTION

An area of significant concern to most states hosting a radioactive waste disposal site is the potential impact of transportation of radioactive waste on the public health and safety. As part of a series of agreements between the Department of Energy (DOE) and the State of New Mexico,[1,2] the WIPP Technical Support Contractor (TSC) (Westinghouse Electric Corporation) has prepared a "Preliminary WIPP Transportation Analysis" (PTA).[3] This analysis evaluates radiological impacts of the transportation of contact-handled (CH) transuranic (TRU) waste to WIPP on the State of New Mexico from the various major generators (see Fig. 1). The impact of remote-handled (RH) waste and the experimental waste (DHLW) are not included in this preliminary analysis since necessary data are still incomplete. However, as can be seen in the WIPP FEIS,[4] these two waste forms do not contribute significantly to the impact on public health and safety. The impact of these two waste forms will be evaluated in a later analysis. A final analysis of the radiological impact of transportation of all the waste projected to be received at WIPP will be published about one year before the receipt of waste at WIPP.

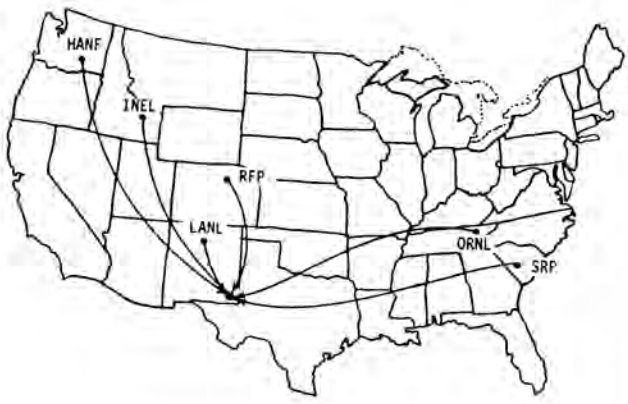

Fig. 1 Major Waste Generators For CH Waste.

DESCRIPTION OF ANALYSIS

The analysis described in the PTA uses the RADTRAN II computer program developed by Sandia National Laboratories.[6,7] This program allows an assessment of the impact of both incident-free transportation and transportation accidents.

ROUTE CHARACTERISTICS

The analysis requires that the projected routes to a disposal site and the number of shipments per year on each route be established. Each section of a route in New Mexico is then analyzed and the total impact of shipping is obtained by totaling the impact of each route. Figures 2 and 3 are examples of a truck and a rail route respectively to WIPP.

To characterize each route, it is necessary to establish the distance traveled on each route in rural, suburban, and urban areas. The distance traveled in suburban areas should be sufficiently conservative to include the distances traveled in cities with significant population densities. It was assumed in this analysis that an urban area (city) has a population greater than 100,000 people and a suburban area has a population of at least 3 to 4 thousand people. The suburban population density for various cities along the route are then averaged to obtain a typical value for the route. This averaging technique is appropriate since accident-related impacts are probablistically averaged in the analysis and the impact of averaging on incident-free transportation results is compensated for by the short time periods the waste is near a unit of higher density population. Table I summarizes the data used in this analysis. In addition, local data can be used for the accident rates for various routes. The PTA used local accident rates for truck shipments but used the national averages provided in RADTRAN II for rail accidents since local data was unavailable.

Characteristic meteorological assumptions were established for each local area and then each route. The assumptions were based on meteorological data summarizing "Monthly and Annual (Day/Night) Wind Distribution of Pasquil Stability Classes (7) Star Program" available for various localities from the U.S. Department of Commerce, National Climatic Center. This data reflected a characteristic

