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National Cooperative Highway Research Program

NCHRP Synthesis 261

Criteria for Highway Routing of Hazardous Materials

A Synthesis of Highway Practice

Transportation Research Board
National Research Council

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Synthesis of Highway Practice 261

Criteria for Highway Routing of Hazardous Materials

Deborah K. Shaver, CHMM
and
Marsha Kaiser
ICF Kaiser International, Inc.
Fairfax, Virginia

Topic Panel

WILLIAM E. BENSMILLER, *Federal Highway Administration*
RAYMOND M. BROWN, *Port Authority of New York and New Jersey*
THOMAS HICKS, *Maryland State Highway Administration*
STEVEN LESSER, *Public Utilities Commission of Ohio*
FRANK N. LISLE, *Transportation Research Board*
DAVID K. PEACH, *Washington State Department of Transportation*
PETER F. RUSCH, *Wisconsin Department of Transportation*
CAPTAIN ALLAN M. TURNER, *Colorado State Patrol*

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PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation Research Board

This synthesis will be of interest to staff of state departments of transportation responsible for highway routing, traffic engineering, traffic operations and signing, and maintenance. It will also be useful to state police, who may also be responsible for routing, and other enforcement personnel, as well as to emergency and fire personnel. The trucking industry will also find the information of value to their operations. Information is presented on the current practices of states for the highway routing of vehicles that transport hazardous materials. The Federal Highway Administration (FHWA) in 1994 issued *Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials*, which are used by agencies that elect to designate such routes.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

This report of the Transportation Research Board is based on information obtained from a survey of states concerning the routing of hazardous materials vehicles that asked respondents to rate the importance of 24 factors in the categories of roadway, environment, population, or other criteria in establishing routing policy. The survey also identified the principal agencies responsible for routing, as well as other agencies that typically participate in the routing plan. Enforcement and cost issues are discussed, as is risk assessment. This report presents a unique discussion of the issues as identified by interviews with trucking trade associations and other organizations involved with hazardous materials transport. In addition, technology applicable to more effective monitoring and enforcement is described. The appendices include commodity flow studies and route designation case studies for selected jurisdictions.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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CRITERIA FOR HIGHWAY ROUTING OF HAZARDOUS MATERIALS

SUMMARY

Increasingly large quantities of hazardous materials are transported via the nation's highways every day. Public concerns about potential accidents or incidents involving hazardous materials led Congress to pass the Hazardous Materials Transportation Uniform Safety Act of 1990 (HMTUSA). The act placed responsibility on the Secretary of Transportation for developing regulations establishing uniform standards to be used by states and Native American tribes when designating routes for transporting hazardous materials. In response, the Federal Highway Administration (FHWA) issued a rule in October 1994 that established standards for the designation of such routes. Under this rule, states and Native American tribes are not required to establish routes for hazardous materials transport; however, if they choose to do so they must follow certain procedures contained in the rule.

Activities currently being undertaken by states and Native American tribes related to the designation of routes for highway transport of hazardous materials were identified from a survey and an extensive literature search. The survey addressing current routing practices was developed and sent to all 50 states and two Native American tribes. Representatives of the highway hazardous materials transportation industry were contacted to obtain private sector views regarding routing. Case studies were developed using information obtained from several other sources.

Many states have conducted commodity flow studies to identify the types and quantities of hazardous materials transported on highways within their borders. In-depth reviews of six commodity flow studies show that these studies vary in level of detail and area of study. Some have been conducted on a countywide basis, others on a statewide basis, others by interstate route. Most of the flow studies reviewed were conducted to assess emergency response capabilities and develop recommendations. Most emphasized the quantity of petroleum products flowing through the study area and focused recommendations on worst-case scenarios involving petroleum product incidents.

Several databases exist that contain accident, exposure, and incident data required to conduct a routing analysis, although the quality of data and the compatibility of the databases vary greatly. (Accidents are defined as vehicle collisions with another vehicle or object, vehicle turnovers, or vehicles unintentionally leaving the highway. Incidents are a spill or release of hazardous materials from a transport container.)

Of the states that responded to the questionnaire, 16 indicated that they have designated routes for the transport of hazardous materials. Most of the 16 states that reported route designations did so before the current rule was promulgated (i.e., prior to October 1994).

Specific procedures vary among the states that designate routes. Many of the 16 states designate routes for several classes of hazardous materials. Others do so for only certain hazard classes. Responsibility for route designation falls upon different agencies from state to state, with the most common being the state Department of Transportation.

Most states that have not designated routes indicated that they have not done so because there is little perceived need to conduct routing analyses, and the resources required to do so are significant. Some states believe that the benefits of routing are limited. Other states indicated that an official designating agency had not been established.

The general position of the hazardous materials transport industry is that route designation is a reasonable requirement for transporters of hazardous materials. Members of the industry generally believe that its concerns have been addressed adequately in HMTUSA and in the routing guidelines established by FHWA. Furthermore, routing is only one of the many requirements that the industry must meet when transporting hazardous materials. Of more concern to industry members are route restrictions, such as time-of-day constraints and lane restrictions.

Technology applications available to increase the safety of hazardous materials transport fall primarily into the following categories: vehicle control, vehicle detection, driver/vehicle performance monitoring, and driver information systems. Each can aid in safe transport, although none has a direct role in route designation.

Routing activity in practice is minimal, especially activity under the 1994 FHWA hazardous material routing rule. States are not required to designate routes, but only to follow the requirements in the rule if they do so. The FHWA has developed an elective course offered through the National Highway Institute to train states on how to use the hazardous materials transportation route designation rule to designate routes. States may decide to designate routes based on perceived need or public pressure, both of which may be sporadic or reactive to hazardous materials accidents. Obtaining reliable statistics needed to conduct a route assessment can be difficult and designating routes can cause potential conflict among neighboring jurisdictions. Considering this information along with the fact that the federal route designation rule is relatively recent, it is understandable that little activity has occurred nationwide in designating routes for hazardous materials transportation. However, with additional time, training, and expected positive safety results, it is likely that more jurisdictions will designate routes for the transport of hazardous materials.

CHAPTER ONE

INTRODUCTION

BACKGROUND

The U.S. Department of Transportation (US DOT) estimates that approximately four billion tons of regulated hazardous materials are transported each year and that approximately 500,000 shipments occur each day (*1*). More than 90 percent of these shipments are transported via truck on the nation's highways. At any given time, 5 to 15 percent of the trucks on the road are carrying hazardous materials regulated under the Hazardous Materials Transportation Act of 1975 (HMTA). Steadily growing demand for these commodities and products derived from hazardous commodities has translated into an increase in the number of hazardous shipments on the nation's highways. Almost 50 percent of these materials are gasoline and other corrosive or flammable petroleum products, and 13 percent are chemicals. The remainder of the shipments are any of the 2,700 chemicals considered hazardous when transported in interstate commerce. Increased transportation of these materials has resulted in heightened public concern about potential accidents involving vehicles transporting hazardous materials, and about potential incidents exposing the public and damaging property and the environment. For purposes of this synthesis, accidents are defined as vehicle collisions with another vehicle or object, vehicle turnovers, or vehicles unintentionally leaving the highway. An incident is a spill or release of hazardous materials from a transport container. An incident may be the result of an accident; however, an incident can occur without an accident, and an accident can occur without an incident. In this synthesis, incident is used interchangeably with spill and release.

The designation of highway routes for the transport of hazardous materials can be an effective means to reduce the potential for hazardous materials incidents, particularly when coupled with packaging and handling requirements, effective driver training programs, and enhanced emergency preparedness and response capabilities. Highway routing is a process based on consideration of various defined standards and factors whereby specific routes are designated on which hazardous materials carriers must travel. Routing can also entail avoiding restricted roads, including tunnels and bridge segments, on which hazardous materials may not be transported, as well as designation of selected highway lanes, time-of-day travel, prior notice of travel, and shipment escort requirements. Presumably, once selected and enforced, hazardous materials routing designations will result in reduced risk of an incident during transport, or less severe consequences, should an incident occur.

LEGISLATIVE AND REGULATORY HISTORY

As a result of increasing concern about the transport of hazardous materials, Congress passed the Hazardous Materials Transportation Act of 1975 (HMTA), which placed the ultimate responsibility for hazardous materials transportation in interstate and intrastate commerce with the Secretary of Transportation. The HMTA empowered the Secretary to designate as a "hazardous material" any particular quantity or form of a material that may pose risk to public health and safety, or to the environment. The act also gives the Secretary the authority to regulate any feature necessary to ensure safe transportation, including routing, packaging, placarding, labeling, and handling. The HMTA preempts state and local requirements that are inconsistent with the requirements of HMTA or any regulations issued in support of HMTA. The Secretary is authorized under HMTA to waive the preemption if the state requirements provide an equal or better level of safety as HMTA, and do not unreasonably burden interstate commerce (e.g., create delays resulting in increased costs).

The Hazardous Materials Transportation Uniform Safety Act of 1990 (HMTUSA) amended the HMTA and delegated responsibility to the Secretary to develop and issue regulations on uniform standards to be used by states and Native American tribes in establishing, maintaining, and enforcing routing designations for placarded hazardous materials transport. These routing regulations were published by the Federal Highway Administration (FHWA) as a final rule in the *Federal Register* on October 12, 1994, and became effective on November 11, 1994. They have been codified in Title 49 of the USC, Section 5112 and 5125. Although the rule allows for the effective and consistent highway routing of hazardous materials, it is a voluntary regulation that is both implemented and enforced by the routing authority. However, if a routing authority designates hazardous materials routes, it must follow the standards and factors set forth in the federal regulations.

OBJECTIVE OF SYNTHESIS

The objective of this synthesis is to identify whether and how states and Native American tribes currently designate highway routes for the transport of hazardous material (49 CFR, Part 397), including the extent to which federal regulations have been implemented, associated implementation costs, institutional or regulatory constraints, and any related concerns and needs of the transportation industry.

An extensive literature review was conducted and states and Native American tribes were surveyed to obtain specific information on existing programs, practices, successes, and failures regarding highway routing of hazardous materials. Chapters 2 and 3 present the results of these efforts. Chapter 2 discusses recent literature topics about highway routing, state commodity flow studies, and current databases and tools used by routing authorities as they attempt to ensure the safe transport of hazardous materials within their jurisdictions. Chapter 3 presents the results of a survey to determine whether hazardous materials routing has been implemented in accordance with FHWA guidelines. A survey questionnaire was developed to capture a current picture of highway routing efforts nationwide. A copy of the questionnaire is provided in Appendix A and agencies that provided responses are listed in Appendix B. Additional relevant routing information, such as the costs of designating routes, enforcement, and emergency response, was also compiled from the survey responses and is also presented in chapter 3.

Chapter 4 identifies existing regulatory, institutional, and jurisdictional constraints and inconsistencies impacting effective routing of hazardous materials from the perspective of the transportation industry. This perspective was obtained through direct interviews with several industry representative organizations. Chapter 5 addresses Intelligent Transportation Systems (ITS) and progressive operational strategies applied in routing. Chapter 6 discusses the findings of the synthesis and conclusions regarding the perceived future of hazardous materials highway routing. Appendix C provides an annotated bibliography of related resources. Flow studies conducted in five states are presented in Appendix D. Selected case studies that highlight the implementation, maintenance, and enforcement activities within certain states are presented in Appendix E.

CHAPTER TWO

RELEVANT LITERATURE

Performing routing analyses can be a complex effort, requiring a great deal of data, analytical capabilities, and coordination of several groups with often differing interests and agendas. One purpose of this synthesis report is to identify current research, available commodity flow studies, and databases used to analyze highway routes. This chapter presents current literature relevant to the highway routing of hazardous materials shipments.

Information on the quantities and types of hazardous materials transported provides a sound basis for performing a routing analysis. Specific information on hazardous materials shipments is being collected in several states through various state-specific routing analysis activities. The frequency and severity of accidents and incidents involving hazardous materials and the consequences associated with those accidents and incidents are other key pieces of data needed to make effective routing designation decisions. Such information is available from several national and state databases. These are discussed at the end of the chapter.

LITERATURE SEARCH

National statistics on hazardous shipments exist but are generally not specific to state and local transportation systems. An extensive literature search was performed to identify available information on current and recent activities in the area of hazardous materials highway routing. The search was focused on recent articles and information as they relate specifically to routing. Thus, literature with a focus on other related hazardous materials transport topics, such as emergency response, received less focus.

Much of the literature on current routing practices or analytical methods highlighted highway routing computer models. Several articles written shortly after the passage of HMTUSA pertained mainly to the impact of the rule on various affected parties. The articles deemed to be the most applicable are briefly mentioned below and are also presented in Appendix C with a brief abstract. Topics addressed include current routing practices, computer tools used in routing analysis, and the information needed to conduct a routing analysis. Following are general findings of the literature search.

General Routing Issues

The National Governor's Association (NGA) produced a report in 1989 *(2)* that focused on coordinated federal and state regulatory enforcement systems regarding hazardous materials transportation by all modes. The report surveyed agencies in all 50 states and found that of those responding, 14 had designated highway routes. This is similar to the findings from the questionnaire for this synthesis, as reported in chapter 3. Virtually all states surveyed by NGA reported that funding for hazardous materials transportation programs and personnel is an overriding need. A problem mentioned often by states in the NGA survey was the ineffectiveness of existing regulations.

Another paper, presented by T.L. Novak at the 1990 National Conference on Hazardous Materials Transportation, discusses the views of local governments regarding hazardous materials transportation legislation *(3)*. The author stated that most mid-size to smaller cities and rural areas are slow in responding to statutory provisions and need the most training and equipment. City officials are often skeptical of state and federal bureaucracies and dislike outside attempts to govern their affairs.

