LOW-LEVEL RADIOACTIVE WASTE INVOLVED IN TRANSPORTATION EVENTS* **

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ABSTRACT

The Radioactive Materials Incident Report (RMIR) database contains information about radioactive materials transportation accidents and incidents that have occurred in the United States from 1971 through 1989. Using data from RMIR, this paper will provide detailed information on transportation accidents and incidents that have occurred with low-level radioactive wastes. Additionally, overview data on the number of transport accidents and incidents that have occurred and by what transport mode will also be provided.

INTRODUCTION

The Radioactive Materials Incident Report (RMIR) database is a compilation of transportation accidents and incidents that have occurred during the shipment of radioactive materials. The database was developed in 1981 at Sandia National Laboratories (SNL) to support its research and development efforts for the U. S. Department of Energy (DOE).

Currently, RMIR resides on TRANSNET, an interactive computer network that allows outside users to access transportation risk and systems analysis models and associated databases, of which RMIR is one. RMIR has a menu-driven format which expedites database searches, particularly for an infrequent user.

Reporting Requirements for Radioactive Transportation Events

The U. S. Department of Transportation (DOT) and the U. S. Nuclear Regulatory Commission (NRC) are the two federal agencies that have primary responsibility for developing and promulgating regulations for the transport of radioactive materials. Requirements for reporting transport events differ between the two agencies. The NRC regulations are outlined in the Code of Federal Regulations (10 CFR 20.402 and 20.403) and require that the theft or loss of radioactive materials, exposure to radiation, or release of radioactive material be reported. The DOT regulations for reporting a hazardous materials incident (of which radioactive is a subset) are specified also in the Code of Federal Regulations (49 CFR 171.15). The DOT requires that a report be filed after each event that occurs during the course of transporting radioactive materials (including loading, unloading, handling, and temporary storage) in which one of the following directly results: 1) A person dies; 2) a person is injured and requires hospitalization; 3) estimated carrier or other property damage exceeds $50,000; 4) fire, breakage, spillage, or suspected contamination involving radioactive materials; or 5) a situation that the carrier believes should be reported.

The RMIR database contains not only the report filed with the DOT and the NRC, but also data obtained from various state radiation control offices, the DOE Unusual Occurrence Report database, media coverage of a radioactive event, and most recently, the inclusion of data from the files of the DOE Emergency Response Assistance Teams.

Analysis of U. S. Radioactive Materials Transportation Accident/Incident Data

In reviewing the history of transporting radioactive materials, it is important to obtain a perspective by viewing the entire hazardous materials transport environment. According to the Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes (1), it is estimated that during a given year approximately 500 billion packages of all commodities are shipped by all transport modes throughout the United States. Approximately 100 million of that 500 billion are classified as hazardous materials (flammables, explosives, poisons and radioactive materials). The most recent study of the transport of radioactive materials indicates that approximately 2 million shipments are made each year and constitute about 2.79 million packages (2). Therefore, hazardous materials constitute about 0.2% of all commodities transported, and of those hazardous shipments, only 2% are classified as radioactive.

The RMIR database, which was established in 1981, was structured primarily to accommodate the information on the DOT Form 5800 for the recording of transportation events. Entries into the database generally meet both the NRC and the DOT regulatory requirements for notification of an event. The RMIR makes a definite distinction between

* This work performed at Sandia National Laboratories, Albuquerque, New Mexico, supported by the United States Department of Energy under Contract No. DE-AC04-76DP00789

** A United States Department of Energy Facility

an accident and a reported event. The following are definitions of the three classifications of events in RMIR

Incidents: Actual or suspected release of radioactive material, or surface contamination exceeding regulatory requirements on either the package or the transport vehicle.

Transportation Accidents: A transport event ranging from a minor accident to a major collision that involves the vehicles transporting the radioactive material.

Handling Accidents: Damage to a shipping container during loading, handling, or unloading operations; e.g., a forklift puncturing a package at an air terminal.

Table I provides a tabulation of the accidents, incidents and handling accidents that have occurred since 1971. Only 20% of the 1,319 events compiled for the United States are classified as transport accidents. As Table I indicates, 62% of all transportation events are classified as incidents.

