TechBrief

The goal of the Federal Motor Carrier Safety Administration (FMCSA) is to reduce commercial vehicle related fatalities, as well as the number of persons injured in commercial vehicle related crashes, by 50 percent by the year 2010.

FMCSA's Research and Technology programs encompass a range of issues and disciplines, all related to motor carrier and bus safety and security. FMCSA defines a "research program" as any systematic study directed toward fuller scientific discovery, knowledge, or understanding that will improve safety and security, and reduce the number and severity of commercial motor vehicle crashes. Similarly, a "technology program" includes those that adopt, develop, test and/or deploy innovative driver and/or vehicle best practices, and technologies that will improve safety and security, and reduce the number and severity of commercial motor vehicle crashes.

Currently, FMCSA's Office of Research and Technology conducts programs in the area of *Driver Safety Performance, Commercial Vehicle Safety Performance, Carrier Compliance and Safety, Safety Systems and Technology, Cross-Cutting Safety Initiatives,* and *Security.* The study described in the following Tech Brief was designed and developed as part of FMCSA's Research and Technology *Carrier Compliance and Safety* Program. The primary goal of this program is to improve the safety of all motor carriers—particularly high-risk carriers—by ensuring compliance with safety performance regulations set forth by the organization.

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Hazardous Materials Risk Assessment: Final Report

Introduction

As part of its efforts to promote the safe transportation of hazardous materials (HM), the Federal Motor Carrier Safety Administration (FMCSA) sponsored a study to assess and compare the risks posed by transporting hazardous materials and non-HM shipments in order to assist in identifying high-risk motor carriers. The results of this research study may be used in the development of a transportation risk assessment model, which will enable FMCSA to identify programs that will result in the greatest improvement in safety.

Background

In Phase I of the three-phase project, researchers assessed the feasibility of conducting a comprehensive risk study of HM and non-HM transportation. Specifically, researchers chose one year, 1996, to look at the costs of transporting flammable/combustible liquids, which represent more than 50 percent of all HM truck transport. The study results were published in the *Hazardous Materials Risk Assessment: Year Portrait of Hazardous Materials Accidents/Incidents and Impacts.* This process was then extended to three years of records, 1995-1997, for flammable gases (considered Class 2.1 HM) and corrosive materials (considered Class 8 HM), which provided a preliminary estimate of the cost impact of transporting HM shipments.

In Phase II, which is the primary focus of this Tech Brief, researchers produced an actual comparative risk assessment by calculating and comparing the costs and risks associated with transporting HM and non-HM truck shipments. The third phase of the project focused on how the HM risk information, collected during the first two phases, could be applied to the SafeStat program to help identify potentially unsafe motor carriers.

This Tech Brief summarizes the project described in the final report, *Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents*, 2001, which is available on the FMCSA Web site at http://www.fmcsa.dot.gov/Pdfs/HMRiskFinalReport.pdf.

Purpose

The purpose of the study was to assess and compare the calculated risks associated with the transportation of HM and non-HM shipments. The results also will be used to assist the FMCSA in identifying high-risk motor carriers.

Phase II Methodology

Researchers analyzed two types of HM events—*accidents* and *incidents*. An *accident* occurs when a vehicle transporting hazardous goods is involved in a collision, regardless of whether any material is spilled or released in the atmosphere. An *incident* occurs when a vehicle transporting hazardous goods spills some of the cargo, but is not involved in a collision. An *incident* resulting in the spill or release of hazardous materials during loading or unloading is defined as a *loading/unloading incident.*

Researchers calculated the risks associated with each of the nine HM classes to obtain the overall HM risk. The Federal Code of Regulations (FCR) lists nine classes of hazardous materials as shown in Table 1.