The tradeoffs associated with highway routing and risk minimization were addressed in an article written for *Risk Analysis*, by T.S. Glickman and M.A. Sontag, as well as whether routes that minimize the risk of incidents and accidents should be established as opposed to routes that have the lowest operating cost *(4)*. Using computer software, the authors computed cost-risk tradeoffs and estimated the average cost of rerouting per fatality averted. This value was found to fall within the range of values for a number of existing regulations. Another finding was that minimum risk routes, on average, reduce population exposure about tenfold, but reduce risk only about sixfold because of the influence of other factors, such as road type and distance.

The 1991 *Proceedings of Hazmat Transport* includes a report by Turnquist and List that describes a multi-objective routing model used to analyze the different objectives that various stakeholders bring into routing decisions *(5)*. The authors used four measures (operating cost, accident rate, population exposure, and number of schools in exposure area) of various routes and considered two different policy objectives (i.e., minimizing accident rate and minimizing risk exposure). They concluded that policies based on a few selected routes can provide substantial public risk reduction without micromanagement of shippers. In some cases, route designation may not be necessary because the least-cost route is also the least-risk route.

"Working Together to Build a Safer Future," by Abkowitz, provides an overview of hazardous materials transport safety during the 1990–1991 timeframe *(6)*. With respect to routing, the author discussed the issue of route equity, cost to shippers and carriers, and the confusion that can potentially occur from inconsistent routing between jurisdictions. The author discussed the need for a major national effort to improve the quality and compliance of incident reporting, the development of a truck commodity flow information system, and the issue of whether the current placarding system is adequate, and if not, what an adequate alternative might be.

In May 1990, the Midwest Research Institute prepared a report for the FHWA entitled "Present Practices of Highway Transportation of Hazardous Materials," which provided a comprehensive overview of the safety of highway transportation of hazardous materials around the 1989 timeframe *(7)*. Several issues were discussed, including the responsibilities of federal, state, and local agencies during that time period (pre-HMTUSA), risk assessment models, and analysis of hazardous materials incident, accident, and exposure databases. Recommendations for revisions to FHWA routing guidelines were made.

While these resources discussed relevant routing issues, only the document prepared prior to HMTUSA considered state routing practices in any detail. The hazardous materials transportation literature following the promulgation and codification of the FHWA routing regulations has been silent regarding practical issues, data concerns, and methods of implementing routing analysis to designate routes.

Computer Tools Used in Routing

Several sources that documented the application of various computer models to routing analysis were identified. "Interactive Selection of Minimum-Risk Routes for Dangerous Goods Shipments," identifies various routing strategies for chlorine shipments in the Toronto, Canada area *(8)*. "Selecting Criteria for Designating Hazardous Materials Highway Routes," documented the use of software to analyze routes in Southern California and highlighted the difficulties of designating routes based on a single criterion, such as minimizing risk *(9)*. In "Siting Emergency Response Teams: Tradeoffs Among Response Time, Risk, Risk Equity, and Cost," author George List discusses a model used to aid in the designation of locations for emergency response teams in order to satisfy different criteria, such as minimizing response time *(10)*. In addition, other researchers *(2–5)* used computer routing models to analyze higher level routing policy issues. In general, the most current literature applies or considers computer models in conducting the routing analysis but does not speak to process participation, or how to integrate local/state needs into effective decision making.

Technology Applications

The application of geographic information systems (GIS) and advanced vehicle identification (AVI) technology to highway transport of hazardous materials was discussed in several references. "Databases and Needs for Risk Assessment of Hazardous Materials Shipments by Trucks" provides further detail as to how these technologies can be applied to accident data acquisition to simplify data collection and manipulation *(11)*. These technologies were also considered with other vehicle control systems to assist the driver in controlling the truck, but advanced technologies were not deemed the only answer to safety problems, as described in "Use of Advanced Technologies for Improving Hazmat Transportation" *(12)*. The Arizona highway system was used by Anders and Olsten in a specific case for the application of GIS to assess the risks and vulnerability of highway transport of hazardous materials *(13)*. Chapter 6 discusses technology applications in greater detail.

COMMODITY FLOW STUDIES

At the federal level, monitoring the flow of hazardous materials on highways is limited. The Truck Inventory and Use Survey (TIUS) of the Bureau of the Census, discussed in more detail in the following section on databases, contains estimates of the number of vehicle miles of travel for some types of hazardous materials. However, information pertaining to specific highways and commodities is limited at the federal level.

Individual states have conducted commodity flow studies to determine the types and amounts of hazardous materials moving across their borders. To determine recent activities in this area, the survey asked respondents whether they use flow studies as a tool to designate routes; Delaware, Kentucky, Nevada, Oregon, and Virginia replied that flow studies are used. Flow study reports were obtained from four of these five states and one from an additional state identified during follow-up interviews. The studies are briefly discussed below. Appendix D presents more detail on each study.

Delaware

The Delaware Hazardous Material Transportation Flow Study *(14)*, completed in 1994, was sponsored by the State Emergency Response Commission. The study investigated the movement of hazardous materials within and through the state of Delaware by air, water, rail, pipeline, and highway transport modes. Among the findings of the placard survey: petroleum represents the highest percentage of hazardous materials transported by highway and the average incident occurrence is just over four per year.

Kentucky

The Center for Community and Economic Development at Morehead State University conducted two commodity flow analyses of Kentucky's portion of the I-64 and I-75 corridors in 1994 and 1995 *(15,16)*. The studies identified regional differences in transport frequency, peak movements by year, day of the week, and time of day, and the number of intrastate versus interstate shipments. Recommendations from the studies are to incorporate the movement statistics and findings into emergency response training, distribution, and implementation decisions.

Nevada

The Douglas County Emergency Communications Center commissioned two studies in 1993–1994 *(17)* involving the transportation of hazardous materials through the area referred to as Casino Row, located in Stateline, Nevada. The studies were conducted at one location on five different occasions. Limited analysis of the data was contained in the reports, and no mention of recommendations from the studies was made.

Oregon

The Public Utility Commission of Oregon and the Oregon Department of Transportation conducted a hazardous material commodity flow study in 1987 *(18)*. Details obtained include the number and type of hazardous materials transported on Oregon highways, the primary hazard classes, shipment quantities, container types, load origins and destinations, the routes traveled, and the counties and cities exposed to this traffic. Information regarding the movement of hazardous materials was gathered at truck weigh-scale locations in Oregon and Washington. The report identified seasonal differences in flow and quantified the amount of hazardous materials entering the state through each of four points of entry.

Virginia

The New River Valley Planning District Commission conducted a hazardous materials transportation study in 1994, covering both highway and rail transport *(19)*. The highway portion of the study focused on three highways covering 120 miles. Peak movements by day of week and time of day were identified, as well as highway segments with high risk potential due to population density. The study also uncovered emergency response logistical concerns due to regional topography. Worst case incident scenarios were identified based on findings of the study.

These studies provide useful information about the transport of hazardous materials within certain states. States are able to characterize the materials traversing their borders. The primary purpose of the flow studies identified is to gather information to assess and determine emergency response capabilities. States have consistently found that a majority of the hazardous materials transported in their study areas are petroleum products. Recommendations contained in the studies tend to focus mainly on emergency response needs associated with this high level of petroleum product transport.

DATABASES

Designating routes requires gathering and analyzing a significant amount of data in order to consider all the criteria required under the routing regulations. Information pertaining to accidents, incidents, and exposure is critical in determining the risks involved in transporting materials on different routes. Brief descriptions of several databases identified in the literature that can be used in the route designation process are presented below, along with some of the limitations of each database.

The databases are categorized by the types of information they contain. Relevant *accident* databases contain historical information regarding traffic accidents that involve trucks transporting hazardous materials. Relevant *incident* databases are those that contain information on unintentional releases of hazardous materials during transport. These data give an indication of the frequency of events. *Exposure* databases provide information regarding the occurrence of hazmat shipments by truck in the general traffic flow, e.g., the number of hazardous materials shipments, amount of materials shipped, number of truck miles of hazardous materials shipped.

Accident Databases

National Accident Sampling System

NASS is a National Highway Traffic Safety Administration (NHTSA) system that provides accident data on police-reported accidents, including nonfatal injury and/or property damage. It is a probability sample of all police-reported accidents in the United States collected by each state under contractual arrangement with NHTSA. The database relies on the cooperation of state and local enforcement agencies, and it is unclear as to what mechanisms are in place to ensure that all relevant data are entered in a timely fashion.

Fatal Accident Reporting System

Provided by NHTSA, FARS contains information on every police-reported traffic accident in the United States that results in a fatality. The database contains 40,000 to 50,000 accidents per year. Approximately 120 to 150 accidents per year involve vehicles carrying hazardous materials. FARS does not provide information on incidents as a result of the accidents or corresponding exposure data.

State Traffic Accident Records Systems

Each state maintains a traffic accident records system containing data from police accident reports. Only 15 states identify whether vehicles carrying hazardous materials were involved, and only three states identify whether a release occurred during the accident. Each state has a different data format. Accident reporting thresholds vary and many accidents are not reported.

Incident Databases

Research and Special Programs Administration
Hazardous Materials Incident Information System

HMIS is the primary management and research system used by the US DOT to monitor the safety of hazardous materials transport. Used for compiling, analyzing, and disseminating multimodal incident data, this database contains information by year and mode (including highway) of incidents excluding most bulk water transporters and most carriers that perform solely intrastate transportation. (HMIS does include hazardous waste incident information regardless of whether the shipment was intrastate or interstate transport.) Because intrastate hazardous materials incidents are excluded, but intrastate hazardous waste incidents are not, the database may show a higher rate of hazardous waste incidents versus hazardous materials incidents (for example, petroleum carriers tend to comprise well over 50 percent of the hazardous materials carriers, and a large percentage of these shipments tend to be local, intrastate shipments). In addition, because the database relies on self-reporting of incidents, all incidents may not be reported.

RSPA Hazardous Materials Registration Program

This system contains information provided by suppliers and transporters of hazardous materials on an annual registration statement required by HMTUSA. This system contains information on the name and principal place of business of each registrant, and on the activities in which the registrant engaged during the previous year that required registration.

Exposure Databases

Commodity Transportation Survey

From the Bureau of Census, the CTS is a voluntary survey of multimodal transportation activities based on a sample of about 16,000 companies that ship specific commodities, including hazardous materials. Data contained in the survey include the types of commodities shipped, the shipment weight, and the origin and destination of the shipment. CTS provides flow data only on shipments from manufacturing plants to first destinations, and therefore does not characterize the complete distribution chain or nonmanufactured goods. The survey further does not provide vehicle miles of travel or ton-miles of cargo shipped.

Motor Carrier Management Information System

This system is used by FHWA's Office of Motor Carriers to support its safety program. It contains information on interstate motor carrier safety performance records, including on-site reviews of carriers and shippers, driver and vehicle data collected during roadside inspection, and accident profile reports. This system also contains census information on carriers.

Truck Inventory and Use Survey

From the U.S. Department of Commerce, Bureau of Census, TIUS is part of a census of transportation conducted every 5 years (the last census was 1992). The census involves a random sampling and survey of truck owners in all 50 states. TIUS is an exposure database that provides nationwide statistics on hazardous materials highway transport. Owners are asked to provide the percentage of time that a particular truck is used to carry hazardous materials, using one of five categories (0 percent, below 25 percent, 25 to 49 percent, 50 to 74 percent, and 75 to 100 percent). Owners are also asked about the types of hazardous materials hauled.

A 1991 report by the U.S. General Accounting Office *(20)* on hazardous materials information systems concluded that the US DOT has historically lacked accurate, complete data that are critical to effectively managing the Department's hazardous materials programs. This applies to all modes of hazardous materials transport. State agencies and other groups contacted through this project have contributed similar statements regarding the need for better data on hazardous materials transportation, including accidents and incidents.

CASE STUDIES

Actual experience in the processes of designating highway routes for hazardous materials transport is briefly described in the following case studies, which resulted from research and interviews. These studies were selected because of the differing issues involved and the readily available information. More detail is provided on these case studies in Appendix E.

Designation of Routes in the Northeastern Ohio–Cleveland Area

The Public Utilities Commission of Ohio awarded a planning grant in 1993 to the Northeast Ohio Areawide Coordinating Agency (NOACA) to conduct a routing study and develop recommendations for highway hazmat shipping routes. NOACA formed a task force of representatives of local governments, public interest groups, local industries, and various state agencies to provide input and oversee the study.

NOACA implemented a detailed process to evaluate more than 37 segments of the northeast Ohio expressway system according to the risk factors in the federal standards, and determined various weights to apply to each of the risk factors. The analysis resulted in recommended route sequences with the least risk. A public hearing was held on the selected routes, comments were received and responded to, and recommendations were approved by the NOACA Board and forwarded to the Public Utilities Commission for approval and rule promulgation.

The Commission received numerous comments through the rule-making process from local governments, environmental industries, trucking companies, and citizens. Based on the issues raised in these comments, the Commission determined that further study was needed. Grant funds for hazardous materials planning were invited from interested parties, and the Commission directed NOACA to further study the effects of establishing a certain Interstate as a designated hazardous materials route.

