Transportation Incidents and Lessons Learned From Nearly 20 Million Miles of WIPP Shipments - 10053

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ABSTRACT

The Waste Isolation Pilot Plant (WIPP) is probably best known for its permanent isolation of long-lived radioactive waste in a deep geologic repository. But just as important is the transportation program that has successfully shipped almost 25,000 type B packages about 20 million miles since operations began in 1999, the largest type B fleet operation in the world. In the 1980's and early 1990's the transportation risks of WIPP dominated the debate about the safety of WIPP. As part of an overall review of WIPP in 1994, the National Academies of Science projected that WIPP's planned shipping program would be "*safer than that employed for any other hazardous material in the U.S.*"

Now, with more than ten years of operation containing numerous transportation incidents, it is instructive to review WIPP's transportation incident record for accident severity and consequence. Comparisons with both early fears and apocalyptic prophecies made by WIPP critics, as well as with reasoned accident projections from sources such as environmental impact studies are presented.

Transportation incidents over the past 10 years have been statistically fewer and much less severe than what was predicted on the basis of route-specific predictions, and certainly less than the foreboding warnings made by anti-nuclear activists. Although the possibility of incidents cannot be eliminated, they can be significantly reduced through strict adherence to requirements designed to enhance safety and performance. Several explanations for this reduction are suggested and discussed, with liberal use of examples.

WIPP and the transportation authorities in jurisdictions through which WIPP shipments travel adopted a very rigorous transportation plan early on, before shipments began. This transportation program implementation guide introduced a number of specific measures to reduce accident probability and severity, which clearly contributed to the program's success. These included actions such as frequent en route vehicle and trailer inspections by the drivers, very stringent driver qualification requirements, thorough driver training programs, external safety inspections of shipments before departure, and en route safety inspections that meet or exceed the industry's highest standard.

The accident statistics and descriptions of settings and conditions for a number of the transportation incidents that have occurred in the past 10 years are discussed, with particular emphasis on illustrative examples. It is concluded that WIPP's special measures, developed, implemented and practiced well before the shipping campaign began, are the primary explanation for the reduced transportation incident frequency and severity from those made in pre-operational projections.

PREOPERATIONAL PLANNING AND INTERGOVERNMENTAL INTERFACE

To reach WIPP's volume capacity, as limited by statute over its 30-year operational life, will require a minimum of about 20,000 shipments. These shipments, originating at five major DOE sites and various smaller sites throughout the United States, must traverse 30 states and the lands of at least 11 sovereign tribal governments. Because of the large number of shipments, DOE believed that every reasonable precaution should be taken to enhance public confidence in the safety of the WIPP shipping campaign, and early on, required the highest standards for incident prevention and emergency preparedness.

The great majority of shipments have been, and will continue to be, across the western states. Figure 1 shows the transportation routes that have been established in concert with the inter-governmental agencies in various regions of the country. The bulk of the shipments originate, and traverse corridors, within the states represented by the Western Governors Association (WGA). Figure 1 also shows the number of shipments that have originated from the various sites as of the end of 2009. Note that over 8,000 shipments (40% of the estimated total) have been successfully completed.

Fig. 1. Transportation corridors from former nuclear weapons sites to WIPP, showing shipments made from major sites through 2009.

Construction of WIPP was initiated in 1981, and by 1989, the Department of Energy (DOE) considered the facility fully operational. Negotiations for the protocols to be employed in the transportation program were part of this developmental work. However, efforts to open WIPP were not successful until 1999 due to legislative and regulatory processes. This unanticipated

delay may have also contributed to the successful shipping program during subsequent operations. It provided almost 11 years of continued interface with the many transportation authorities that would be involved with actual shipments before a single wheel turned carrying waste.

During this pre-operational period, DOE and the corridor states negotiated several related policy resolutions addressing the safety of the WIPP shipments. The objective was the safe and uneventful transportation from the generator sites to WIPP, and with the bulk of TRU waste at sites in western states, the WGA led these negotiations with DOE.