Completing Phase II of the project enabled the comparison between the risks of transporting any HM class to the risks of transporting other HM classes and non-HM shipments. Researchers used data from a variety of sources including federal and state databases, local authorities and private companies. For the final analysis, data from 1990 through the beginning of 1999 were used to create an annual estimate of HM impacts. To derive an estimate of the annual economic impact of HM accidents and incidents, a number of considerations were taken into account including the following five-step process:

Table 1
Classes of Hazardous Materials

Class	Hazardous Material
1	Explosives • Potential for mass detonation likely • Potential for mass detonation unlikely
2	Gases • Flammable • Non-Flammable • Poisonous
3	Liquids (flammable and combustible)
4	Flammable solids • Spontaneously combustible materials • Dangerous when wet materials
5	Oxidizers and organic peroxides
6	Toxic materials and infectious substances
7	Radioactive materials
8	Corrosive materials
9	Miscellaneous dangerous goods

1. The following cost impacts were included in the model:
   - Injuries and deaths
   - Cleanup
   - Property damage
   - Evacuation
   - Product loss
   - Traffic incident delay
   - Environmental damage
2. Review several sources of information such as federal and state databases in order to establish reasonable estimates of the economic impact of each consequence
3. Tally the cost impacts reported in Federal and state databases and other sources
4. Create models or cost impacts not readily available from sources, e.g., incident delay, which is not reported by HMIS and other databases
5. Convert all cost impacts into dollar values to enable a financial and economical comparison among different cost impacts to come up with a total impact value for one year

The Hazardous Materials Information System (HMIS), a database that tracks highway transportation events, was an important source for estimating the cost impacts of accidents and incidents associated with product loss, cleanup costs, and property damage. Injuries and fatalities were valued to be the amount the U.S. Department of Transportation (DOT) would be willing to spend to avoid an injury or death. This averaged out to be $200,000 to avoid an injury and $2,800,000 to avoid a fatality. Delays caused by traffic events were identified as the total number of people delayed at an incident or accident multiplied by $15 per hour. Environmental damage was identified as the size of an average spill plus the value of environmental contamination (determined by an average of 30 legal settlements).

Results

Results from the study were reported in terms of Frequency, Hazardous Materials Impacts/Costs, Non-Hazardous Materials Impacts/Costs, Comparative Risks, and Accident Rate and Cost per Mile, specifically:

Frequency

The average frequency of HM accidents for one year was estimated to be 2,484 accidents, with 768 resulting in the release of hazardous materials. The average annual frequency of HM incidents was 1,455. The average annual frequency for loading/unloading incidents was 10,746.

Shipments of flammable and combustible liquids (considered Class 3 HM), as well as corrosive materials (considered Class 8 HM) accounted for about 64 percent of total HM release accidents and 52 percent of non-release accidents. HM classes 3 and 8 also were involved in about 77 percent of the annual enroute incidents where an HM release occurred, and 84 percent of all loading and unloading incidents.

Hazardous Materials Impacts/Costs

HM shipments make up between 4 and 8 percent of all transported shipments. The estimated total cost for HM truck accidents and incidents for a period of one year is about $1.2 billion. HM accidents account for about 89 percent of the total cost impact, or $1 billion.

Accidents that resulted in a release of hazardous materials cost $416 million and accounted for about 40 percent of enroute accident cost impacts. While accidents that resulted in fire or explosion made up only about 12 percent of the total number of HM release accidents, they were estimated to cost $139 million, or about 34 percent of the total cost of HM release accidents. Non-release accidents made up about 60 percent of the total annual accident cost impacts while enroute incidents with HM release and loading/unloading incidents accounted for about 11 percent of the total cost impacts.

Not surprisingly, the costs associated with injuries and fatalities from HM accidents accounted for about 80 percent of all impact costs for enroute accidents. For both release and non-release accidents combined, injuries represented about 40 percent of the impact costs, and fatalities represented about 40 percent of all impact costs for enroute accidents. Delays caused by traffic events for both release and non-release accidents added up to about 9 percent of the total costs. Environmental damage, clean up, and evacuations accounted for the remaining 3 percent of cost impact.

Non-Hazardous Materials Impacts/Costs

There were approximately 126,880 accidents for one year involving the transport of non-HM shipments and, after compensating for under-reporting, approximately 109,779 injuries and 5,009 fatalities. Although primarily due to a much larger volume of transport activity, the annual economic impact of non-HM accidents is over $43 billion —considerably higher than for HM accidents. All but $7 billion of that cost resulted from injuries and fatalities.