Modification of a Hazardous Materials Route in Duluth, Minnesota

In 1989, Interstate 35 was extended through the City of Duluth, Minnesota. The extension included three tunnels along the route, and hazardous materials were restricted from travel through the tunnels on Interstate 35 between the Mesaba Avenue exit and the intersection of London Road. Hazardous materials transporters were required to take T.H. 61 around the tunnels. As a result of community and industry concerns with the use of T.H. 61 as a hazardous materials route, the City of Duluth requested that the Minnesota Department of Transportation (Mn/DOT) evaluate the risks posed by hazardous materials transport along each of the routes.

Mn/DOT formed an interagency task force in the spring of 1992 to evaluate the two route alternatives. The task force consisted of representatives from federal, state, county, and city agencies. The task force calculated the accident rates on I-35 and T.H. 61 over a 9-month period, and came up with an accident rate of 1.91 accidents per million vehicle miles (acc/mvm) for I-35 versus 8.30 acc/mvm for T.H. 61. The task force also used data from a May 1984, *Report on Prevention and Control of Highway Tunnel Fires* (United States Department of Transportation, Federal Highway Administration, Research Development and Technology) to calculate the frequency of spills and fires on I-35.

The task force determined that hazardous materials transport on T.H. 61 has a higher risk than transport through the tunnels on I-35. This was primarily due to the fact that T.H. 61 has a higher accident rate than I-35, and T.H. 61 passes through business areas, two hospital areas, and a government center. The task force also recognized that I-35 was the better route for hazardous materials transport based on various other factors.

As a result, the task force unanimously recommended that the restriction on hazardous materials transport through the I-35 tunnels be lifted. Following the task force's recommendations, Mn/DOT proceeded to lift the ban on hazardous materials transport through the tunnels along I-35 in the City of Duluth. In addition, Mn/DOT worked with the Duluth Fire and Police Departments and the Minnesota State Patrol to develop an emergency contingency plan for the I-35 tunnels. Since the designation of I-35 as a hazardous materials route through the City of Duluth in 1993, there have been no incidents involving hazardous materials in the tunnels.

Pennsylvania Turnpike

The Pennsylvania (PA) Turnpike is a state-owned and toll-funded highway that consists of numerous tunnels, each approximately three-fourths to one mile in length. Currently, hazardous materials are restricted from the Blue Mountain, Kittatinny, Tuscarora, and Allegheny tunnels on the PA Turnpike. This restriction leaves hazardous materials transporters only one major north-south route through central Pennsylvania, Route 322, which connects Routes 80 and 76. Route 322 has several sections of two-lane highway and has statistically high hazardous materials incident rates, as well as fewer emergency response capabilities than the PA Turnpike.

There are several physical conditions that create an unsafe environment for hazardous materials transportation on Route 322. First, numerous two-lane sections are mountainous and have sharp curves. Second, the Seven Mountains area of Route 322 contains steep grades for several miles. To combat the steep grades, trucks are required to stop at the top of the mountain and are required to descend in low gear at a maximum of 25 miles per hour. Runaway truck ramps have also been installed along the route. Third, Route 322 runs through numerous small towns and is used frequently by local school and commuter traffic. Route 322 also runs through Penn State University, which can be very congested, especially in the fall.

The emergency response capabilities on Route 322 are much different from those on the PA Turnpike. The PA Turnpike has emergency response stations with highly trained teams situated approximately every 15 to 20 miles along the highway. The Route 322 area relies on county-run emergency response stations that vary from trained emergency response teams to local fire departments. There is no emergency response consistency along Route 322, either in distance from the highway or spacing along the highway.

The PA Turnpike Commission is currently conducting a study to determine risk and whether to change the current policy regarding hazardous materials routing on the PA Turnpike. It is unknown at this time when a final decision will be made concerning this issue. Until that time, hazardous materials will continue to be transported on Route 322 and Route 80.

CHAPTER THREE

FHWA GUIDELINES AND STATE INITIATIVES

FEDERAL HIGHWAY ADMINISTRATION CRITERIA FOR ROUTING DESIGNATIONS

Regulatory authority over the routing of hazardous materials transportation resides primarily with the federal government in the movement of goods by land, air, and water. However, implementation and enforcement of hazardous materials routing policy is primarily the realm of state and local governments. This chapter addresses state activities in the highway routing of hazardous materials. States that designate highway routes must follow the FHWA regulations (49 CFR Part 397.61-225), including provisions for public participation, consultation, through shipment considerations, reasonable access to terminals and facilities, reasonable times to reach agreement with affected states or Native American tribes, timely responsibility for local compliance, and the 13 factors identified below that must be considered when designating routes.

Based on the October 1994 revised routing rule, the FHWA published a revised document in May 1995, entitled *Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials*, which was intended to assist states and Native American tribes in assessing risk and designating routes for transport of nonradioactive hazardous materials (NRHM) in accordance with the final routing rule. The document (hereafter referred to as *Guidelines*) is intended to permit someone with limited knowledge of hazardous materials safety issues to analyze and compare route risk and designate routes for the transportation of nonradioactive hazardous materials, based on the results of the analysis. The *Guidelines* estimate that approximately 40 to 80 person-hours are required to conduct an analysis of several highway route alternatives ranging from 50 to 100 miles in length. Factors such as the availability of local data, the depth of the analysis, and the characteristics of the routes analyzed will affect the level of effort needed to complete the analysis. Route designation factors include

- Population density,
- Type of highway,
- Type/quantity of hazardous materials,
- Emergency response capability,
- Results of consultation,
- Terrain considerations,
- Route continuity,
- Alternate routes,
- Effects on commerce,
- Delays in transportation,
- Climatic conditions,
- Congestion, and
- Accident history.

QUESTIONNAIRE RESPONSE

The first question in the survey for this synthesis (Appendix A) asked whether the recipient's agency designates highway routes for the transport of hazardous materials. If the answer was yes, the respondent was asked to continue answering routing questions. If the answer to this question was no, recipients were asked to identify the agency with responsibility for highway routing and a contact person within that agency. This agency was then contacted and sent a questionnaire. This improved the chances of reaching the correct contact and reflecting highway routing practices as accurately as possible nationwide. Follow-up calls were also placed with those states that did not respond to the questionnaire in an effort to obtain a high response rate.

The questionnaire contained a series of questions designed to obtain insight into the current state of practice for highway routing. Twenty questions were asked on the topics identified below:

- Types and materials routed,
- Interagency considerations,
- Public participation,
- Tools used in routing practices,
- Routing criteria,
- Time and cost considerations,
- Routing enforcement, and
- Emergency response.

The primary focus of this synthesis is on existing routing practices, and therefore, the questionnaire concentrated on questions that would provide insight into routing. Less attention was given to other hazardous materials transportation issues, such as enforcement and emergency response. The compilation and discussion of responses to the questions are the topics of this chapter.

A total of 67 questionnaires were sent to states and Native American tribes. Appendix B lists all questionnaire respondents. A total of 43 responses were received, representing 39 states (78 percent of the states) and one Native American tribe. Of the responding jurisdictions, 16 states (41 percent of responding states) reported that they designate routes for highway transportation of hazardous materials. The routing practices of these 16 states are the main focus of the survey findings discussion. Some of the states that indicated that they do not designate routes did respond to other survey questions regarding emergency response. These answers have been incorporated where applicable.

The extent to which jurisdictions have designated hazardous materials routes differs; some states have designated routes for only some classes of hazardous materials while others have

TABLE 1

STATES THAT DESIGNATE HAZARDOUS MATERIALS ROUTES AND THE TYPES OF MATERIALS FOR WHICH ROUTES ARE DESIGNATED

State	NRHM	HRCQ (RAM)	LLRAM	Hazardous Waste	Other
Alabama	•	•			
Arkansas	•	•			
California		•			Explosives Inhalation Hazards
Colorado	•	•	•	•	
Connecticut		•	•		
Delaware					Munitions
Iowa		•			
Louisiana	•	•	•	•	
Minnesota		•			
Nevada	•	•	•	•	
New Mexico		•			
Ohio	•			•	
Oregon	•	•			
Rhode Island				•[a]	
Tennessee		•			
Virginia					•[b]

NRHM = nonradioactive hazardous materials, HRCQ (RAM) = highway route controlled quantities of radioactive materials, and LLRAM = low-level radioactive materials.

[a] Rhode Island designates routes for a subset of extremely hazardous wastes, as defined by the state.
[b] Virginia regulates transportation of materials by hazard class (Prohibited, Restricted, and no Restrictions).

designated routes for all hazard classes. Responsibility for route designation lies with a variety of state agencies, as does responsibility for enforcement and emergency response. Of responding states that do not designate routes, some indicated they have established preferred truck routes that *all* trucks, including those transporting hazardous materials, must take. Other states have not identified a need to designate routes. The remainder of this chapter discusses the questionnaire findings in more detail.

Routing Practices

Respondents that indicated that they designate highway routes for hazardous materials and the materials for which routes have been designated are presented in Table 1.

As shown in Table 1, states often designate routes for certain classes of hazardous materials rather than all classes. Highway route controlled quantities (HRCQ) of radioactive materials (RAM) have been selected for designation more often than other materials (12 states), followed by nonradioactive hazardous materials (NRHM), hazardous waste, and low-level radioactive materials (LLRAM). The Glossary contains definitions of these materials.

Of the states that designate routes for more than one type of hazardous material, most indicated that the designated routes apply equally to all materials. However, Colorado handles routes for HRCQ separately from routing of all other materials. Similarly, California replied that routes are established independently for HRCQ, inhalation hazards, and explosives, with some overlap.

Maryland and North Dakota have established truck route systems within their states. All trucks, including those transporting hazardous materials, must use the truck routes. In Maryland, the truck route system consists of the interstate highways and several other multi-lane connecting highways. It is unclear if established truck routes is a defacto routing method. If so, it does not appear to be risk based.

Use of Federal Guidelines

Of the states reporting that they have designated hazardous materials routes, Louisiana, Minnesota, and Rhode Island stated that the currently established routes were grandfathered after the promulgation of the federal routing regulations in 1994 and that they have not designated routes since that time. The remaining states that designate routes report that they use the federal guidelines. It is unclear from questionnaire responses as to whether these states also have grandfathered routes; however, contact with FHWA has indicated that all currently designated state highway hazardous materials routes were grandfathered and were therefore designated using the existing federal requirements. As of July 1996, no state routing agencies have designated routes using the new federal regulations.

Routing Criteria

Questionnaire respondents were asked to rate 24 factors as to their importance as routing criteria. The factors were categorized by roadway, environmental, and population criteria, as well as a general category. (See question 9 of the questionnaire in Appendix A). Respondents rated the importance of each factor according to the following scale:

0 = NOT IMPORTANT
1 = SOMEWHAT IMPORTANT
2 = IMPORTANT
3 = VERY IMPORTANT
4 = CRITICAL

Table 2 presents the criteria and the responses of each state that rated them. Although somewhat subjective, the rating exercise provides insight into the relative importance to states of the 24 criteria. Ratings were compiled and averaged for each of the states that responded, and the standard deviation, median, and mode were determined. Table 3 presents this data. The 24 criteria are listed in descending order according to the mean rating of the responses. The mode indicates the most common importance rating among the states, and the standard deviation indicates the variation in responses.

Table 3 indicates that *population density* was very important to the states as a routing criterion. This factor also had the lowest standard deviation among responses, indicating that most states felt similarly about its importance. In fact, all respondents answered that *population density* was either a very important or a critical factor in the process (a rating of 3 or 4). Likewise, *location of special populations* was considered an important factor, although there was less uniformity of response regarding this factor (i.e., the standard deviation was higher). More than half of the states responding rated this factor as critical. *Accident history* is an important factor, as are *type of highway* and *availability of alternate routes*, but there was high variability regarding their perceived importance as indicated by the standard deviations. Many states indicated that *underpass and bridge clearance* was important, as indicated by its mode, although there was high variability among the responses, with some states indicating that this was only somewhat important. In general, the key factors that appear to be consistently important in the route designation process were *population criteria, accident history, availability of alternate routes, and highway type.*

Factors receiving the lowest importance rating included *highway drainage system, climate considerations,* and *median and shoulder structures*. The mean rating for these factors was around one (somewhat important). Data presented in an FHWA report *(7)* suggest that the type of highway on which vehicles operate is known to have a strong effect on accident rates for all vehicle types, including trucks. In addition

TABLE 2

STATE RATINGS OF THE IMPORTANCE OF 24 CRITERIA USED TO DESIGNATE HAZARDOUS MATERIALS ROUTES

Factors	AL	AR	CA	CT	CO	DE	IA	LA	MN	NV	NM	OH	OR	TN	VA
Roadway Criteria:															
Availability of alternate routes	3	4	2	4	4	3	3	3	4	4	1	2	1	2	2
Type of highway	2	4	3	3	3	2	4	3	3	2	3	4	3	3	2
Vehicle weight and size limits	1	2	1	4	4	4	3	2	1	3	3	2	2	3	1
Underpass and bridge clearances	1	2	1	3	4	4	4	4	3	2	4	1	2	4	1
Roadway geometric design elements	2	3	2	3	3	3	2	3	3	2	4	1	1	3	2
Number of lanes	1	3	2	2	3	1	3	2	1	2	1	3	1	3	3
Degree of access control	2	3	1	3	2	2	3	2	1	1	1	3	1	4	3
Median and shoulder structures	1	2	1	2	2	0	2	0	0.5	1	2	2	2	2	1
Highway drainage system	1	2	0	1	1	0	2	1	0.5	1	1	0	1	2	1
Congestion	3	4	1	3	2	1	3	3	3	3	1	2	1	4	3
Environmental Criteria:															
Location of sensitive environments	4	4	2	3	2	1	3	2	2	1	2	3	3	2	2
Terrain considerations	2	3	0	2	1	0	2	1	2	2	1	2	1	3	2
Climate considerations	2	0	0	2	1	0	2	1	0	2	2	3	1	2	1
Population Criteria:															
Population density	3	3	4	4	3	3	3	4	4	4	3	4	3	4	3
Location of special populations (schools, hospitals, etc.)	3	4	4	3	3	2	4	4	4	4	2	3	2	4	3
Property value risk analysis	2	1	3	2	1	1	3	2	0	2	1	1	1	2	1
Other:															
Effects on commerce	1	3	4	2	3	1	3	2	3	3	0	4	1	2	1
Cost to transporter	1	3	4	0	2	2	3	1	1	1	0	1	1	1	1
Accident history	2	4	4	3	4	2	3	3	3	3	2	4	1	4	3
Through routing	2	3	4	2	4	1	2	3	2	2	3	3	2	3	2
Type and quantity of hazardous material	3	2	3	3	2	2	3	3	3	4	4	1	1	4	3
Relative impact zone and risks of each type and quantity	4	1	3	4	2		3	2	3	3	1	3	1	3	2
Proximity of emergency response facilities	3	3	3	3	2	1	4	3	2	3	2	2	1	2	2
Capability of ER teams to contain/suppress release	3	3	2	3	2	1	4	3	3	3	3	2	1	3	3