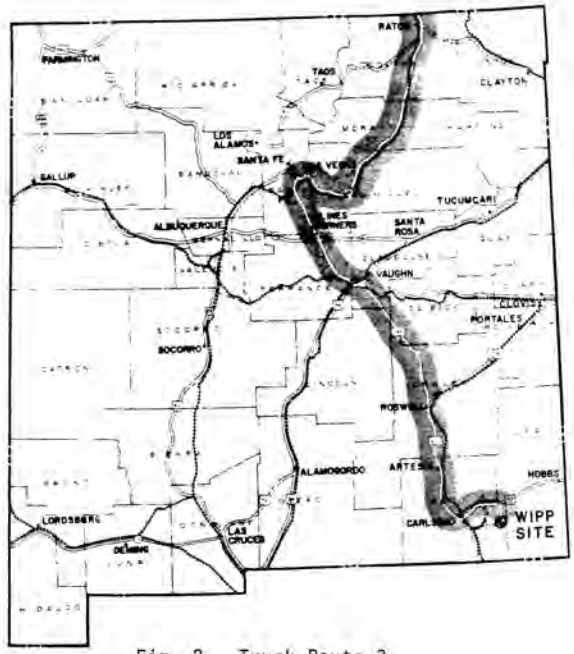

Fig. 2. Truck Route 3

Fig. 3. Rail Route 4

TABLE I

Route Data

Routes	No. of Shipments	Suburban* Population Density People Km^2	Length of Travel in New Mexico Type	(km)	Fraction of Travel Rural	Suburban	Urban
1	32	492	Truck	81	.90	.1	0
2	2	492	Truck	128	.93	.07	0
3	90	898	Truck	772	.95	.05	0
4	28	622	Truck	602	.94	.06	0
5	2	622	Truck	751	.94	.06	0
6	11	592	Truck	767	.95	.05	0
7	0	592	Truck	927	.96	.04	0
8	167	624	Truck	628	.94	.06	0
9	0	653	Truck	779	.92	.04	.04
10	98	653	Truck	914	.93	.04	.03
11	14	850	Truck	919	.93	.04	.03
12	30	624	Truck	666	.90	.05	.05
Total Truck	474						
1R	0	712	Rail	1018	.97	.03	0
2R	154	492	Rail	102	.96	.04	0
3R	8	648	Rail	370	.93	.07	0
4R	521	691	Rail	580	.94	.06	0
5R	28	903	Rail	578	.93	.05	.02
Total Rail	711						
Total	1185						

Urban Population Density (Albuquerque)
1,144/People/Km^2

Rural Population Density
2 People/Km^2

increase in atmospheric stability at night in the New Mexico area. The impact of this diurnal variation in stability class will be investigated at a later date although the use of averaged stabilities is apparently conservative, since the increased stability increases the exposure of the public in the immediate area surrounding an accident.

SOURCE TERMS

The source terms used in the analyses are route dependent and are summarized in Table II.

To minimize the variation in the potential accident release impacts (operational,

TABLE II
Isotopic Distribution in Waste

Facility	Activity (Curies/TRUPACT) U-233	Pu-238	Pu-239	Pu-240	Pu-241	Am-241	Cm-244	Cf-252
HANF & SRP-NH*		19	196	37	986	185		
INEL & RFP	3	152	88	14	412	210		
LANL	0	277	16			30		
ORNL	25	168	21	10	218	15	422	4
SRP-H*		302	1		32			
Weapons Grade		18.1	213	47.3	1110	2.79		
Heat Source	0	303	0.317	0.317	14.3			
Americium Enhanced	0	168	52.5	12.5	406	185	3.33	

*304 is weapon grade plutonium waste.
It is heat source plutonium waste.

TABLE III
TRUPACT Response to Accident Containers*

Severity Class of Accident	Fraction of Content Released
1	0
2	0
3	1.0-6**
4	1.0-5
5	1.0-4
6	1.0-3
7	1.0-2
8	1.0-1

*These data are based on design basis criteria for the TRUPACT and the projections in Reference 3 for typical packages put into service after 1985. The projected performance of the TRUPACT is several orders of magnitude better than indicated in this table.

**1.0-6 = 1.0×10^{-6}

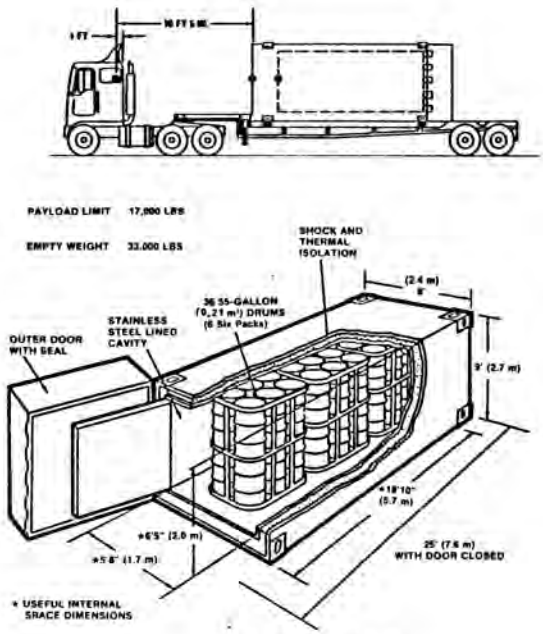

Fig. 4 TRUPACT.

transportation, and long term), a Plutonium-239 equivalent activity limit (PE-Ci) was established for drums and boxes of waste shipped to WIPP. This equivalency is based on Column 1, Table 1 of Appendix B of 10 CFR 20. This method of comparison was chosen since inhalation is the primary exposure pathway for all accidents at WIPP and this data should track current dose assessment techniques as they change. Further discussion of the PE-Ci limit can be found in Appendix A of the PTA as well as a summary of the impact of potential changes in Appendix B of 10 CFR 20.

