
An Historical Summary of Transportation Accidents and Incidents Involving Radioactive Materials (1971 - 1988)*

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INTRODUCTION

The Radioactive Materials Incident Report (RMIR) Database is a compilation of transportation events that have occurred during the shipment of radioactive materials. The database was developed in 1971 at the Transportation Technology Center (TTC) 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 an outside user to access transportation risk and systems analysis models and their associated databases. Within the last few months, the RMIR database has been modified so that the menu-driven format expedites database searches, particularly for the infrequent user.

Reporting Requirements for Radioactive Transportation Events

Two agencies in the United States have primary responsibility for developing and promulgating regulations for the transport of radioactive materials: the U.S. Department of Transportation (DOT) and the U.S. Nuclear Regulatory Commission (NRC). Requirements for reporting accidents and incidents differ between the two agencies. The NRC regulations which are outlined in the Code of Federal Regulations (10 CFR 20.402 and 20.403), 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

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(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 incident that occurs during the course of transportation (including loading, unloading, handling, and temporary storage) in which one of the following directly results in the course of transporting the radioactive material: (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.

In addition to the reports received from the DOT and NRC, the RMIR contains data obtained from various state radiation control offices, the DOE Unusual Occurrence Report database, and media coverage of radioactive materials transportation events. Attempts are made to collect all data pertinent to transportation events involving radioactive materials, and to provide the most complete record possible, which often necessitates follow up calls to clarify or obtain additional information on an event.

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

When evaluating the history of transporting radioactive materials, it is important to obtain a perspective of radioactive materials by viewing the entire hazardous materials shipment record. According to the Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes (1977), it is estimated that during a given year approximately 500 billion packages of all commodities are transported by all modes throughout the United States. Of those 500 billion packages, approximately 100 million are classified as hazardous materials (flammables, explosives, poisons, and radioactive materials). And, according to the most recent study of the transport of radioactive materials (Javitz et al. 1985) approximately 2 million shipments are made each year and constitute about 2.79 million packages. Thus, making hazardous materials approximately 0.2% of all commodities transported, and of those hazardous shipments, only 2% can be classified as radioactive.

When the RMIR database was established in 1981, it 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 DOT regulatory requirements for notification of an event. The RMIR makes a definite distinction between an accident and a reported incident. Definitions of the three kinds of reported events classified in RMIR follow:

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 vehicle 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 1 tabulates the accidents, incidents, and handling accidents that have occurred for the 18-year time frame of 1971 through 1988. Only 19% of the 1,249 events compiled for the United States are classified as transport accidents. As Table 1 indicates, 63% of all transportation events are classified as incidents.

TABLE 1
U.S. RADIOACTIVE MATERIALS TRANSPORTATION EVENTS
(1971 - 1988)

Transportation Accidents	233
Handling Accidents	228
Transportation Incidents	<u>788</u>
TOTAL	1249

Most radioactive materials are transported by highway, those that are shipped by air are generally radioactive isotopes with short half lives that need to be delivered immediately for medical use. Radioactive materials transported by other modes are usually those that do not require immediate delivery. Most highway routed materials 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 2 shows the RMIR breakdown for accidents, incidents, and handling accidents by transportation mode. As Table 2 illustrates, radioactive material packages transported by highway account for more than 75% of all the incidents that have occurred and 87% of all accidents. Over 50% of all handling accidents recorded in the RMIR database have occurred during air transport. Most of these handling accidents happened during loading or unloading of the radioactive package.

Packaging Performance in Transportation Accidents and Incidents

The release or suspected release of radioactivity from a packaging can result from many situations, not just accidents. The most common occurrences as noted in the database include: minor external damage to a packaging, a packaging that has become wet or damp, and liquid leaking from a tractor trailer. During the course of normal transportation conditions some Type A packagings may be damaged slightly as a result of load shifts. Wet or damp packages generally result from

TABLE 2
 TRANSPORTATION EVENTS BY MODE
 (1971 - 1988)

Mode	Accidents	Incidents	Handling Accidents
Air	14	135	129
Courier	1	1	1
Freight Forwarder	0	7	3
Highway	203	625	87
Rail	15	10	2
Warehouse	0	1	1
Water	0	5	4
Other, unidentified	0	4	1
	—	—	—
TOTALS	233	788	228

being loaded or unloaded during rain or snowfall and not from the release of contents. Events have occurred where liquid was discovered leaking from a tractor trailer - these situations were caused by the accumulation of rain or snowfall in the rear trailer doors that eventually seeped out during transport. Between the years 1971 through 1988, 2,833 packages, as documented in Table 3, were involved in accident conditions. Of that total, only 148 packages (5%) were classified as having been damaged or failed (loss of radioactive contents). Industrial packages, or those that are classified as strong and tight, have been involved in 34 accidents and of the 963 packages involved, 69 were identified as having been damaged or failed. These industrial packages are designed to withstand normal transport conditions. Type A packages accounted for the majority of the package damages/failures with 53 percent; however, these packages are designed for the rigors of normal transport conditions, not accident conditions.