0 = not important 1 = somewhat important 2 = important 3 = very important 4 = critical

TABLE 3

RELATIVE IMPORTANCE OF 24 ROUTING CRITERIA, BY MEAN RATING

Rank	Criteria	Mean Rating	Std Dev	Med	Mode
1	Population density	3.47	0.5	3.0	3
2	Location of special pops (schools, etc.)	3.27	0.8	3.0	4
3	Accident history	3.00	0.9	3.0	3
4	Type of highway	2.93	0.7	3.0	3
5	Availability of alternate routes	2.80	1.0	3.0	4
6	Type and quantity of hazardous material	2.73	0.9	3.0	3
7	Underpass and bridge clearances	2.67	1.2	3.0	4
8	Cap. of ER teams to contain/suppress releases	2.60	0.8	3.0	3
9	Through Routing	2.53	0.8	2.0	2
10	Relative impact zone & risks of each type and quantity	2.50	1.0	3.0	3
11	Roadway geometric design elements	2.47	0.8	3.0	3
12	Congestion	2.47	1.0	3.0	3
13	Vehicle weight and size limits	2.40	1.1	2.0	1
14	Location of sensitive environments	2.40	0.9	2.0	2
15	Proximity of emergency response facilities	2.40	0.8	2.0	3
16	Effects on commerce	2.20	1.2	2.0	3
17	Degree of access control	2.13	1.0	2.0	3
18	Number of lanes	2.07	0.9	2.0	3
19	Terrain considerations	1.60	0.9	2.0	2
20	Property value risk analysis	1.53	0.8	1.0	1
21	Cost to transporter	1.47	1.1	1.0	1
22	Median and shoulder structures	1.37	0.7	2.0	2
23	Climate considerations	1.27	0.9	1.0	2
24	Highway drainage system	0.97	0.6	1.0	1

0 = not important 1 = somewhat important 2 = important 3 = very important 4 = critical
Standard Deviation: A measure of deviation from the mean. A lower number indicates less deviation from the mean among responses.
Median: The number exactly in the middle of all responses.
Mode: The number that is represented the most among responses.

to roadway type (i.e., interstate or rural access road), access control, number of lanes, and median structures are key factors used to define highway type. Table 3 indicates that *degree of access control, number of lanes,* and *median and shoulder structures* rank low in importance among all routing criteria. While some states believe that *number of lanes* and *degree of access control* are very important, most consider *median and shoulder structures* only somewhat important.

Effects on commerce and *cost to transporters* were at the lower end of the importance scale, although significant variability exists among the states, with some reporting that these factors were not important (a rating of 0) while others answered that they were critical (a rating of 4). The mode for *effects on commerce* is 3, reflecting the fact that many states believed it was very important. However, the mode for *cost to transporter* is 1, indicating that states were less concerned with this factor.

State Agency with Primary Responsibility for Routing

Respondents were asked to identify the agency within their state that has primary jurisdiction over highway routing of hazardous materials, as well as other agencies involved in routing policy decisions. Sixteen states that designate routes responded. In addition, four states responded that, although they do not designate routes, they have an officially designated routing agency within the state.

TABLE 4

AGENCIES WITH RESPONSIBILITY FOR ROUTE DESIGNATION

Primary Routing Responsibility	Number of States Reporting
Department of Transportation	11
State Highway Patrol/Police	3
Department of Public Safety	3
Environmental Agency	2
Public Utilities Commission	1

Routing agencies with primary responsibility for route designation tend to be state DOTs; however, many other agencies are also involved in the routing decision-making process (Table 4). Additional agencies identified as involved in routing decisions include

- U.S. Air Force (Delaware),
- Emergency Management Department,
- Fire Marshall,
- Nuclear/Radioactive Waste Authority,
- Public Health Department,
- County Emergency Management,
- City and county engineers,
- Local and county governments, and
- Local fire and police departments.

Routing Time and Cost Considerations

FHWA guidelines estimate that approximately 40 to 80 person-hours are required for the analysis of highway route alternatives ranging in length from 50 to 100 miles. The questionnaire asked respondents to estimate the number of person-hours required to designate a route based on their experience. Fifteen states responded as indicated in Table 5. The variability is most likely due to the differing methods used by states to designate routes, the availability of data, and the characteristics of the routes analyzed.

TABLE 5

TIME REQUIRED TO DESIGNATE ROUTES

Time in Person-Hours	Number of States Reporting
20 to 40 hours	4
40 to 60 hours	2
60 to 80 hours	2
80 to 100 hours	2
100 + hours	2
Not available	3

Respondents were also asked what additional costs are associated with routing, such as costs of signage. Few states provided a dollar figure, but rather identified the types of costs incurred. These costs included computer equipment, software, consulting services, maintenance of signs, and route maps. One state replied that the cost of signage maintenance is approximately $5,000 per year for hazardous materials signs, while another replied that six hazardous materials signs currently scheduled for replacement will cost $15,000 to $20,000. One state estimated map costs to be $500 per year.

Formal Process for Resolving Routing Issues

Respondents were asked whether a formal process to resolve issues with local/state/tribal jurisdictions existed within their state, as well as with adjacent jurisdictions (i.e., other states). Of the 15 states answering this question, eight replied that a formal process existed for resolving intrastate issues. One state replied that the process was established through state statutory/legal responsibility. Arkansas stated that pre-routing conferences are held within the state, while Minnesota has established an interagency task force. (The other states did not provide specific information on their process). Four states replied that they have a formal process to reconcile issues with adjacent states, while one state has an informal process.

Public Participation in the Routing Process

Questionnaire recipients were asked to indicate the methods, if any, used by their state to seek public participation in the routing decision process. A variety of public participation processes are used. Responses to this question are given in Table 6 for the 13 states that answered.

Metropolitan planning organizations (MPOs) are involved in the decision process in some states. In Delaware, members of the State Emergency Response Commission participate in routing designation. California, Nevada, and New Mexico reported extensive public participation processes, while Alabama has no public participation and Iowa and Tennessee consult only with other jurisdictions. Eight states hold meetings with industry during the routing designation process.

Public participation is specifically addressed by the routing requirements in 49 CFR Part 397.71. For states with grandfathered routes, public participation may not have been required when those routes were established.

Enforcement of Hazardous Materials Transport Routes

To obtain information about state practices regarding route enforcement, respondents were asked questions about agency responsibility for enforcement, training for enforcement personnel, and costs associated with enforcement. Because the focus of the synthesis is on routing, the questionnaire did not ask specific enforcement questions that would shed light on jurisdictional overlap or additional enforcement issues.

Agency Responsibility for Route Enforcement

Respondents identified the organization within their state that has primary responsibility for hazardous materials routing enforcement as shown in Table 7. Agencies that are reported to have primary responsibility include highway patrol/state police departments of public safety and transportation, public utilities commission, and the state environmental agency.

TABLE 6

PUBLIC PARTICIPATION METHODS USED BY RESPONDING STATES

Method	AL	AR	CA	CT	CO	IA	NV	NM	OH	OR	RI	TN	VA
Public notice followed by a comment period		X	X		X		X	X	X	X	X		X
Public hearings			X		X		X	X		X	X		X
Meetings with community groups			X				X	X		X			
Meetings with industry		X	X		X		X	X	X		X		X
Meetings with other jurisdictions		X	X		X	X	X	X	X	X		X	
No public participation	X											X	
Unknown				X									

TABLE 7
AGENCY WITH PRIMARY ENFORCEMENT AUTHORITY IN RESPONDING STATES

Primary Enforcement Authority	
Authority	Number of States
Highway Patrol/State Police	8
Department of Public Safety	3
Department of Transportation	2
Environmental Agency	1
Public Utilities Commission	1
Not Enforced	1

Other agencies and groups with enforcement authority were also identified. Most states reported that local police officers have enforcement authority within their jurisdictions. Other enforcement authorities included the state attorney general and departments of energy, motor vehicles, and taxation/revenue.

Training for Enforcement Personnel

Twelve states indicated that they provide training for route enforcement. Two states said that no training is provided, one state has no enforcement personnel, and one state respondent did not know whether training for enforcement personnel is provided. Of those that provide enforcement training, most offer classes ranging from 2 to 80 hours, covering routing, permitting, and related topics.

Louisiana reported that they provide US DOT Hazardous Materials Enforcement training and US DOT Motor Carrier Safety Enhancement. Minnesota reported that enforcement training includes "need to know" training for state troopers; commercial vehicle inspectors receive the 40-hour basic hazardous materials course provided by FHWA; hazmat specialists in the state motor carriers office receive 400 plus hours of hazmat training; and other transportation specialists within the state receive 100 plus hours of training.

Enforcement Costs

Respondents were asked to specify the average cost per year to enforce hazardous materials routes. Most of the respondents replied that enforcement costs are unknown. They are often part of a larger office budget or routine patrol budget. Some states that designate only a small number of routes reported that enforcement costs were minimal. Two states answered that enforcement costs were approximately $1,000, while New Mexico reported a cost of $300,000. However, New Mexico's figure also included emergency response costs.

Hazardous Materials Emergency Response

As with enforcement, questions regarding emergency management practices were posed. Information was requested about agency responsibility for emergency response, training for emergency response personnel, and costs associated with emergency response. However, the questionnaire did not ask specific questions that would shed light on jurisdictional overlap or additional response issues.

Agency Responsibility for Emergency Response

Respondents were asked to identify the organization in their state with primary responsibility for hazardous material emergency response. Many states reported that organized emergency response teams have been established. These teams are often composed of members of various state and local agencies, and are administered by one lead agency. The agencies identified as having primary responsibility for emergency response include state highway patrol/police, departments of public safety/emergency management, local fire departments, and the state environmental agency.

In most of the states reporting, local fire departments usually have secondary responsibility for emergency response, with the exception of Ohio, where local fire departments and hazmat teams are reported to have primary responsibility. Many states also have identified emergency response coordinators on a county or regional basis to coordinate efforts.

Emergency Response Training

Twelve states responded that training for emergency response is provided. The Shoshone Bannock Tribe also responded that they provide emergency response training. Four states responded that their agency does not provide training; however, training may be provided by other agencies within the state or at the local department level.

States that provide emergency response training report different levels of training and materials used. Arkansas provides initial awareness training. Colorado offers 8 hours of awareness training, 24 hours of operations training, 80 hours of technician training, 40 hours of cargo tank and rail response, and 40 hours of radiological response training, for specialized personnel only. In Louisiana, all state police officers receive, at a minimum, technician level training. Minnesota reports that each agency is responsible for training its own staff. The Minnesota Office of Motor Carrier Services staff have each had in excess of 400 hours of training. Minnesota also provides training four times per year for the state emergency response team, using materials from US DOE, US DOT, US EPA, and state created materials. California provides 16 hours of first-responder operational training, 32 hours of hazardous materials incident command training, and 240 hours of hazmat technician/specialist training.

Emergency Response Costs

Respondents were asked to report the average cost per year for emergency response capabilities, including training and supplies. As with enforcement costs, most of the respondents replied that emergency response costs are unknown, usually because they are part of a larger office budget. However, six states and one Native American tribe reported emergency response costs. Colorado reported a cost of $170,000 per year for equipment plus 24 full-time response and enforcement officers. Louisiana replied that emergency response receives high priority in the state and reported an annual cost of $875,000. Rhode Island reported a cost of $80,000 per year, Minnesota reported $50,000 per year, and Oregon reported $300,000 plus per year. The Shoshone Bannock Tribe reported emergency response costs of $120,000 per year. The questionnaire did not request that respondents break down cost figures, and few respondents provided further details in the space allocated for elaboration.

Incident Records

Respondents were asked to indicate whether their agency provides quality control review of incident records. The purpose of this question was to provide an indication of whether agencies are examining the actions taken after an incident or perhaps recording data for future incident response needs. Eleven states and one Native American tribe answered yes to this question, three states answered no.

Risk Assessment

Respondents were asked if their agency conducts a quantitative risk assessment as part of designating routes, and if so, to identify the tools used. Ten states answered yes and six states answered no. Of the states answering yes, the tools and databases that were used for risk assessment are identified in Table 8.

Chapter 2 presented a discussion of many of these databases identified by state agencies as input to their routing risk analyses. Given the stated limitations of many of these databases, few states use them. Additional types of data that states use for analysis include census, road type, truck traffic, and vehicle type data.