In 1989, the WGA established its Technical Advisory Group, originally consisting of representatives from seven Western states along the initial transportation corridors to the WIPP: New Mexico, Colorado, Wyoming, Utah, Idaho, Oregon, and Washington. The Technical Advisory Group was later expanded to include Arizona, California, Nebraska, Nevada, Texas, and Wyoming, other western states through which inter-site shipments or shipments to the WIPP would also occur. Initial funding was provided by a 1988 Cooperative Agreement with the U.S. Department of Transportation (DOT). In 1989, the Technical Advisory Group prepared a Report to Congress describing the needs of the Western states to prepare for the WIPP and intersite shipments in the following areas:

- Accident Prevention
    - High–Quality Drivers and Carrier Compliance
    - Independent Inspections
    - Bad Weather and Road Conditions
    - Safe Parking During Abnormal Conditions
    - Advance Notice of Shipments
    - Access to Information on Shipment Status

- Emergency Preparedness
    - Mutual Aid Agreements
    - Emergency Response Plans and Procedures
    - Training and Retraining
    - Emergency Response Equipment

- Public Involvement and Information

DOE agreed with the conclusions in the 1989 Report to Congress and entered into a Cooperative Agreement with the WGA to develop a model program to help ensure that TRU waste shipments would be “safe and uneventful.” The elements of this program are described in the *WIPP Transportation Safety Program Implementation Guide* [1], humorously referred to by all WIPP entities that are involved in its use as the “PIG”.

ELEMENTS OF THE PIG

Most truck accidents can be avoided by alert, skilled drivers who avoid driving when road and weather conditions are particularly hazardous and use high-quality, well-maintained equipment. These preventative measures were used in developing the accident prevention portion of the program to reduce the risks associated with transporting hazardous materials.

Drivers & Carriers: The U.S. Department of Transportation sets standards for drivers of trucks that carry hazardous cargo, and the WIPP transportation program goes beyond these. DOE has contracted with exclusive carriers whose drivers have extensive, accident-free experience. WIPP drivers are provided an extensive training and certification program. Additionally, they are subject to unannounced drug testing; have no financial incentive to speed; and are terminated upon any moving violation, even in their personal vehicles. While commercial carriers often pay drivers for mile-traveled, WIPP drivers are given incentives for safe passage and trucks are governed at 105 km per hour (65 miles per hour). The states have a program to audit the shipping contractors for compliance with the vehicle and driver requirements.

Route Planning: Before a designated route is used for TRU waste shipments, WIPP instructors train first responders along the route to assure effective response to a WIPP-related transportation accident. Once a route is open, the state must evaluate the route within its borders every two years. Evaluation criteria include route safety, frequency of commercial vehicle accidents, environmental justice issues and carrier adherence to the designated routes. States assess the information to identify trouble spots and, if necessary, consider the use of other routes.

Independent Inspections: To identify and correct any mechanical defects in the vehicle, the trailer, and payloads, all shipments are subject to multiple inspections using enhanced safety standards that are much more stringent than those for other hazardous materials shipments. Inspections are made at the site of origin by certified independent transportation authorities (usually the origin state's highway law enforcement agency personnel). Inspections take place prior to departure from the generator sites, and optionally (at each state's discretion) at ports of entry (only Colorado and New Mexico have elected to perform inspections upon entry into the state). In addition, as a carrier contract requirement with DOE, drivers must stop approximately every three hours to conduct a mechanical self-inspection of the vehicle.

Meticulous Inspection Protocol: The WIPP shipment inspections are based on the most stringent existing protocols for North American commercial vehicles available, as administered by the Commercial Vehicle Safety Alliance (CVSA). The CVSA Level VI protocol was specifically developed for shipments of TRU waste and Highway Route Controlled Quantities (HRCQ) of radioactive material, and nominally require several hours to complete. The CVSA Level VI inspection protocol can be reviewed at http://www.cvsa.org, and is summarized in Table I. Figure 2 shows a typical CVSA Level VI inspection. There are additional inspection elements associated with driver's fitness for duty.