SHIPPING CONTAINER

The final data necessary for an analysis of the impact of transportation are the container characteristics. It is projected that the CH waste will be shipped to WIPP in Type A 55-gallon drums or various Type A boxes with a TRUPACT. The TRUPACT projected design is shown in Fig. 4. When used in rail transport, two TRUPACTs will be placed on a railcar.

The characteristic projected releases from TRUPACTs in various severity accidents are summarized in Table III. Accident severity is defined as a function of the crush force and fire duration (1300° Kelvin fire).

Figure 5 shows the accident severity classes for a truck accident.

The impacts of transportation accidents are found by summing the overall severity classes of the accident times the probability of each severity class in rural, suburban, and urban areas for each route.

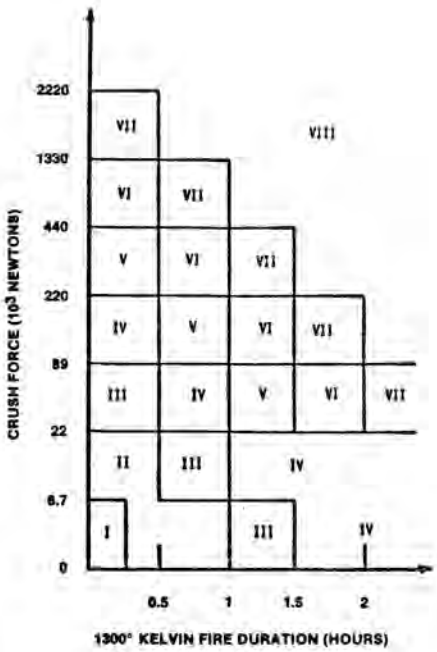

FIGURE 5. ACCIDENT SEVERITY CATEGORY CLASSIFICATION SCHEME - MOTOR TRUCKS

SUMMARY OF RESULTS

Incident-Free Transportation

Table IV summarizes the impact of incident-free transportation of CH waste to WIPP. (Detailed exposure data is summarized in Table V of the PTA.) It should be noted that the exposure on a very short transport route is dominated by the exposure received while stopped rather than the characteristics of the route.

TABLE IV

Expected Annual Number of Latent Cancer Deaths From Incident-Free Transportation

Method	No. of Shipments	General Population	Crew
Truck	474	3.-5	1.3-4
Rail	711	1.-4	1.6-5
All Forms	---	2.-4	1.6-4

Impact of Transportation Accidents

Table V provides a quantitative assessment of the radiation-related impact of radioactive waste transportation accidents on the public health and safety. The analyses indicate that there is no measurable probability of a radiation-related fatality occurring during or shortly after the projected accident. The analyses calculate the probable number of the following effects:

1. early morbidity (a non-fatal illness occurring shortly after exposure), which may or may not lead to a fatal cancer or genetic effect at a later date;

2. latent fatal cancer occurring as a result of the exposure received in this hypothetical accident; and

3. genetic effect occurring as a result of the exposure received in this hypothetical accident.

The dose conversion factors used in these analyses are for 0.3 micron insoluble particles and are based on the models in Reference 5. This assumption is conservative as the waste form will consist almost entirely of oxides and hydroxides of the actinides which are very insoluble.

Plutonium-239 Equivalent Activity (PE-Ci)

Activity limits for WIPP are established in terms of equivalent hazard based on Pu-239. Establishing this type of control minimizes the impact of variation in isotopic distribution. Source terms such as "weapon grade," "heat source" and "americium enhanced," summarized in Table II, were used to test the effectiveness of this technique. Table VI summarizes the results of this comparison. It is apparent that these equivalent PE-Ci of activity produce approximately the same effect, with widely varying isotopic distributions. It appears to be a very beneficial way of characterizing and limiting waste activity content for a disposal facility since it eliminates the importance of having an accurate isotopic distribution during the preparation of NEPA documentation and safety analysis reports.

CONCLUSION

There is no significant radiation-related impact on the health and safety of New Mexico citizens from incident-free transportation of CH TRU waste to the WIPP Site. It is projected that the expected radiation-related latent fatal cancer rate from incident-free transportation associated with WIPP is about 0.0002 occurrences per year of operation. In fact, the projected population doses are not significant when compared to doses from natural background radiation.