TABLE 8

RISK ASSESSMENT TOOLS

	Number of States
Accident records systems	9
Spill reporting systems	4
Office of Motor Carrier Safety form 50-T	3
Hazardous materials information systems	2
Truck inventory and use survey	1
Commodity flow survey	1
SAFETYNET	3
Trucks involved with fatal accidents	1
US DOT Prevention and Control of Highway Tunnel Fires	1

Routing Tools

One question was asked regarding tools used for overall route designation, specifically, whether flow studies, databases, or vehicle identification and tracking systems are used. Respondents were asked to specify other tools as well. Six states replied that commodity flow studies are used in routing, and six states replied that relevant databases are used. Flow studies and databases are discussed in chapter 2. No states reported using vehicle identification, reporting, or tracking systems.

States also reported that census data and population concentration data are used, as well as accident rates, statistics, and traffic counts. Additional tools mentioned include StateGEN (used for RAM routing), SafetyNet inspection database, and Adequate Geometry.

States that Do Not Designate Routes

Respondents indicating that they have *not* designated routes for highway transportation of hazardous materials were asked to supply reasons, if known. The reasons ranged from perceived lack of need, to no designated state agency to do routing, to too much cost for too little benefit. Some specific reasons include few hazardous materials incidents or movements, and reliance on compliance with federal regulations.

CHAPTER FOUR

INDUSTRY NEEDS

INTRODUCTION

The hazardous materials transportation industry is required by the Hazardous Materials Transportation Uniform Safety Act (HMTUSA) to follow certain regulatory requirements governing the transport of hazardous materials. First, hazardous materials transporters must carry shipping papers (or a hazardous waste manifest for hazardous waste) with each shipment of hazardous materials. Second, carriers are required to notify the responsible authority in the event of an incident that occurs at any time during the transportation of a hazardous material (including loading, unloading, and temporary storage). Third, transporters are required to train employees involved in the transport of hazardous materials on both a function-specific and a safety basis. Fourth, hazardous materials transporters are required to comply with the Department of Transportation's safe transport regulations, which include provisions for: loading and unloading procedures; driver training and qualification; minimum levels of financial responsibility; and parts and accessories required for safe vehicle operation. In addition to these requirements, hazardous materials transporters are required to comply with routing designations that have been properly implemented in states, counties, or local jurisdictions.

METHOD

To identify the pertinent routing issues affecting the hazardous materials transport industry, several interviews were conducted with some of the major trade associations and educational organizations involved with commercial highway transport and hazardous materials. Associations were identified through the literature search and through contact with some of the staff at the Federal Highway Administration (FHWA). Interviews were conducted with: the Association of Waste Hazardous Materials Transporters (affiliated with the American Trucking Associations (ATA);the National Tank Truck Carriers (NTTC); and the Hazardous Materials Advisory Council (HMAC).

FINDINGS

General Routing Issues

The interview results indicated that the hazardous materials transportation industry does not appear to have any significant issues or concerns related to the highway routing of hazardous materials for the following stated reasons:

- The designation of highway routes is a reasonable requirement for the transport of hazardous materials;
- Industry concerns were adequately addressed in HMTUSA and the 1994 guidelines for establishing highway hazardous materials routes; and
- Highway routing of hazardous materials is only a small part of the numerous requirements involved with hazardous materials transport.

In fact, the industry groups interviewed encouraged the designation of reasonable routes (i.e. routes that are continuous, consistently applied, and not excessively circuitous), because they believed it would reduce their liability associated with the transport of hazardous materials, as well as reducing the burden on the carrier to determine the safest route.

Highway routing of hazardous materials may be more of an issue on a regional basis, particularly in states that have designated routes. This is evidenced by the variability reported in chapter 3 of the questionnaire responses of the two routing criteria that involve industry: "effects on commerce" and "cost to transporter." Some states regarded these criteria as critical to the routing designation process, while others believed that they were not important. Despite hazardous materials highway routing not being a major issue within the transportation industry, the industry groups interviewed did have some specific concerns regarding highway hazardous materials routing.

Specific Industry Concerns

Consistency of Routes

The biggest concern for the industry groups interviewed was ensuring continuity of hazardous materials highway routes. First, hazardous materials routes must be consistent across jurisdictions, from the local to the interstate level. The regulations address this problem, but several instances have occurred where inconsistent routes or proposed routes have caused problems for hazardous materials carriers. Second, if routes are designated, and hazardous materials transport is restricted on certain roads, the restrictions should be consistently applied for both intra- and interstate carriers (this also applies on the county and local level). In other words, intrastate hazardous materials carriers should not be allowed to use a road for hazardous materials transport that interstate carriers cannot use. This inconsistency has caused some problems for interstate haulers in the past.

Exporting Risk

One association specifically addressed the issue of exporting risk. Whether it be on the local, county, or state level, the agency responsible for route designation must be careful not to designate routes based on removing the risk associated with hazardous materials transport from their jurisdiction. This can be a problem especially on the local level, where one city makes a decision to route hazardous materials around the city, then outlying jurisdictions do the same. Eventually, access in and around the city that originally designated the hazardous materials route could be severely limited, and risk, on the whole, is not decreased. In fact, the risk has merely been "exported" to outlying areas.

Time-of-Day Restrictions

Two associations interviewed expressed opposition to imposing time-of-day restrictions as a method of designating routes. Restricting hazardous materials transport to certain times during the day can increase the time that hazardous materials trucks are on the road. Since time is a factor in calculating risk, increased time on the road could mean increased risk.

Lane Restrictions

As with the time-of-day restrictions, two industry groups oppose the establishment of lane restrictions for hazardous materials carriers. In most cases, if there are lane restrictions, trucks are required to use the right lane(s) only. This is especially problematic in urbanized areas, where there are numerous entry and exit ramps, and increased vehicle traffic crossing in and out of the right hand lanes. Restricting trucks to the right lane(s) on highways might increase the probability of accidents. One association advises its member carriers to drive in the middle lanes of multi-lane highways with lane restrictions for safety reasons.

Tunnel Restrictions

One association mentioned that tunnel restrictions are a major concern and problem for its members. Most tunnel restrictions are very broad based, and in some instances, hazardous materials transport through tunnels is banned altogether. The major problem with tunnel restrictions is that tunnels often make travel accessible in areas that would otherwise be impassable to highway traffic. In the cases where hazardous materials are banned from tunnels, alternative routes around the tunnels can be many miles longer than the route that includes the tunnel. This has most affected carriers whose hazardous materials transport makes up only a small percentage of their cargo, but still must take an alternative route due to tunnel restrictions.

Economic Issues

One trade association interviewed believes that the designation of routes might act as an economic barrier to the transport of hazardous materials, because any increase in mileage caused by route designation would likely result in increased costs of transport.

From an industry standpoint, highway routing of hazardous materials has not been of much concern, and further designation of reasonable routes should be encouraged. Industry groups are not dedicating many resources to this issue, at least on a national level. However, inconsistent routes across jurisdictions, exportation of risk, time-of-day restrictions, lane restrictions, and tunnel restrictions have caused sporadic problems for hazardous materials carriers.

CHAPTER FIVE

TECHNOLOGY APPLICATIONS

The technological applications inherent in various components of Intelligent Transportation Systems (ITS) can enhance the safe transport of hazardous materials on our nation's highways. These advanced technologies include vehicle control and driver information systems, heavy vehicle detection systems, and driver/vehicle performance monitoring systems. While not specifically of use for designating routes, these technologies can provide valuable information to aid in the safe transport of hazardous materials while en route.

TECHNOLOGY TYPES

Vehicle control systems are intended to assist the driver of the vehicle through methods such as tracking the vehicle in front to avoid a collision. Collision avoidance systems measure and monitor the distance between two vehicles and their relative speeds. If a collision is imminent, the control system either alerts the driver or automatically applies the brakes in an attempt to avoid the anticipated collision. This technology is still primarily in the development stage and will take some time before it is perfected and widely available. In addition to providing a method to monitor and react to actions of nearby vehicles, this device should, once perfected, provide a technique to counter accidents due to driver fatigue.

Driver information systems use advanced technologies to improve the quality and the real-time availability of information provided to drivers. Automatic vehicle location (AVL) technologies are used to provide the driver with real-time information concerning his location with respect to his destination. Satellite surveillance systems are one such technology that enables the constant surveillance of trucks in transport through the use of satellite systems. Each vehicle is fitted with an antenna that beams information to two satellites. One satellite gathers operational data and the other reports the position of the vehicle. The satellites beam data to a ground-based terminal, which immediately forwards the information to a host computer that passes the information to the traffic department of the shipper and the dispatch office of the carrier. Information is exchanged with the vehicle driver through an on-board computer. At any time, the shipper and the dispatch office have the ability, through this driver information system, to pinpoint the vehicle's precise geographic location.

Radio determination satellite systems (RDSS) technologies can determine the location of vehicles and distance from destination through the use of tow satellites. Locational information provided by the satellites is transmitted to a central facility which calculates, from this information, the location of the vehicle relative to its destination and then transmits this information back to the truck and the fleet headquarters. Another, less-effective technology for automatic vehicle location is a proximity system that determines the location of vehicles en route through transponders on-board the vehicle. The transponder transmits information to readers mounted at various locations, such as signposts, traffic lights, and on the ground. Obviously, the main drawback of the AVL system is that a dense network of readers is necessary to provide an effective system for determining vehicle locations.

Driver performance systems can monitor the performance of a driver or vehicle continuously through an on-board computer management system that records information such as time on the road, vehicle speed, and time between travel breaks. The equipment reports the real time information back to a dispatch system, which then monitors and manages the performance of the driver. This type of technology can result in safer operations and less risk in the transport of hazardous materials since it expands the monitoring and management of the driver and vehicle while in transport.

Another technology that can have added benefits in the safe transport of hazardous materials is the use of weigh-in-motion (WIM) systems. These systems are imbedded in the pavement and provide a measurement of the vehicle's weight as it travels over the system at normal operational speeds. Detection of overweight vehicles through this system combined with adequate enforcement procedures ensures that vehicles operating at an unsafe weight are removed from the highway, thus possibly reducing the risk of a potential accident.

ITS technology applications are expected to be commonplace in the next decade. Three examples of ITS technology applications, Advantage I-75, CVISN, and Operation Respond, are presented here.

Advantage I-75

Advantage I-75 is a public/private partnership formed in 1990 to implement Automatic Vehicle Identification technology along the U.S. Interstate 75 and Canadian Highway 401 corridor that runs almost 2,000 miles from Kingston, Ontario to Miami, Florida. The Advantage I-75 Operational Test Project utilizes electronic truck processing systems called Mainline Automated Clearance Systems (MACS) to track vehicles and eliminate the need for multiple weigh station stops. A pilot program is in operation in which 4,500 trucks equipped with transponders are communicating electronically with roadside readers and each weigh station they pass along the corridor.

Each truck participating in the program uses an on-board transponder to communicate with roadside readers. A reader is located approximately 0.5 miles before each weigh station and two to three readers are located within each weigh station. A truck is processed through an initial weigh station, where each reader records truck-specific information such as current location, date, time, weight data, and axle data that is stored electronically in the truck's transponder. As the truck approaches the next weigh station, the roadside reader records information from the on-board transponder. The reader sends the data to a computer that processes the information and sends back a clearance signal to the truck's transponder indicating whether the driver is required to stop at the weigh station or is cleared to proceed. The transponder indicates the signal to the driver of the truck using tones and lights. An addition being made to the system will provide high-speed, weigh-in-motion equipment on the actual roadway that will eliminate the need to stop at the initial weigh station to record vehicle weight.

Using this system, hazardous materials transportation can be readily monitored and tracked. This can improve incident response time and provide truck-specific information to emergency responders. Moreover, proper response guidelines for each cargo can be maintained in the MACS database and provided to responders. In addition, acceptance into Advantage I-75 requires an acceptable safety rating, safety record, and vehicle inspection program. This is expected to provide the incentive to improve safety performance for motor carriers who want to become participants.

The Advantage I-75 participants are FHWA, the six I-75 states (Florida, Georgia, Kentucky, Michigan, Ohio, and Tennessee), the province of Ontario, the Canadian Ministry of Transport, U.S. and Canadian trucking associations, and individual trucking companies. The Kentucky Transportation Cabinet is the lead agency and the University of Kentucky's Transportation Center provides staff support.

CVISN

Commercial Vehicle Information Systems and Networks (CVISN) is not a specific technology application but rather a way for existing information systems to exchange electronic information. CVISN's goal is to apply information exchange standards and use the U.S. commercial communications infrastructure to enhance safety and increase the productivity of commercial vehicle operations. CVISN is a voluntary program in which public and private organizations participate.

CVISN includes a group of key commercial vehicle operation information systems called the Core Infrastructure. This Core Infrastructure supplies an infrastructure for safety, registration, fuel tax, hazmat, and driver license information exchange among states and organizations. CVISN will enable these systems to share information and allow stakeholders to obtain information from one place, eliminating the need to interact with various state agencies.

Implementation of CVISN will occur in five major steps. Step 1 develops the management and technical plans to coordinate the remaining steps. Step 2 will develop a prototype in an actual environment using the states of Virginia and Maryland to demonstrate and validate the concept. Step 3 will pilot this approach in seven states with major truck travel. Step 4 will expand the pilot to partner states of each of the seven states in Step 3. Step 5 will expand the program nationwide.