Most of the industrial and Type A packages that were identified as being damaged or failed did not lose their radioactive contents. Twenty-nine percent of those industrial packages involved in accidents released small amounts of their radioactive cargo. Only 18% of the Type A packages involved in accident conditions were damaged to the extent that there was a release.

TABLE 3
PACKAGINGS EXPOSED TO ACCIDENT CONDITIONS
(1971 - 1988)

Package Category	No. of Accidents	No. of Packages Exposed to Accidents	No. of Packagings Failures/Damages
Industrial (Strong & Tight)	34	963	69
Type A	121	1807	78
Type B	<u>40</u>	<u>63</u>	<u>1</u>
	195	2833	148

There have been 40 accidents involving Type B packagings as tabulated in Table 4. Of these accidents, seven involved spent nuclear fuel: three accidents were by rail and four were on the highway. One spent nuclear fuel accident resulted in damage to the packaging, although it was minor damage. The event occurred on December 8, 1971 on U.S. 25 in Tennessee. The driver swerved to avoid a head-on collision with an oncoming vehicle and, in so doing, the tractor trailer went off the road. The spent nuclear fuel cask that it was carrying was thrown off and embedded in the ground. The radiation surveys taken at the accident scene indicated that the structural integrity of the cask was intact and that there was no release of contents.

There have been a number of more recent transportation incidents that have occurred during which radioactive materials were released, although release or suspected release of radioactivity is most often assigned to accident conditions. However, there have been transport incidents during which the radioactive materials have been released from their packaging. A case in point is an event that occurred in Houston, Texas, on January 26, 1988. A pickup truck with a camper shell housing a darkroom rounded a corner and an improperly secured radiographic camera broke through the door and fell out of the truck. Subsequently, a car struck the camera and eventually, the source became dislodged from the camera. The 48-curie Iridium-192 source was found lying in the road - the road and the car that struck the source had to be decontaminated. According to the Bureau of Radiation Control Office of the Texas Department of Health in their investigation report, the radioactive material was not transported in accordance with the DOT regulations as outlined in 49 CFR, Part 177.842 (d). The source was not properly secured to prevent change of position during transport. This transport event has not been classified as an accident, since the transport vehicle was not involved in an accident as defined earlier. However, when struck later, the package was exposed to accident conditions and the package did release its contents.

TABLE 4
SUMMARY OF TYPE B ACCIDENTS
(1971 - 1988)