The radiation-related impacts of transportation accidents involving waste shipped to WIPP are extremely small. It is projected that the expected radiation-related latent fatal cancer rate from transportation accidents associated with WIPP is about 0.00001 occurrence per year of operation. This is estimated to be about 1.5% of the latent fatal cancer rate for the shipments of Type B quantities of waste throughout the U.S. and .06% of the rate for all shipments of radioactive material throughout the U.S.[1] The expected number of genetic effects is about 0.0000007 per year of operation. These values, though clearly acceptable, should only be interpreted comparatively and not as actual effects.

It is concluded that transportation of radioactive waste to the WIPP Site will cause no significant impact on the health and safety of the citizens of New Mexico.

TABLE V

Annual Impacts of Truck and Rail Accidents

Facilities	Routes	No. of Shipments	Projected Effects: Early Fatalities	Early Morbidities	Latent Fatal Cancers	Genetic Effects
HANF and SRP-NH	1	16	0	0	5.4-8	3.8-9
	2	1	0	0	3.8-9	2.7-10
	3	23	0	0	6.9-7	4.9-8
	5	1	0	0	2.4-8	1.7-9
	6	6	0	0	9.5-8	6.7-9
	10	22	0	0	4.1-7	2.9-8
	11	6	0	0	1.6-7	1.2-8
Total Truck		75	0	0	1.5-6	1.0-7
	2R	43	0	0	1.6-8	1.2-9
	3R	2	0	0	6.7-9	4.9-10
	4R	140	0	0	6.2-7	4.6-8
	5R	8	0	0	6.6-8	4.8-9
Total Rail		193	0	0	7.02-7	5.2-8
INEL and RFP	3	67	0	0	1.9-6	1.1-7
	6	5	0	0	1.2-7	6.6-9
	10	76	0	0	1.4-6	7.5-8
	11	8	0	0	2.1-7	1.1-8
Total Truck		156	0	0	3.6-6	2.6-7
	4R	381	0	0	1.6-6	1.2-7
	5R	20	0	0	1.6-7	1.1-8
Total Rail		401	0	0	1.8-6	1.4-7
LANL	8	167	0	0	1.9-6	3.5-8
	12	30	0	0	3.1-7	5.6-9
Total Truck		197	0	0	2.2-6	4.1-8
No Rail						
ORNL	4	28	0	0	3.7-7	1.5-8
Total Truck		28	0	0	3.7-7	1.5-8
	2R	67	0	0	2.2-8	1.3-9
	3R	4	0	0	1.1-8	7.0-10
Total Rail		71	0	0	3.3-8	2.0-9
SRP-H	1	16	0	0	3.1-8	2.1-10
	2	1	0	0	2.2-9	1.5-11
	5	1	0	0	1.4-8	9.7-11
Total Truck		18	0	0	4.7-8	3.2-10
	2R	44	0	0	9.6-9	6.1-10
	3R	2	0	0	3.9-9	2.5-10
Total Rail		46	0	0	1.4-8	8.6-10

TABLE VI

Impact of Transportation Accidents for Various Materials

Route	Material	Expected Effects per Shipment: Early Fatalities	Early Morbidities	Latent Fatal Cancers	Genetic Effects
10	Weapons Grade	0	0	1.4-8	9.4-10
10	Am-Enhanced	0	0	3.7-8	2.9-9
10	Heat Source	0	0	1.1-8	7.3-11
1R	Weapons Grade	0	0	3.0-9	2.1-10
1R	Am-Enhanced	0	0	8.0-9	6.2-10
1R	Heat Source	0	0	2.3-9	1.5-10

REFERENCES

1. Agreement for Consultation and Cooperation, State of New Mexico, Civil Action No. 81-0363JB July 1, 1981).

2. Supplemental Stipulated Agreement Resolving Certain State Off-Site Concerns, State of New Mexico, Civil Action No. 81-0363JB, (December 1982).

3. Woolfolk, S. W., Preliminary WIPP Transportation Analysis, WTSD-TME-002, Revision 1, (January 1984).

4. Final Environmental Impact Statement Waste Isolation Pilot Plant, DOE/EIS-0026, I & II, Department of Energy, Washington, D.C. (October 1980).

5. Dunning, D.E., Jr., et al, Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel-Cycle Facilities, Volumes I, II, and III, ORNL/NUREG/TM-190 (Vol. I (1978)), NUREG/CR-150 (Vol. II & III) (1979 & 1981).

6. Taylor, J. M., and Daniel, S. L., RADTRAN II: Revised Computer Code to Analyze Transportation of Radioactive Material, SAND80-1943, (October 1982).

7. Madsen, M. M., Taylor, J. M., Wilmot, E. L., RADTRAN II User Guide, SAND82-2681, (February 1983).