CVISN will enhance the safety of hazardous materials transportation by enabling consistent and accurate data to be obtained from one source. This will aid risk assessment by providing exposure and incident statistics. The CVISN vision also calls for vehicles to be equipped with mobile communications systems, navigation systems, on-board vehicle monitors, collision avoidance devices, and vision enhancement systems.

Operation Respond

Operation Respond is an effort primarily funded by the Department of Transportation to coordinate information and reduce hazmat emergency response costs by making material safety data sheets and cargo contents from rail cars and highway vehicles quickly available to emergency responders. A not-for-profit organization called the Operation Respond Institute, located in Bethesda, Maryland, oversees the program, which was developed after a National Academy of Sciences study recommended experimentation to provide needed data for first responders to hazmat incidents.

Pilot programs are underway that allow responders to immediately tap into a motor carrier's mainframe computer to receive cargo data and emergency response information. All that is needed is a vehicle identification number. The goal is to obtain the data in less than 90 seconds and have it available to aid in proper response to a hazardous materials incident.

ITS and advanced technologies are not the sole answer to safe transport of hazardous materials. However, combined with effective routing designations, adequate driver training and operational improvements, and expanded emergency response capabilities, advanced technologies complement efforts to reduce the risk involved in transportation of hazardous materials. In addition, advanced technologies do provide added benefits besides safety. Enhanced communication afforded by such systems can also provide productivity improvements.

CHAPTER SIX

CONCLUSIONS

The objective of this synthesis was to identify whether and how states and Native American tribes currently designate highway routes for the transport of hazardous materials, including the extent to which the federal regulations have been implemented, associated implementation costs, institutional or regulatory constraints, and any related concerns and needs of the transportation industry. Based on the surveys conducted for this synthesis, it may be concluded that there has been some activity at the state and local level in designating highway routes for the transport of hazardous materials, and that the transportation industry has limited concerns and needs regarding the hazardous materials route designations. Other conclusions based on survey responses and follow-up include:

- Thirty-nine states and one Native American tribe responded to the questionnaire. Of these responses, 16 states replied that they designate routes for the highway transport of hazardous materials. It appears that all these routes are grandfathered under the new federal routing guidelines.
- The most important criterion when routing, from a list of 24 factors supplied to respondents, was population density, followed by location of special populations, accident history, and type of highway.
- The state department of transportation has primary responsibility for routing decisions in the majority of states responding. State police, state emergency management agencies, and state public safety departments also have primary responsibility in some states. Many other agencies are involved in the routing decision-making process.
- States report a range of time requirements to analyze routes, from between 20 and 40 hours to over 100 hours. Detailed routing costs were not available from most states, but costs are incurred for computer equipment, software, consulting services, signs, and maps.
- About half the states that designate routes indicated that a formal process exists for resolving intrastate routing issues, while fewer states have a formal process to deal with neighboring states. Most states that designate routes seek public participation in the process, most often by public notices and comment periods, meetings with industry, and meetings with other jurisdictions.
- State highway patrols have primary enforcement responsibility in the majority of states that designate routes. Eleven states provide training for route enforcement; one state reported no enforcement personnel. Enforcement costs are not generally known but estimates ranged from $1,000 to several hundred thousand dollars.
- State highway patrols were also the agency listed most often as having primary responsibility for emergency management. Eleven states and one Native American tribe provide training for emergency response. Emergency response costs ranged from unknown to as much as $875,000 per year.
- From an industry standpoint, highway routing of hazardous materials has not been of much concern, and further designation of reasonable routes is encouraged. Industry groups are not dedicating many resources to this issue, at least on a national level. However, inconsistent routes across jurisdictions, exportation of risk, time-of-day restrictions, lane restrictions, and tunnel restrictions have caused sporadic problems for hazardous materials carriers.
- The National Governors Association reported in 1989 that virtually all of the states expressed an overriding need for funding for hazardous materials transportation programs and personnel. Federal financial aid is available for a limited number of state commodity flow studies.

Implementation and enforcement of the rule is sometimes viewed as an unfunded voluntary program at the state/tribal level, in an era of widely competing concerns and tight budgets. Many respondents to the survey indicated a limited need for hazardous materials routing. The routing process is perceived by some to be costly and time consuming with limited experience since many states have not experienced serious hazardous materials incidents on their highway systems. Following a serious accident, concern for proper routing designations will be heightened, and action to reduce risk called for. Under such circumstances, the cost of routing will likely be greater and its effectiveness lessened. States and tribes would improve highway safety efforts if they initiated routing actions proactively rather than reacting in the aftermath of a catastrophic accident with a hazardous materials release.

Overall, it appears that there has been activity at the state and local level, with some support from FHWA, to designate highway routes for the transport of hazardous materials. It has been slightly more than 3 years since the FHWA promulgated the final guidelines for designating routes. Given more time and experience, it can be anticipated that more states and Native American tribes will become even more involved in hazardous materials highway route designations.

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GLOSSARY OF TERMS AND ACRONYMS

Agreement of affected States or Native American tribes—States or Native American tribes affected by any NRHM routing designation must be given 60 days in which to review and approve the proposed routing designation.

Burden on commerce—A burden on commerce is an effect that creates additional shipment costs arising from such things as routing restrictions that create circuitous routes that in turn may create shipment delays. Any routing designation made in accordance with Subpart C of Part 397 shall not create an unreasonable burden upon interstate or intrastate commerce.

Census tract—Data on population density are broken down into geographic areas. Census tracts are the boundaries between areas of different population.

Climatic conditions—Weather conditions along a highway route that could affect transport safety, the dispersion of the hazardous material upon release, or increase the difficulty of controlling and cleaning up a hazmat release. Such climatic conditions include snow, wind, ice, and fog.

Consultation—Prior to the establishment of any routing designation, the state or Native American tribe shall provide notice and consult with officials of affected political subdivisions, states and Native American tribes, and any other affected parties.

Designated routes—A route or portion of a route that **must** be used when transporting nonradioactive hazardous materials (NRHM) over highways. When applicable specifically to NRHM-carrying motor vehicles, a route designation includes any regulations, restrictions, curfews, time of travel restrictions, lane restrictions, routing bans, port-of-entry designations, or route weight restrictions.

Emergency response capabilities—The resources available for responding to hazmat incidents to protect public safety and health and the environment. The analysis of emergency response capabilities is to be based on the proximity of the emergency response facilities and their capabilities to contain and suppress hazardous materials releases within the impact zone.

Factors—FHWA regulations (49 CFR Part 397.61-225) list 13 factors at § 397.71 (b)(9) that must be considered in establishing any nonradioactive hazardous materials designation. These factors are: population density, type of highway, type and quantity of NRHM, emergency response capabilities, results of consultation with affected persons, exposure and other risk factors, terrain considerations, continuity of routes, alternative routes, effects on commerce, delays in transportation, climatic conditions, and congestion and accident history.

Hazardous materials—As defined by 49 CFR § 171.8, hazardous material means a substance or material, which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. The term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials, as further defined by this section of the CFR.

Hazardous waste—As defined by 49 CFR § 171.8, hazardous waste means any material that is subject to the Hazardous Waste Manifest Requirements of the U.S. Environmental Protection Agency specified in 40 CFR part 262.

Highway route controlled quantity—As defined by 49 CFR § 173.403, HRCQ means a quantity within a single package that exceeds radionuclide values as specified in § 173.435 for radioactive material by an amount specified in the rule definition.

Jurisdiction—The territory over which a state, local government or Native American tribe has the power or authority to interpret and apply federal regulations.

Placarded shipments of NRHM—Certain types and quantities of NRHM require placarding when they are transported by motor vehicles. These types and quantities are identified in Tables 1 and 2 of 49 CFR 172.504.

Population density—A measure of population along a route used in the relative risk determination. Population may consist of residents, employees, motorists, and other persons in the area. Population density is the population along a segment of an alternative route divided by the segment area.

Public participation—A state or Native American tribe shall provide 1) notice to the public of any proposed routing designation, 2) a period in which to comment, and 3) a public hearing, if deemed necessary by the state or Native American tribe.

Radioactive material—As defined by 49 CFR § 174.403, means any material having a specific activity greater than 70 Bq per gram (0.002 microcurie per gram).

Reasonable access (terminal and facilities)—Any routing designation must provide reasonable access for motor vehicles transporting NRHM to reach terminals, points of loading, unloading, pickup and delivery, and facilities for food, fuel, repairs, rest, and safe havens.

Reasonable routes—The shortest practicable route based on consideration of 13 factors listed in paragraph (b)(9) of § 397.71. The routes established by a state or Native American tribe must provide reasonable access to terminals, points of loading, unloading, pickup and delivery, and facilities for food, fuel, repairs, rest, and safe havens.

Responsibility for local compliance—The states are responsible for ensuring that all of their political subdivisions comply with the provisions of Subpart C of Part 397. The state is responsible for resolving all disputes between subdivisions. A routing agency for the state or Native American tribe, designated by the Governor or Native American tribe, respectively, shall ensure compliance with the federal standards.

Restricted routes—Highway routes along which nonradioactive hazardous materials (NRHM) **may not** be transported. Restrictions covered under this regulation must apply specifically to NRHM-carrying motor vehicles, and could include forbidding travel on specific routes or route segments, or constraining travel by time of day, lane, or type of NRHM.

Routing agency—An agency that supervises, coordinates, and approves the non-radioactive hazardous materials routing designation. For a state, this agency could be the state highway agency, or other state agency designated by the Governor; for an Native American tribe, this would be an agency designated by that Native American tribe.

Route continuity—The state or Native American tribe must consult with adjacent jurisdictions to ensure routing continuity for hazardous materials across common borders.

Standards—Federal standards are the basis for a state or Native American tribe's establishment of a routing designation. The standards are set forth at § 397.71 (b)(1)–(9). They are: enhancement of public safety, public participation, consultation with others, through routing, agreement of other states (burden on commerce), timeliness, reasonable routes to terminals and other facilities, responsibility for local compliance, and factors to consider.

Through routing—The routing designation must ensure continuity of movement so as not to impede or unnecessarily delay the transportation of NRHM. Criteria set forth in the rule to enhance public safety require that, for a proposed designation to go into effect, 1) the current route must present at least 50 percent more risk to the public than the deviation under the proposed designation; 2) the current route presents less than 50 percent more risk, but the proposed designation does not force a deviation from the current route of the lesser of (a) 25 miles or (b) 25 percent of that part of a trip affected by the deviation. A proposed designation cannot go into effect if the current route presents the same or less risk.

Traffic congestion—Congestion is related to the potential for traffic flow to be disrupted by an accident involving a hazardous materials-carrying vehicle. Traffic congestion can affect the potential for a release, the ability of emergency responders to reach the scene, the exposure to motorists, or the temporary closing of a highway for cleaning up any release.

Transportation delays—Transportation delays or traffic backups may be caused by congestion on certain route segments and certain times of day or night. Delays may be a function of the maximum safe posted speed for a route. Delays may be avoided by imposing time of day restrictions for certain routes or segments, maximizing use of Interstates, selecting minimum time in transit routes, and considering single transport modes.

Type of highway—Characteristics of a highway, including vehicle weight and size limits, underpass and bridge clearances, roadway geometrics, number of lanes, degree of access control, and median and shoulder structures. The types of each alternative highway are compared when establishing a routing designation.

APPENDIX A

Questionnaire

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Project 20-5, Topic 27-02

CRITERIA FOR HIGHWAY ROUTING OF HAZARDOUS MATERIAL VEHICLES

QUESTIONNAIRE

Name of respondent: ____________________
Organization: ____________________
Title: ____________________
Phone and Fax No.'s: ____________________
E-mail address: ____________________

CURRENT ROUTING ACTIVITIES:

1. Does your state designate routes for the transport of hazardous materials?

_ YES _ NO (If NO, please go to Question 20.)

If YES, please check those materials for which your state designates transport routes.

Check all that apply:
____ Non-radioactive hazardous materials (NRHM)
____ Radioactive materials (RAM)
____ Low level RAM (LLRAM)
____ Hazardous wastes
____ Highway Route Control Quantities (HRCQ)
____ other, please specify

2. Do you use the federal guidelines for designating routes?

_ YES _ NO

If NO, what, if any, guidelines do you use?

3. a) Does your agency have primary jurisdiction over highway routing of all hazardous materials?

_ YES _ NO

3. b) What other agencies are involved in routing policy decisions?

4. How do you seek public participation in the decision process?

Check all that apply:
____ public notice followed by comment period
____ public hearings
____ meetings with community groups
____ meetings with industry
____ meetings with other jurisdictions
____ no public participation
____ other, please specify

5. Do routing designations differ for different classes of hazardous material (e.g., NRHM, RAM, LLRAM, HRCQ)?

_ YES _ NO

Explain:

6. Which, if any, of the following tools do you use in designating routes?

Check all that apply:
____ flow studies
____ databases
____ vehicle identification, tracking, and reporting systems (including satellite technology)
____ other, please specify

Briefly describe studies, software, or systems used:

7. FHWA guidelines estimate that approximately 40 to 80 person-hours are required for the analysis of highway route alternatives ranging in length from 50-100 miles. What do you estimate is the average number of person-hours required to designate a route?

____ 20-40 ____ 40-60 ____ 60-80 ____ 80-100 ____ 100+ hours

8. a) Do you have a formal process to resolve routing issues with local/state/tribal jurisdictions (i.e., other jurisdictions within your state?

_ YES _ NO

b) Do you have a formal process to reconcile issues with adjacent jurisdictions (i.e., adjacent states)?