TABLE I
U. S. Radioactive Materials
Transportation Events
(1/71 through 1/90)

Transportation Accidents	263
Handling Accidents	236
Transportation Incidents	820
TOTAL	1,319

Most radioactive materials are transported by highway, and those that are shipped by air are generally radioactive isotopes with short half lives that are being shipped over 500 miles from the shipper's location. Upon arrival at an airport, these radiopharmaceuticals are generally delivered to their consignees by a courier service. Radioactive materials transported by other modes are usually those that do not require immediate delivery. Most other radioactive materials traveling by highway are those involving industrial gauges, radioactive material used in or as a result of the nuclear fuel cycle, low-level radioactive materials or waste and teletherapy sources. Table II shows the RMIR breakdown for accidents, incidents and handling accidents by transportation mode. As Table II illustrates, radioactive material packages transported by highway account for about 80% of all the incidents that have occurred and 87% of all accidents. Approximately 56% of all handling accidents recorded in the RMIR database have occurred with low-level materials at air terminals. Most of these handling accidents occurred during the loading or unloading operations.

Low-level Radioactive Waste Transport Data Analysis

A description of low-level radioactive waste (LLW) is one more of exclusion than definition. Low-level waste is radioactive waste that is not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or any byproduct material as defined in Section 11e (2) of the Atomic Energy Act of 1954 (3).

Low-level radioactive waste is generated by commercial nuclear power plants, hospitals, research institutions, the federal government and industries. The type of waste generated by each of these entities may vary; as an example, typical LLW from a nuclear power reactor could include spent resins, dry compressible waste, contaminated plant hardware, filter sludges and evaporator bottoms and concentrated waste. Waste from medical research and the government might include dry compacted trash or solids,

TABLE II
Transportation Events By Mode
(1/71 - 1/90)

Mode	Accidents	Incidents	Handing Accidents
Air	15	138	132
Courier	1	1	2
Freight Forwarder	0	7	3
Highway	229	654	91
Rail	18	10	2
Warehouse	0	1	1
Water	0	5	4
Other, unidentified	0	4	1
TOTALS	263	820	236

absorbed liquids, animal carcasses and laboratory or biological waste. Industrial waste is generally depleted uranium, compacted trash or solids, sealed sources and contaminated plant hardware (4).

Most radionuclides present in LLW generally have lifetime measured in days, weeks, or decades; however, there are some long-lived radionuclides present in small concentrations that require the waste to be managed in a stable environment for an extended period. The method of disposal has been shallow and land burial since 1963 when Maxey Flats (Kentucky) and West Valley (New York) opened. In 1965 the Hanford, Washington site was opened and Sheffield, Illinois and Barnwell, South Carolina sites began operation in 1967 and 1971, respectively. Three of these sites were subsequently closed; Maxey Flats in 1977, West Valley in 1976 and Sheffield in 1978.

Since the RMIR database captures data beginning in 1971 with the initiation of DOT reporting requirements for transportation incidents, there is at least a nine-year time period during which no transportation related events were reported. Table III provides a breakdown of the LLW transportation events that are contained in the RMIR.

TABLE III
LLW Transportation Events

Transportation Accidents	45
Handling Accidents	5
Transportation Incidents	326
TOTAL	376

The RMIR lists only two reported LLW events that have occurred by rail. All other transportation events with LLW have been by highway, the most commonly used mode of transporting most radioactive material. The two events that occurred with LLW rail shipments had the same destination, the Hanford disposal site. The first event occurred in 1974 and involved an ATMX car that was derailed near Deer Lodge, Montana. There was no damage to the ATMX car and there was no damage to the radioactive packages. The next rail incident occurred in 1985 when a rail car with ten empty T-hoppers arrived at Hanford and 20 to 30 small pieces of uranium trioxide were found in or on the deck of the rail car.

Table IV provides a breakdown of the transportation-related events that have occurred by disposal site. The table shows first the open sites and then those that have closed.

Over 56% of the radioactive materials transportation events recorded for these states are related to LLW. However, only 3% of the LLW events are categorized as accidents, and those accidents constitute just under 2% of the total number of RAM transport events for those states. Most of the LLW events for these states were classified as incidents and were discovered at the disposal site. They involved contamination of a trailer bed, surface contamination or high radiation readings for a package, or loose closures of a package.

Of the ten accidents involving low-level waste in states hosting a LLW disposal site, two of the events involved the release of radioactive materials. The first of these events to occur was in Kentucky. A tractor trailer carrying activated shielding material was destined for the Maxey Flats disposal

TABLE IV
LLW Transportation Events For States With Disposal Sites
(1/71 - 1/90)

States with Open Sites	Total RAM Events	LLW Events	LLW Accidents
South Carolina (Barnwell)	206	194	4
Nevada (Beatty)	27	23	0
Washington (Hanford)	50	44	1
	283	261	5
States with Closed Sites			
Kentucky (Maxey Flats)	20	7	2
Illinois (Sheffield)	163	25	3
New York (West Valley)	66	8	0
	249	40	5
Total For States With Open And Closed Sites	532	301	10

site when it rear-ended a Kentucky Bureau of Highways truck that was spreading salt on the icy roads. The truck was transporting 32, 55-gallon steel drums (meeting "strong and tight" requirements), eight of which fell off the truck and ruptured when they hit the road. Radiation surveys of the material and surrounding area indicated no radiation levels above background. The rubble was repackaged and sent on to Maxey Flats for disposal.