Brake systems	Lighting: headlamps, tail lights, stop lights, turn signals, running lights	Cargo securement
Coupling devices	Trailer interconnection systems	Wheels, rims, and hubs
Exhaust systems	Steering linkage	Windshield and wipers
Frames and supports	Suspensions	Emergency equipment
Fuel systems	Tires	Electrical systems

Table I – Summary of CVSA Level VI Inspection Protocol Elements

The CVSA is an international not-for-profit organization comprised of local, state, provincial, territorial and federal motor carrier safety officials and industry representatives from the United States, Canada, and Mexico. Their mission is to promote commercial motor vehicle safety and security by providing leadership to enforcement, industry and policy makers. CVSA began as an informal gathering of Western State Agencies that had the responsibility for conducting commercial vehicle enforcement functions. These meetings highlighted areas of common need and discussed ways in which uniform standards, procedures and methods could be utilized to the greatest extent to promote highway safety.

CVSA implemented the North American Standard Inspection for Transuranic Waste and Highway Route Controlled Quantities (HRCQ) of Radioactive Material. This is an inspection for select radioactive shipments, which include inspection procedures, enhancements to the North American Standard Level I Inspection, radiological requirements and the *North American Standard Out-of-Service Criteria for Transuranic Waste and Highway Route Controller Quantities (HRCQ) of radioactive Material* [2]. DOE in conjunction with the CVSA elected to include its transuranic waste shipments in the North American Standard Level VI Inspection Program to provide assurance that all shipments are stringently inspected prior to and during periods they are on our nation's highways.

Fig. 2. A typical CVSA Level VI inspection being performed by Officers of the New Mexico State Motor Transportation Division of the New Mexico State Police

Bad Weather and Road Conditions: States and DOE have agreed on procedures to monitor weather and road conditions so that shipments can avoid hazards. Shipments do not depart DOE facilities if they are likely to encounter severe weather along the route. If unexpected bad

weather or road conditions are encountered, procedures for the selection and use of safe parking areas have been developed. Protocols are in place to shelter on military bases and gated compounds along the shipping corridors.

Shipment Notification and Tracking: All shipments are monitored and tracked through a satellite-based system called TRANSCOM. All state transportation authorities involved in WIPP shipments have direct access to this system, which provides shipping schedules and real-time tracking of shipments on the road. TRANSCOM allows for two-way communications with drivers and immediate emergency response guidance information, if necessary. In addition, the drivers have cellular and satellite telephones, as well as radios, that can be used in the event of an emergency.

Emergency Response Plans and Procedures: A well organized and coordinated effort is necessary to make response to accidents swift and effective. Plans and procedures specifically designed to deal with transportation incidents involving the WIPP shipments are in place in all corridor states. States also have prepared guidance documents which specify notification, incident command, and response procedures for use in the event of a WIPP transportation accident along their shipping corridors.

Training, Drills & Exercises: In coordination, DOE and the affected states have developed a WIPP-specific training regimen for emergency responders, which is incorporated directly into hazardous materials training programs for fire fighters, police and emergency medical staff along the routes. Hospital emergency room personnel also have been trained. To allay public concerns, DOE initiated an extensive outreach program to inform communities along the routes about the WIPP transportation system and its elemental design for public safety. "Road shows" with WIPP trucks and simulated waste packages on display make stops along the shipping corridors, giving the public an opportunity to learn about the transportation system, get a look at the trucks close-up and ask questions of the drivers and WIPP staff. Local emergency response authorities always participate in these road shows. The public is more apt to trust the opinion of their own local authorities than WIPP representatives.

Emergency Response Equipment: Radiation detection and personal protection equipment has been provided to emergency responders along shipping routes in all corridor states. Responders have been trained to properly use this equipment in the event of an incident involving the various WIPP shipping casks.