_ YES _ NO

Explain:

9. Rate the following factors as to their importance as routing criteria:

0 = not important 1 = somewhat important 2 = important 3 = very important 4 = critical

Roadway Criteria

____ availability of alternate routes
____ type of highway
____ vehicle weight and size limits
____ underpass and bridge clearances
____ roadway geometric design elements
____ number of lanes
____ degree of access control
____ median and shoulder structures
____ highway drainage system
____ congestion

Environmental Criteria

____ location of sensitive environments (e.g., wetlands, parks, natural areas)
____ terrain considerations
____ climate considerations

Population Criteria

____ population density
____ location of special populations (e.g., schools, prisons, hospitals, senior citizen centers)
____ property value risk analysis

Other

____ effects on commerce
____ cost to transporter
____ accident history
____ through routing
____ type and quantity of hazardous material
____ relative impact zone and risks of each type and quantity
____ proximity of emergency response facilities
____ capability of ER teams to contain or suppress releases

Please elaborate on any rating, as needed, to clarify your response:

10. Do you conduct a quantitative risk assessment?

_ YES _ NO

If YES, please respond to the following questions:
(Please indicate to which class of hazardous material the assessment applies: NRHM, RAM, LLRAM, HRCQ)

a) Do you use any of the following sources/tools as part of your risk assessment?

____ State Accident Records Systems
____ State Spill Reporting Systems
____ Office of Motor Carrier Safety "Form 50-T" (OMC)
____ Hazardous Materials Information System (HMIS)
____ Truck Inventory and Use Survey (TIUS)
____ Commodity Transportation Survey (CTS)
____ SAFETYNET
____ National Accident Sampling System (NASS)
____ Fatal Accident Reporting System (FARS)
____ General Estimates System (GES)
____ Trucks Involved in Fatal Accidents (TIFA)
____ other, please specify

11. a) What organization has primary responsibility for hazardous material routing enforcement?

b) What organization(s) has secondary responsibility?

12. Do you provide training for your enforcement personnel?

_ YES _ NO

Please explain (e.g. what course materials are used, how many hours of training):

13. What do you estimate is the average cost per year to enforce hazardous material routing?

14. What additional costs are associated with hazardous material routing (e.g., signage, equipment)

Please explain:

15. What do you estimate is the average cost per year to enforce hazardous material routing?

Please use this space to elaborate on any response or provide additional comments.

16. a) What organization has primary responsibility for hazardous material emergency response?

b) What organization(s) has secondary responsibility?

17. Do you provide training for your emergency response personnel?

_ YES _ NO

Please explain (e.g. what course materials are used, how many hours of training):

18. What do you estimate is the average cost per year for emergency response (e.g. training, supplies)?

19. Does your agency review/critique incident records?

_ YES _ NO

20. What agency has responsibility for highway routing of hazardous materials:

Agency:

Contact (if known

If the state does not provide for highway routing of hazardous materials, please check G

Reasons, if known, for not providing routing.

APPENDIX B

Respondents to the Questionnaire

Alabama Department of Transportation
Alaska Department of Transportation

California Highway Patrol, Hazardous Materials Section
Colorado State Patrol, Department of Public Safety
Connecticut Department of Transportation

Delaware Department of Transportation

Florida Department of Transportation

Hawaii Department of Transportation

Idaho Shoshone Bannoch Tribes
Illinois Department of Transportation
Iowa Department of Transportation, Office of Motor Vehicle Enforcement, Motor Vehicle Division

Kansas Department of Transportation
Kentucky Transportation Cabinet

Louisiana State Police

Maine Department of Environmental Protection
Maryland Department of Emergency Response
Maryland State Highway Administration
Maryland Transportation Authority Police
Michigan State Police Motor Carrier Division
Minnesota Department of Transportation, Office of Motor Carrier Services
Mississippi Emergency Management Agency
Missouri Highway and Transportation Department, Division of Research, Development, and Technology

Nebraska Department of Roads
Nevada Department of Transportation
New Jersey Department of Transportation
New Mexico Department of Public Safety
New Mexico State Highway and Transportation Department
New York State Department of Transportation
North Carolina Department of Transportation
North Dakota Department of Transportation
North Dakota Highway Patrol

Ohio Public Utilities
Oregon Department of Transportation/MCTB

Pennsylvania Department of Transportation

Rhode Island Department of Environmental Management

South Carolina Department of Transportation
South Dakota Department of Transportation

Tennessee Department of Transportation, Maintenance Division
Texas Department of Public Safety
Texas Department of Transportation

Vermont Emergency Management Agency
Virginia Department of Environment Quality
Virginia Department of Transportation

Washington D.C. Department of Public Works
Washington State Department of Transportation
West Virginia Department of Transportation
Wisconsin Department of Transportation Enforcement

APPENDIX C

Annotated Bibliography

This appendix contains information on selected articles identified during the literature review that contain relevant information regarding highway routing of hazardous materials and other hazardous materials transportation safety issues. These articles are referenced in the report. Further information is provided here for interested readers. Also included is a list of the databases searched.

Databases Searched

The following computer databases were searched for articles relevant to this synthesis report:

- Transportation Research Information Service (TRIS)
- Highway Research Information Service (HRIS)
- National Technical Information Service (NTIS)
- Energy Science & Technology
- Enviroline
- Pollution Abstracts
- Environmental Bibliographies
- Ei Compendex*Plus
- Toxline
- ABI/INFORM
- IAC BUSINESS A.R.T.S.

Relevant Articles

Hazardous Materials Transportation Regulatory and Enforcement Programs—A Governor's Guide, prepared by the National Governor's Association for U.S. DOT, Research and Special Programs Administration, 1989.

> This document focuses solely on coordinated federal and state regulatory enforcement systems regarding hazardous materials transportation by all modes. However, state highway routing activities are mentioned briefly. The report surveyed agencies in all 50 states and found that, of those responding, 14 have designated highway routes. The agencies with designation responsibility are state departments of transportation (five states), state police agencies (four states), public service commissions (three states), state environmental agencies (one state) and state departments of safety (one state). An overriding need mentioned by virtually all states is funding for hazardous materials transportation programs and personnel. A problem mentioned often by states is the ineffectiveness of current regulations.

Novak, T.L., "Local Government Views—Hazardous Materials Transport Legislation," *Proceedings of the National Conference on Hazardous Materials Transportation*, American Society of Civil Engineers, St. Louis, Missouri, (May 14–16, 1990) pp. 2–8.

> In this 1990 paper, the author presents the views of local governments regarding hazardous materials transportation legislation. The paper is written from the perspective of the mayors, city council members, city managers, and police and fire chiefs of urban communities who must deal with accidents. The author states that most cities (except for the largest cities) and rural areas are slow in responding to statutory provisions and need the most training and equipment. City officials are often skeptical of state and federal bureaucracies and dislike attempts to govern their affairs from afar. However, they stress a need for uniformity, dispute resolution procedures, and exemptions with regard to hazardous materials transport. Specifically, the author calls for a national study of routes and cargos that will be made available to all parties.

Abkowitz, Mark. "Working Together to Build a Safer Future," *Proceedings of Hazmat Transport '91*, at the Transportation Center at Northwestern University (June 1991) pp. 85–101.

> This paper (written in the 1990–1991 timeframe) discusses the environment in which safe highway transport of hazardous materials is being addressed, the progress made in safety of transport, and future improvements. The author discusses routing considerations, evaluating considerations, evaluating and communicating risk, emergency preparedness, data collection and information management, and inspection and enforcement. With respect to routing, the author discusses the issue of route equity, cost to shippers and carriers, and the confusion that can potentially occur from inconsistent routing between jurisdictions. A routing software tool was used to demonstrate that a small increase in travel time can result in a significant reduction in risk. The author discusses the need for and importance of a major national effort to improve the quality and compliance of incident reporting, as well as the development of a truck commodity flow information system. Also discussed is the issue of whether the current placarding system is adequate, and if not, what an adequate alternative might be. The author argues that a good faith relationship between industry, government, and the public is the foundation for future progress in safe transport.

Hobeika, Antoine G. and Sigon Kim. "Databases and Needs for Risk Assessment of Hazardous Materials Shipments by Trucks," *Proceedings of Hazmat Transport '91*, at the Transportation Center at Northwestern University (June 1991) pp. 135–157.

> The authors present a review of several data sources for conducting a risk assessment of highway transport of hazardous materials. Data available at both the state and federal level are discussed, with an emphasis on accident and incident databases. The reliability and problems associated with existing databases and strategies for addressing them are examined. The authors state that it is often necessary to force a fit between disparate

data sources in order to determine truck accident rates. Mismatches between databases often restrict the ability to perform valid transportation safety research. In addition, the authors compared national default values for risk assessment factors, such as truck accident rates and probability of hazardous materials releases, with data from the few states that track similar information. They found discrepancies that led them to state that it may not be reasonable to use national default values in some states when conducting risk assessments. The authors also found, by comparing databases and following up on accident reports, that a significant amount of underreporting occurs. The authors also briefly discussed how Geographic Information System (GIS) and Advanced Vehicle Identification (AVI) technologies can be applied to accident data acquisition to simplify actual data collection and manipulation.

Boghani, A.B., "Use of Advanced Technologies for Improving Hazmat Transportation Safety," *Proceedings of the National Conference on Hazardous Materials Transportation*, American Society of Civil Engineers, St. Louis, Missouri (May 14–16, 1990) pp. 262–270.

This paper presents an overview of advanced technologies that can improve the safety of highway transportation of hazardous materials. The author discusses vehicle control systems, in which technology assists the driver in controlling the vehicle. An example would be automatic application of vehicle brakes when the vehicle is too close to another object. Driver information systems are discussed, whereby the driver is informed of his vehicle's location at all times, and has access to electronic maps indicating routes, populations, and other important data. Another technology can monitor driver/vehicle performance to improve safety, as well as determine when loads may be too heavy for existing conditions. The author concludes that advanced technologies are not the only answer to safety problems. Additional needed improvements include enhanced routing, greater control over allowable travel time, and better training of transportation personnel.

Anders, C., Olsten, J., "GIS Risk Analysis of Hazardous Materials Transport," *Proceedings of the National Conference on Hazardous Materials Transportation*, American Society of Civil Engineers, St. Louis, Missouri, (May 14–16, 1990) pp. 248–261.

This paper discusses the application of geographic information systems (GIS) to assess the risks and vulnerability of highway hazardous materials transportation on the Arizona highway system. GIS allows planners to determine how the transportation system interacts with population and land use. Specific sites such as hospitals, schools, prisons, emergency response units, and environmentally sensitive areas (e.g., drinking water reservoirs) can be determined. Data from agencies in Arizona were obtained and used in a GIS analysis to determine the vulnerability of each highway segment in the transportation network. The estimated volume of hazardous materials transported on the state highway system was categorized by hazard type. The number of truck trips of each type of material was estimated for more than eighty route segments, and truck accident data were obtained and analyzed. Population data for the state and the locations of emergency response units were also obtained. The result of the analysis was an assessment of the relative vulnerability for each route segment. The analysis was conducted for illustrative purposes only to demonstrate a potential application of GIS. Other applications include highway construction and maintenance prioritization, routing of hazardous materials and waste, transportation mode alternative analysis, siting emergency response units, determining training needs for emergency response units, minimum time and mileage routing, minimum population exposed routes, and time of day risk analysis.

Glickman, T.S., Sontag, M.A., "The Tradeoffs Associated with Rerouting Highway Shipments of Hazardous Materials to Minimize Risk," *Risk Analysis*, Vol. 15, No. 1 (1995) pp. 61–67.

The authors investigate whether routes that minimize the risk of release accidents should be established as opposed to routes that have the lowest operating cost. The PC*HAZROUTE™ model developed by ALK Associates was used, along with 100 origin-destination pairs representing state capitals. The cost-risk tradeoffs are computed and used to estimate the average cost of rerouting per fatality averted. This value falls within the range of values for a number of existing regulations, and is very close to the National Highway Traffic Safety Administration's regulation that requires rear seat belts in passenger cars. Another finding is that minimum risk routes, on average, reduce population exposure about tenfold, but reduce risk only about sixfold because of the influence of other factors like road type and distance.

Saccomanno, F.F., M.Van Aerde and D. Queen, "Interactive Selection of Minimum-Risk Routes for Dangerous Goods Shipments," *Transportation Research Record 1148*, TRB, National Research Council, Washington, D.C. pp. 9–17.

The authors discuss an interactive model that computes minimum-risk routes through an urban road network, based on each shipments origin and destination. Observed accident rates, population, and a fault tree analysis for estimating damage potential are used. The model was applied to chlorine shipments in the Toronto, Canada area. The model developed different routing patterns based on a specific strategy (i.e., minimum cost, minimum accident rate, minimum spill damage potential, and minimum risk exposure) and the sensitivities of routes based on the strategy selected.

Abkowitz, M., Lepoksky, M., Cheng, P., "Selecting Criteria for Designating Hazardous Materials Highway Routes," *Transportation Research Record 1333*, TRB, National Research Council, Washington, D.C. (1992) pp. 30–35.

The authors present an analysis of highway routing of hazardous materials in Southern California using HazTrans, which is a risk management, routing, and emergency planning software tool for transporting hazardous materials. Several routing criteria were analyzed on this road network. The authors found that route designation based solely on risk minimization will result in circuitous routes that appear to be economically infeasible and will typically lead to higher likelihood of a release-causing accident. Furthermore, routes that appear to have reduced risk may often be accompanied by poor response coverage. The authors also state that public perception of preferred routes will differ from preferred routes identified on the basis of a scientific risk analysis. Thus, risk communication should be improved or risk perception should be incorporated into the risk assessment methodology.