The other accident involving the release of radioactive materials occurred in Washington on December 31, 1987. A truck transporting six metal boxes of compacted and non-compacted trash contaminated with cobalt-50, cobalt-60 and cesium-137 isotopes was involved in an accident in Richland, Washington. The DOT report indicated that the truck overturned and five of the boxes ruptured when they hit the highway. The surrounding area was decontaminated and the material repackaged and sent to Hanford for disposal.

Summary information on LLW transportation events was provided in Table III and Table V provides a year-by-year breakdown of these events.

Packaging Performance with Low-Level Waste

The type of packaging used for the transport of low-level waste to disposal sites is determined by the form and activity of the radioactive material. Typically, low-level radioactive wastes fall into the category of low specific activity (LSA) and Type-A quantities. The Department of Transportation requirements for shipping low-level wastes including 55-gallon steel drums, reinforced plywood boxes and casks or overpacks. There have been some occasional shipments in Type-B containers indicating that the radioactive contents are of a higher curie content than most low-level radioactive materials sent for disposal. Of the 376 events classified in the RMIR as low-level waste transport events, 30 events involved a shipment of waste in a Type B container. Those events involved shipments to and from commercial utilities, specifically, nuclear power plants.

Table VI outlines the categories of packaging used to transport the low-level waste with the number of packages

TABLE V
LLW Transportation Events

Year	Accidents	Incidents	Handling Accidents	Total
1971	0	1	0	1
1972	0	3	0	3
1973	0	3	1	4
1974	3	2	0	5
1975	4	5	0	9
1976	2	32	0	34
1977	1	43	0	44
1978	4	65	1	70
1979	6	87	1	94
1980	8	33	0	41
1981	1	16	0	17
1982	4	6	0	10
1983	5	5	2	12
1984	3	3	0	6
1985	1	11	0	12
1986	1	7	0	8
1987	2	3	0	5
1988	0	0	0	0
1989	0	1	0	1
1990	0	0	0	0
	45*	326	5	376

*The 45 accidents listed in Table V include the previously discussed accidents that occurred within the states hosting a LLW disposal site. Thus, almost 25% of the LLW accidents found in RMIR have occurred in a state that was or is a host state for low-level waste.

TABLE VI
Packages Involved In LLW Transportation Events
(1/71 - 1/90)

Package Category	No. of Packages Shipped	No. of Accidents	No. of Packages Exposed to Accidents	No. of Package Damages/ Failures	No. of Packages Released Contents
Industrial (strong & tight)	12,971	20	810	19	8
Type A	1,134	17	275	11	10
Type B	39	3	3	0	0
	14,144	40	1,088	30	18

shipped and the number of packages that were damaged or failed.

The total number of accidents in Table VI differs from the number indicated in Table V because there were five accidents with missing information concerning the number and type of packages that were involved in the event.

Of almost 13,000 "strong and tight" packages involved in accident conditions, only 19 packages have been damaged with eight of those packages releasing their contents. This appears to be a good safety record for a package that is not designed to meet transportation accident conditions.

There have been three accidents which involved a total shipment of 13 Type A packages; two packages were in good condition and undamaged, ten packages failed and released their contents, one package was damaged and found only to have a slightly high radiation reading. The two transportation accidents with Type A package failures involved waste destined for Hanford disposal site in Washington. One accident occurred in November 1987 on Interstate-80 between Cheyenne and Laramie, Wyoming. The other accident occurred in Richland, Washington in December 1987 and was previously described. As in the Richland accident, the truck overturned and five of the six packages in each truck broke open and released their contents. The radioactive material (trash with cobalt-50 and cobalt-60 isotopes) was repackaged and the surround areas were cleaned and surveyed to ensure there was no contamination.

SUMMARY AND CONCLUSIONS

The data contained in the RMIR provides a historical perspective of the transportation of radioactive materials in the United States. The data indicate that the transportation regulations have been effective in protecting persons and the environment from radioactive materials. The "strong and tight" and Type A containers, which are generally designed for normal transport conditions, have performed quite well in actual transport accidents, with only 18 packages out of 14,000 releasing materials.

Data from the RMIR is used in a number of ways including: Transportation environmental analyses, safety analyses, public information materials, responses to public inquires and in mitigating institutional concerns. For further information regarding the database, contact Cheryl Cashwell at (505) 845-8021.

REFERENCES

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