Comparative Risks

All HM release and non-release accidents and incidents for transporting the various categories of HM shipments averaged about $414,000 per event for one year. All non-HM accidents/incidents averaged about $340,000 per event. Over a period of one year, the average cost per HM accident/incident *with a release* was about $536,000. There is even greater contrast between the average cost impact of an HM release accident/incident *resulting in fire or explosion* compared to the average cost of a non-HM accident/incident.

The average cost of HM and non-HM motor carrier events are shown below in Table 2.

Table 2
Average Costs of HM and Non-HM Motor Carrier Events

TYPE OF EVENT	AVERAGE COST	PERCENTAGE OF NON-HM CRASH	AVERAGE TRAFFIC DELAY
Non-HM Event	$340,000	-----	2 hours
All HM Event	$414,000	122%	-----
HM Event w/ Spill Release	$536,000	158%	5 hours
HM Event with Fire	$1.2 million	353%	8 hours
HM Event with Explosion	$2.1 million	617%	12 hours

Accident Rate and Costs per Mile

The estimated number of annual accidents and incidents can be converted into rates by using annual vehicle miles of HM operation. Based on estimated mileage from the 1997 Commodity Flow Survey (CFS), the accident rate for transporting non-HM is 0.73 per million vehicle miles and is more than double the average HM accident rate of 0.32 per million vehicle-miles. While the average cost for a single HM accident is higher than for a single non-HM accident, the overall cost of non-HM accidents clearly dominates due to a large disparity in shipment volume between HM and non-HM shipments.

While mileage numbers provided a general measure of difference, more rigorous comparisons must await further refinements in the accuracy of CFS mileage numbers.

Researcher
This study was performed by Battelle, 505 King Ave. Columbus, OH 43201-2693. Contract No. DTFH61-98-C-00060.

Distribution
This Tech Brief is being distributed according to a standard distribution. Direct distribution is being made to the Service Centers and Divisions.

Availability
Phase one of the study's final report is available from the National Technical Information Service (PB99-150245).

Key Words
accident and incident delay, hazardous materials, hazardous materials classes, HM and non-HM accidents and incidents, HMIS, impact costs, risk assessment.

Web Site
All FMCSA Tech and Analysis Briefs may be accessed at: http://www.fmcsa.dot.gov.

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Conclusion and Findings

In conclusion, the findings of this study can be used to increase our understanding of the key risk contributors of transporting HM and non-HM shipments. The results allow for risk comparisons to be made between HM and non-HM shipments by establishing a general dollar estimate of the financial impact, rather than a precise valuation. It is anticipated that meaningful research and policy inferences can be derived for risk management purposes. This report demonstrates the usefulness of a methodology for estimating the number of accidents and incidents for a 1-year period.

Several findings were reported from the results of the study. The results suggest:

- HM truck accidents and incidents cost society nearly $1.2 billion on an annual basis
- Injuries and fatalities make up the largest component of this cost
- Flammable and combustible liquids contribute the largest economic cost impact associated with HM accidents and incidents
- Annual economic cost impacts of non-HM accidents is considerably higher than for HM accidents due to the shear volume of their occurrences, even though the cost impact of a single accident with an HM release is higher than a non-release HM accident
- Accidents with HM releases that result in explosions have the highest cost impact followed by HM release accidents resulting in fires

Although public databases contain useful information for conducting risk assessments, they are deficient in a number of areas that can be improved. The research study suggests that better coordination efforts among the multiple agencies that collect transportation data would correct data collection inconsistencies. Also, the collection of data should be done in coordination with other datasets to enhance cross-referencing capabilities, which would enable FMCSA to improve its safety performance monitoring abilities. The benefit of such improvements would allow for the availability of information and a more economical way of maintaining the databases—all of which can be used to help identify high-risk motor carriers and improve the safety of transporting hazardous and non-hazardous materials.

Future Action

Applying the results of the risk assessment study to the SafeStat algorithm (an instrument used to measure the safety fitness of motor carriers) is currently underway. Phase III of the study analyzed the impact of HM on the carrier selection methodology and made recommendations on the inclusion of hazardous materials risks, which are currently under review by the FMCSA.

References

Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents, FMCSA, Washington, DC, March 2001.

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