EARLY ESTIMATES OF TRANSPORTATION ACCIDENTS

The earliest estimates of the potential impact of shipping all known TRU waste across the country to WIPP were made in the various documents that culminated in the 1980 *Final Environmental Impact Statement* [3]. Transportation incident estimates were updated in other analyses, most recently in the WIPP *Disposal Phase Final Supplemental Environmental Impact Statement* (SEIS) in September 1997 [4]. Table II (below) is a reproduction of Table 5-6 from the 1997 SEIS, and shows the most recent estimates of the transportation incident statistics over the period of WIPP's disposal phase. All numbers include the impacts from potential transportation between sites with small volumes of waste and the 10 major treatment sites. These estimates were based on a carefully weighted analysis using route-specific accident statistics (current through 1995) and projected mileage along all corridors. For the proposed

action, the key predictions were that 56 accidents, 39 injuries, and 5 traffic-related fatalities would occur over the transportation period of 35 years.

Impact	CH-TRU Waste	RH-TRU Waste	Total Impact
Number of Accidents	43	13	56
Number of Traffic Injuries	30	9	39
Number of Traffic Fatalities	4	1	5
Pollution Health Effects (fatalities)	.1	.04	.1

Table II – Reproduction of SEIS Table 5-6, Non-radiological Impacts of Transporting TRU Waste by Truck for the Proposed Action.

ACTUAL TRANSPORTATION ACCIDENTS THROUGH 2009

With over 8,000 shipments over almost 20 million miles of road history, it is instructive to review the actual case history of transportation incidents after almost 11 years of WIPP operations. Figure 3 shows a time line of the actual incidents superimposed on a cumulative graph of total mileage tallied in the WIPP shipping program.