Date of Accident	Mode	Description of Package Involved	RAM Involved	Packages Involved Shipped/Damaged	No. of Accident Conditions
07/10/71	Highway	Lead container	CO-60	1/0	Collision
12/08/71	Highway	Cask, spent fuel	Spent Fuel	1/1	Truck left road and cask thrown off
03/10/74	Highway	Container	Ra-192	1/0	Trailer involved
03/29/74	Rail	Cask, spent fuel	Spent Fuel	1/0	Derailment
08/09/75	Highway	Cask	U-235, U-238, Pu-239	1/0	Trailer ran off road & overturned
05/05/77	Highway	Radiography camera	Ir-192	1/0	Collision
08/11/77	Highway	Radiography camera	Ir-192	1/0	Collision with gasoline truck
10/03/77	Highway	Radiography source	Ir-192	1/0	One vehicle accident
02/09/78	Highway	Cask, spent fuel	Spent Fuel	1/0	Trailer buckled from truck weight
04/10/78	Highway	Radiography camera	IR-192	1/0	One vehicle accident
07/26/78	Highway	Steel cask, lead lined	Cs-137	2/0	Jeep overturned
08/13/78	Highway	Cask, spent fuel	Empty spent fuel	1/0	Empty cask broke through trailer bed
08/27/78	Highway	Radiography camera	Ir-192	1/0	Collision
09/11/78	Highway	Radiography camera	Ir-192	1/0	Truck overturned
09/15/78	Highway	Radiography camera	Ir-192	1/0	Truck overturned
11/28/78	Highway	Radiography camera	Ir-192	1/0	Truck overturned
01/10/79	Highway	Cylinder	Ir-192	5/0	Vehicle rear-ended truck
08/12/79	Highway	Cask	Empty	2/0	Truck sideswiped by another truck
01/14/80	Highway	Cask, teletherapy	Co-60	1/0	Semi struck truck
01/31/80	Highway	Cask	Low Level Waste	2/0	Semi jackknifed
07/21/80	Highway	Source	Ir-192	1/0	Collision
08/22/80	Highway	Cylinder, 30B	UF6	5/0	Truck forced off road
09/06/80	Rail	Cylinder, 30B	UF6	8/0	Train Wreck
09/29/80	Rail	Radiography source	Sr-90, Y-90	3/0	Rail accident
06/09/81	Highway	Source, shielded	Am-241/Be	1/0	Pickup accident
09/02/81	Highway	Source	Ir-192	1/0	Collision
11/03/82	Highway	Cask	Empty LLW	2/0	Truck overturned, cask thrown off
03/11/83	Highway	Cask	LLW	1/0	Truck sideswiped by another truck
05/10/83	Highway	Radiography source	Ir-192	1/0	Head-on collision
07/14/83	Air	Cask	Y-90, Ir-192	2/0	Plane overshot runway, crashed
12/09/83	Highway	Cask, spent fuel	Spent Fuel	1/0	Tractor separated from axles
08/08/84	Highway	Container	Reactor waste	1/0	Trailer tipped over
02/11/85	Highway	Steel drum	Ir-192	1/0	Trailer jackknifed
02/13/85	Highway	Steel drum	Ir-192	1/0	Vehicle overturned
01/10/86	Highway	Source	Cs-137	1/0	Truck ran off road
03/24/87	Rail	Casks, spent fuel	Spent fuel	2/0	Train/auto crash
10/26/87	Highway	Radiography source	Ir-192	1/0	Truck overturned
01/09/88	Rail	Cask, spent fuel	Spent fuel	1/0	Train derailed
01/23/88	Highway	Radiography camera	Ir-192	1/0	Truck ran off road
09/23/88	Highway	Radiography camera	Ir-192	1/0	Truck ran off road

Releases of radioactivity have also occurred during the shipping and handling of Type A packages. Such an event occurred on September 25, 1986 when 15 employees were exposed to low levels of gaseous Iodine-125. The Atomic Energy of Canada shipment of eight Iodine-125 sources in a lead vial was packaged in a metal can and surrounded by a corrugated cardboard box. As the shipment was being opened, radiation surveys were taken and the release was detected. The two persons who opened the package were taken to a hospital for measurement of thyroid uptake. Test results indicated that the thyroid uptake was in the range of 300 to 400 millirem. While significant, these doses are not above individual dose levels for individuals and are well below. The normal range for a diagnostic medical procedure for the thyroid is 4 to 87 rads. This particular event is the most serious of any radioactive release of Type A packages thus far.

SUMMARY AND CONCLUSIONS

The historical data provided by the Radioactive Materials Incident Report database for this paper in part reflects the stringency of the transportation regulations that are in effect. That is, the packages that have experienced releases are those that contain limited quantities of radioactive materials. The Type B packagings are required by regulations to be used for the transport of larger quantities of nuclear materials, thus posing a potentially greater consequence if the contents are released. Also, in accordance with the U.S. Department of Transportation regulations, Type B packagings are designed and tested to withstand "hypothetical" accident conditions. Data from RMIR indicate that the Type B packages that have been involved in accidents have performed extremely well in that only very minor damages have occurred and there have been no release of radioactive materials.

Since its development in 1981, the RMIR database has evolved to become one of the most comprehensive compilations of information on transportation events involving radioactive materials. Every attempt necessary is made to report as accurately as possible on the events that have occurred and to augment the available resources by establishing a network of contacts other than the two primary reporting agencies.

It is imperative to provide the most credible and complete history of radioactive transportation events since the data are used in the following ways: transportation environmental analyses, safety analyses, public information materials, responses to public inquiries, and in mitigating institutional concerns. In order to maintain and enhance the database, any additional information on transport events is welcomed.

REFERENCES

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