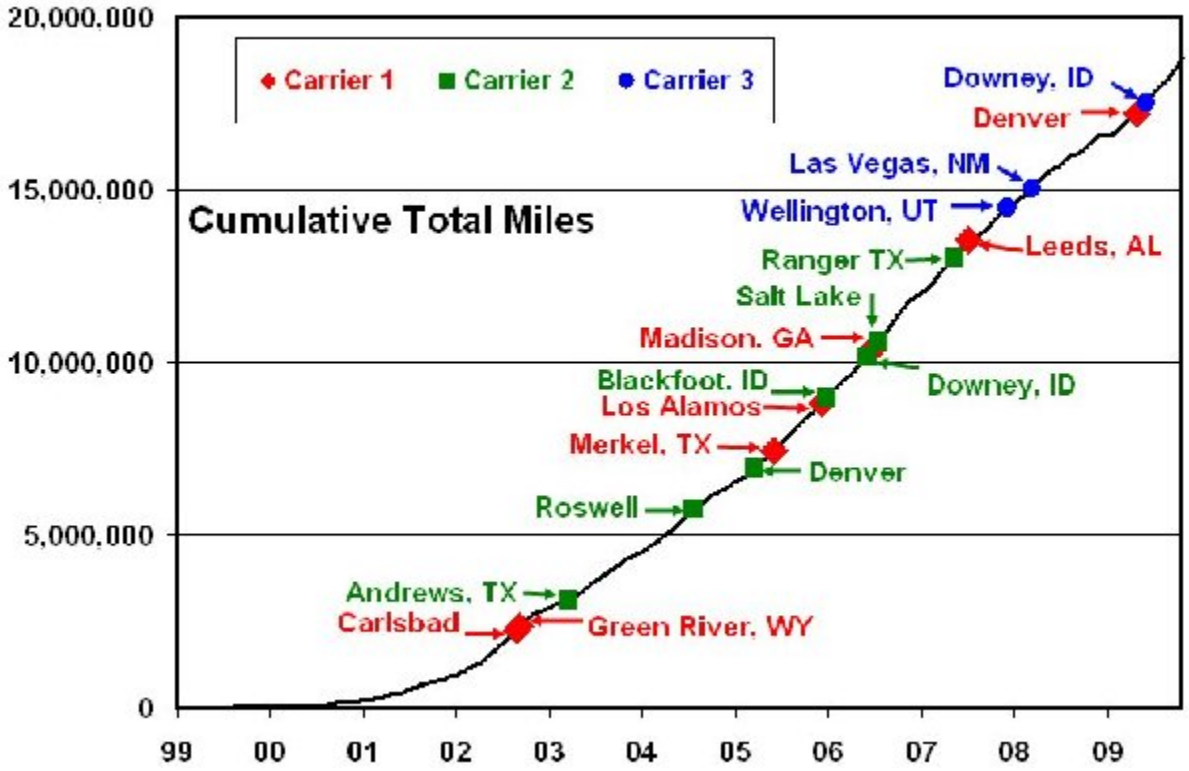

Fig. 3. Transportation incidents as a function of cumulative mileage during the shipping campaign to WIPP through 2009.

Note that there have been three carriers that have driven WIPP shipments thus far. Carrier No. 3 replaced carrier No. 2 at the beginning of 2008. No carrier stands out more or less accident-prone than the others. Also note the random nature of transportation incidents in time and/or

mileage. There do not appear to be any trends. There are 17 transportation incidents shown in Figure 3. This is too few to quantitatively evaluate whether the incidents are following what would be expected to be a Poisson distribution.

A tally of injuries associated with the 17 incidents shows only 4 injuries and zero fatalities to date. No WIPP drivers have been injured as a result of any of the incidents. Two of the 17 incidents have been the result of WIPP drivers' error, and both drivers were discharged as a result. These actual accident statistics are below those that were predicted in the EIS and their severity is far less than those predicted as well.

Figure 4 shows a map of the locations of the 17 transportation related incidents too date. The great majority of miles driven to date have been between WIPP and the two most productive sites in the western states, Rock Flats and the Idaho National Laboratory sites. Thus, it is not surprising to note that the great majority of transportation incidents have occurred along these corridors.

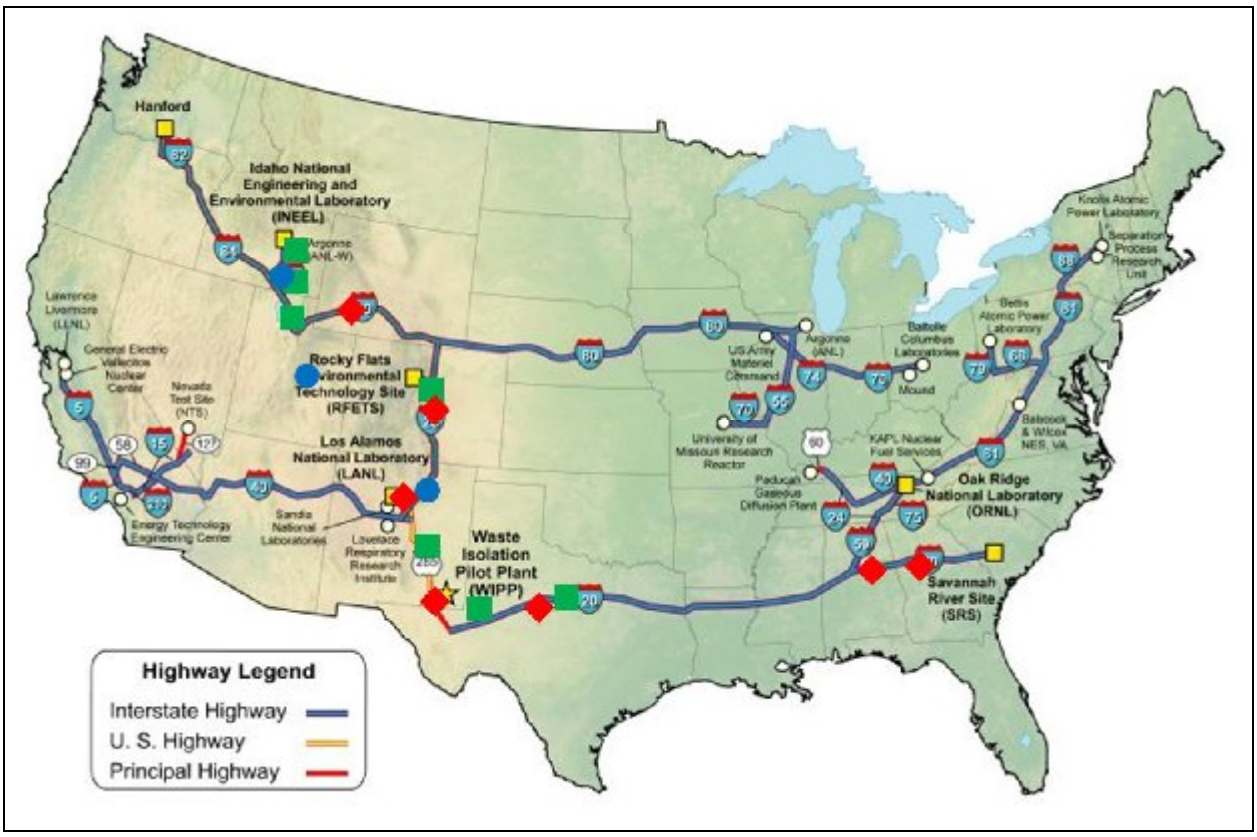

Fig. 4. Map of WIPP shipping corridors with the location of transportation incidents superimposed. The symbols shown are associated with the same carriers as shown in Fig. 3.

All but four of the 17 incidents could be characterized as relatively minor "fender-benders". It is ironic that the first serious transportation accident of the WIPP shipment campaign occurred just outside of Carlsbad, New Mexico, within a few miles of the shipment arriving safely at the WIPP site. That first serious incident involved a drunk driver (convicted) who rear-ended a loaded WIPP shipment in the very early morning hours and was hospitalized. There was minor damage to the trailer and the rear tires of the trailer had to be exchanged, but after repairs and a thorough CVSA Level VI re-inspection, the shipment was allowed to continue the few remaining miles to

the WIPP site, while escorted by the New Mexico transportation authorities. While the shipment was demonstrably unaffected by the rear-end collision, an independent WIPP oversight organization based in Carlsbad still elected to collect numerous samples along the roadway near the accident site the next day, and analyzed them for radioactive materials. Needless to say, none were found.

The second serious accident was near Blackfoot, Idaho in 2006, when a WIPP driver apparently dozed off in the early morning hours and rolled the truck and trailer carrying empty containers bound for the Idaho National Laboratory generator site. The three TRUPACT-II containers came loose of the trailer and rolled to a stop along both sides of the freeway. All three were damaged (predominantly cosmetic), but subsequent leak tests of their post-accident integrity indicated that if the accident had involved loaded containers, the casks would have contained all radioactivity and no release would have occurred.

In July 2006, the third serious accident involved a small car that entered the north-bound (4-lanes) freeway just north of Salt Lake City in the early hours before dawn and crossed the inner 2 lanes of traffic, merging into the third-lane path of a north-bound (empty) WIPP shipment. The car's driver (who was legally deaf) was injured as her car bounced off the front of the WIPP truck and spun backwards around the trailer. The WIPP driver attempted to avoid impact by sounding his horn and emergency braking, but another car in the lane immediately left of the WIPP truck precluded him from veering left into the outer lane to avoid the collision.

The fourth serious incident occurred in 2007 near Leads, Alabama during a sudden thunderstorm rain burst. A westbound WIPP shipment on I-20 was involved in an accident caused by an eastbound vehicle that spun out and crossed the 30 meter median and struck another westbound vehicle which was several hundred meters in front of the WIPP truck, and which was pushed into the WIPP shipment's path. The injuries were a result of the two private vehicles impacting and not due to the subsequent low-speed collision of the second vehicle with the WIPP truck.

Note that there are some accident locations shown in Figure 4 that are not along the designated transportation corridors. These incidents occurred during shipments of empty containers back to generator sites. Return shipment routes are not always along the same corridors as for waste shipments.

ANALYSIS

With 40% of the projected shipments that WIPP expects to make now completed, it is instructive to compare the accident predictions made in the various decision making analyses leading up to WIPP operations. Clearly, the number of actual transportation incidents is less and their severity is much, much less than the statistically based predictions that were made. This is most likely explained by the extra efforts made by the WIPP transportation program to maximize the safety of each and every shipment. The predicted accident rates were based on route-specific accident rates for commercial truck shipments. WIPP shipments are far safer that the average commercial truck shipment on the nation's highways today.

A CVSA Level VI inspection prior to departure for every shipment ensures all safety elements of a transportation system are functioning properly. The added formal CVSA Level VI inspections some states impose en route probably do not significantly add to the safety posture, but the fact that the drivers must stop and self-inspect about every three hours, along with the prospect of

having to pass a re-inspection of such thoroughness en route as they approach New Mexico, probably does add to safety, since they might otherwise allow some small relaxation of the safety envelope.

The intensive training and frequent zero-tolerance reinforcement of the importance of an uneventful trip helps the drivers maintain their conservative driving posture. An example of such is an event in February 2004, when an un-forecast dense fog and freezing rain caused a ~50-car pile-up near Beaufort, Wyoming on east-bound I-80. A WIPP shipment from the Idaho National Laboratory site slowed to ~60 km per hour (~40 miles per hour) when it encountered limited visibility conditions going downhill on the eastern slope of the Wyoming mountain passes toward Cheyenne, Wyoming. Other traffic, not fazed by the poor visibility and driving conditions, maintained nominal high interstate highway speeds (120 km per hour in that location). The WIPP drivers suddenly came upon a 50-vehicle pile up, and successfully pulled to the right along the shoulder. The driver brought the WIPP truck and trailer to a stop along the shoulder and well ahead of the potential collision envelope as it continued to grow from the rear of the pile-up. WIPP drivers then rendered emergency aid to dozens of victims while awaiting state emergency responders. WIPP drivers were subsequently awarded meritorious acknowledgement of their role by the Wyoming Highway Patrol.

CONCLUSION

WIPP's transportation system was described as "*safer than that employed for any other hazardous material in the U.S.*" by the National Academies of Science as part of an overall review of WIPP in 1994. The WIPP transportation record after almost 11 years of shipping TRU waste across the nation's highways seems to confirm that assessment. Transportation incidents over the past 10 years have been statistically fewer and far less severe than what was predicted on the basis of route-specific predictions, and certainly less than the foreboding warnings made by anti-nuclear activists. Although the possibility of incidents cannot be eliminated, they can be significantly reduced through strict adherence to requirements designed to enhance safety and performance.

WIPP and the transportation authorities in jurisdictions through which WIPP shipments travel adopted a very rigorous transportation plan early on, before shipments began. This transportation program implementation guide introduced a number of specific measures to reduce accident probability and severity, which clearly contributed to the program's success. These included actions such as frequent en route vehicle and trailer inspections by the drivers, very stringent driver qualification requirements, thorough driver training programs, external safety inspections of shipments before departure and en route; safety inspections that meet or exceed the industry's highest standard.

It is concluded that WIPP's special measures, developed, implemented and practiced well before the shipping campaign began, are the primary explanation for the reduced transportation incident frequency and severity from those made in pre-operational projections.

REFERENCES

1. WIPP Transportation Safety Program Implementation Guide, Western Governors' Association WIPP Transportation Technical Advisory Group, and DOE, July 2008 (http://www.westgov.org).
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