Turnquist, Mark A. and George F. List, "Multiobjective Policy Analysis of Hazardous Materials Routing," *Proceedings of Hazmat Transport '91*, at the Transportation Center at Northwestern University, (June 1991) pp. 103–116.

The authors present a case study in developing hazardous materials truck transportation route policies in the Capital District in New York State. A multiobjective routing model is used to analyze hazardous waste shipments entering the study area to access a treatment site. The stakeholders involved in routing decisions include shippers, carriers, local fire departments, departments of transportation and/or environmental protection, citizen groups, and federal agencies. Each of these stakeholders brings a different set of objectives into routing decisions. Therefore it is usually not possible to identify a single "best" route. The authors use four measures (operating cost, accident rate, population exposure, and number of schools in exposure area) of various routes and consider two policy objectives: minimize accident rate, at less than or equal to a 50 percent increase in operating cost; and minimize risk exposure by focusing on population and number of schools within one-half mile of each route.

The authors conclude that policies based upon a few selected routes can provide substantial public risk reduction without micromanagement of shippers. In some cases, route designation may not be necessary because the least cost route is also the least risk route. A multiobjective analysis is possible and it can yield useful results.

List, George F., "Siting Emergency Response Teams: Tradeoffs Among Response Time, Risk, Risk Equity, and Cost," *Proceedings of Hazmat Transport '91*, at the Transportation Center at Northwestern University, (June 1991) pp. 117–133.

The author uses a large-scale urban area as a case study to describe a model that recommends emergency response team sites for hazardous materials transportation incidents. The model attempts to determine how many response teams should be established in a typical urban area and where they should be located. Sites are chosen to satisfy certain objectives, such as minimizing average and maximum response time and the average and maximum level of risk imposed. The paper utilizes a road network in the Capital Area of New York state. In the illustrated case, 19 potential sites were chosen. Given the stated objectives, the model determined that only three to five teams are required to effectively minimize risk and response time. Careful site selection, determined by the model, enables this small number of teams to be achieved.

APPENDIX D

Flow Studies

Delaware

The Delaware Hazardous Material Transportation Flow Study was sponsored by the state Emergency Response Commission and funded by the U.S. Department of Transportation Hazardous Materials Uniform Transportation Safety Act. The study investigated the movement of hazardous materials within and through the state of Delaware by air, water, rail, pipeline, and road transport modes. (Only the road transport findings are discussed here). The hazardous materials road study was conducted by University of Delaware's civil engineering students and consisted of a placard survey at 18 sites. The survey was conducted from March 28–31, 1994. Each site was surveyed only once, limiting the statistical significance of the results. The findings of the placard survey include: 1) petroleum represents the highest percentage of hazardous material transported by highway; 2) over 50 percent of placarded trucks carry either gasoline, fuel oil, propane, or petroleum products; 3) the average incident occurrence is just over four per year; 4) over 50 percent of all incidents per year involve vehicle or cargo fuels; and 5) New Castle county has the highest frequency of hazardous material transport (80 percent). Some activities resulting from the flow study's findings include: 1) additional truck surveys for statistical significance; 2) quarterly and diurnally sampling for seasonal and daily relevance; 3) revisiting of truck survey sites; and 4) a survey involving waste disposal companies.

Kentucky

The Center for Community and Economic Development at Morehead State University conducted two commodity flow analyses of Kentucky's portion of the I-64 and I-75 corridors. These analyses, conducted on behalf of the Rowan County Emergency Planning Committee, were intended to report 1994 and 1995 hazardous materials flow patterns, and summarize historical data (1990–1994) of truck transport incidents.

The analyses of both corridors consisted of empirical results based on:

1) a 5-year study of the history of transportation incidents;
2) a 1-year placard survey consisting of 800 observational hours; and
3) a fixed facility survey of numerous establishments that either store 500 lbs or surpass threshold planning quantities of extremely hazardous materials.

The results of the historical study are presented in Table D-1. The recommendations from the Kentucky study are to

TABLE D-1

KENTUCKY I-64 FLOW STUDY RESULTS

I-64	I-75
Study Results	
An average of 205 incidents occur per year	An average of 99 incidents occur per year
Incidents occur in direct proportion to population density and economic activity	
The types of hazmats involved in highway incidents do not directly correspond to population density or economic activity	Major incidents are more uniformly spread throughout the corridor than total incidents
Over 50 percent of all incidents involve released motor fuels	Nearly 50 percent of all incidents involve released motor fuels
	Fayette county has a disproportionately large variety of hazmat releases
Placard Survey Results	
The western portion of the corridor contains twice the frequency of the eastern region	The southern region of the corridor experiences a substantially higher flow of hazmats and a greater variety of materials
Peak movements in the western region occur during winter months, Fridays, and morning rush hours. Peak movements in the eastern region occur in summer months, Wednesdays, and midday hours. There is a lull in movement in both regions on the weekends	The peak movements of hazmats in both regions of the corridor are on Wednesdays. Both regions experience a lull on Saturdays. The southern region has higher flow rates on Monday and Tuesday and during evening rush hours, the northern region has a higher flow rate on Sundays and during the morning and afternoon hours
A larger variety of hazmats are transported in the eastern regions	The southern region has a higher frequency of corrosive materials, the northern region has a higher frequency of flammable liquids.
Fixed Facility Survey Results	
35 percent of shipments are intra-corridor, and 44 percent are intrastate	The average facility has reduced shipments in the last 5 years by 9 percent
Local routes used in rural/small urban settings are more predictable than in larger urban settings	40 percent of shipments are intra-corridor and 56 percent or intra-state
Many facilities send/receive hazmat shipments that aren't often seen in other data sets	

incorporate these statistics and findings into emergency response training, distribution, and implementation decisions. A follow-up interview with Kentucky indicated that the state currently has no broader routing plans based on the flow study findings.

Nevada

The Douglas County Emergency Communications Center commissioned two studies involving the transportation of hazardous materials. The primary goal of the first study, entitled Hazardous Materials Transportation Study, was to determine the types and frequency of hazardous materials being transported through the casino row located in Stateline, Nevada. The study was conducted at one location on five different occasions. The second study, entitled A Study of Hazardous Materials Commodity Flow and Associated Statistical Risk Models for Local Emergency Planning Committees, encompassed two main areas: hazardous materials commodity flow and statistical risk models. The study was initiated to quantify the risks associated with the highway transportation of hazardous materials. The data for the study were drawn from a 1993 Nevada Department of Transportation flow study, and represent counts of placarded vehicles traveling through Nevada.

Oregon

The Public Utility Commission of Oregon and the Oregon Department of Transportation conducted a hazardous material commodity flow study in 1987 to provide details of the number and type of hazardous materials transported on Oregon highways, the primary hazard classes, shipment quantities, container types, load origins and destinations, the routes traveled, and the counties and cities exposed to this traffic.

Information regarding the movement of hazardous materials was accomplished at ten truck weigh-scale locations in Oregon and one in Washington. Truck scales were used because they provided existing facilities for separating hazard-placarded vehicles from the general traffic stream. Five weighing stations were located along Interstates 5 and 84, three were located on U.S. highways, and three were located on Oregon state routes. Seven scale sites were located within 100 miles of Portland, Oregon, where most of the hazardous material shipments that originate within the state of Oregon are generated.

The study was conducted in three phases throughout 1987. Phase One served as an initial on-highway recording of hazardous material movements. Phase Two was initiated to gather comparative information on seasonal differences in truck traffic and hazardous material movements. Phase Three identified hazardous material movement entering Oregon through four ports-of-entry.

Oregon Study Results

Total Truck Traffic—A count of all trucks (empty and full) at the eleven weighing stations varied from 96 trucks per hour to 46 trucks per hour. Seasonal variations in truck traffic ranged from twice as many trucks in the month of August as opposed to March at one station, to a decrease in truck traffic in August as opposed to March at two other stations.

Hazardous Material Movements—Hazardous materials accounted for 5.5 percent of the total truck cargo. Hazardous material movement varied from 5.2 percent of total traffic in March to 8.0 percent in August.

Movements by Hazard Class—Flammable or combustible placards marked over half (54 percent) of the 2,511 vehicles surveyed, with the majority of those being gasoline and diesel shipments. Corrosive placards marked 16 percent of the hazardous material traffic surveyed.

Shipments by Shipping Name—208 different hazardous materials in 3,637 shipments were transported aboard the 2,511 movements, of which the most common shipments were gasoline, fuel oil, and diesel fuel. Paint was the second most common material, with hazardous waste third. Liquid sodium hydroxide and wet batteries, were fourth and fifth in number of shipments, respectively.

Movement Origin and Destination—Three of every four vehicles originated in Portland, Oregon. Only 16 percent of the shipments were passing through Oregon to another state, while 2,189 deliveries were made to 186 cities in Oregon's 36 counties.

Point-of-Exit—Hazardous materials destined for Washington from Oregon were mostly flammable, while materials transported eastward included more corrosives and nonflammable gases. Materials transported southward were mostly corrosives.

Movements by Time of Day—70 percent of the hazardous materials movements within Oregon took place between 6 a.m. and 6 p.m. Flammable and corrosive placarded vehicles traveled mostly during the daylight hours, while dangerous placarded vehicles traveled mostly at night.

Virginia

The New River Valley Planning District Commission conducted a hazardous materials transportation study for the Montgomery/Blacksburg Local Emergency Planning Committee and released the study in August of 1994. The study, which covered both highway and rail transport, focused on the types of hazardous materials traveling in the region on a routine basis. The roadways examined are Interstate 81, US 460, and VA 100, covering approximately 120 miles.

The study found that 13 percent of all hazardous materials transported by highway originated or terminated in the region, and 68 percent of the materials observed were flammable liquids, the majority being petroleum based products. Peak hazardous materials traffic occurs in mid-week during the morning hours, and the lightest period is during weekends. An accident analysis was conducted as part of the study, and found that accidents involving tractor-trailers are increasing. A risk assessment determined that certain sections of the US 460 corridor have high risk potential due to population density. It was also determined that regional topography creates special logistical concerns with incidents involving large liquid spills.

A hazard analysis was also conducted to determine the worst case scenario as the result of an accident. The scenarios looked at the effects of accidental releases to the surrounding environment, including injuries and fatalities. A computer software program called ARCHIE (Automated Resource for Chemical Hazard Incident Evaluation) was used. The scenarios are used to determine if local response teams are adequately prepared for such an accident.

Several recommendations were made as a result of the study. Due to the large proportion of flammable liquids moving through the region, the study stressed the importance of training to mitigate the impacts of an incident involving these materials and recommended specific training actions to take. Suggestions to the local planning and emergency personnel were also made regarding evacuation procedures, emergency by-pass routing, and mock incident drills.

APPENDIX E

Case Studies

DESIGNATION OF ROUTES IN THE NORTHEASTERN OHIO/CLEVELAND AREA

Background

The Public Utilities Commission of Ohio awarded the Northeast Ohio Areawide Coordinating Agency (NOACA) a hazardous materials planning grant on July 15, 1993 to conduct a routing study and develop recommendations for the Commission for the routing of through shipments of hazardous materials in northeast Ohio. NOACA formed a Task Force consisting of 15 voting representatives from local governments, public interest groups, and local industry, as well as five non-voting representatives from various state agencies.

Route Designation Process

Development of the Designated Route

First, NOACA divided the expressway system in northeast Ohio into 37 segments and developed measurements for each of the 13 risk factors required to be considered by the federal standards. Next, local data were collected and compiled for each of the measurements of the 13 risk factors. NOACA then developed and applied decision rules to weigh the risk factors in each of the 37 segments of the expressway system. Highway segments were combined into through-region directional corridors and compared to the relative risks of alternative routes. Recommended routes were subsequently determined by selecting highway sequences with the least risk, or in the cases with inconclusive risk factors, determined by following decision rules agreed upon and adopted by NOACA. Once the recommended routes were selected, a public hearing was held to present the draft regional routing plan and to solicit comments. Comments received were considered and the resulting recommendations were forwarded to the NOACA Board for approval. Upon approval, the recommendations were forwarded to the Public Utilities Commission of Ohio, which then prepared the proposed rules to implement the recommended routes. A hazardous materials advisory panel was created to advise the Commission on the rules applicable to the highway routing of hazardous materials into, through, or within the state of Ohio.

As a result, NOACA has designated routes in Cuyahoga, Geauga, Lake, Lorain, and Medina counties. The following interstate highways were selected as hazardous material designated routes: I-80, I-480, I-271, and portions of I-90, I-71, and I-77. The following interstate highways have been designated as prohibited routes: Ohio 02, Ohio 44, and portions I-90, I-71, I-77 that run directly through downtown Cleveland.

Important Issues/Concerns with the Designated Routes

The Commission received several comments opposing specifics of the proposed rule from numerous sources including: the City of Cleveland, Research Environmental Industries, The Lynden Hauling Company, Eaglebrook Transport of Ohio, Inc, and S.H. Lustig. The major issues/concerns and the Commission's responses are highlighted below.

Interstate-480—The City of Cleveland opposed the selection of Interstate 480, which intersects two prohibited routes and bisects Cleveland, as a designated route. The City argued that NOACA's risk analysis demonstrated that I-480 carries twice the risk of the Ohio Turnpike for east/west shipments of hazardous materials. Also, I-480 borders the Hopkins International Airport which causes unnecessary risk. NOACA responded to this concern by suggesting that the City focused on only one of the thirteen risk factors: the relative risk of each highway segment as measured by population density and accident history. NOACA stated that, based on all of the risk factors, I-480 was recommended as a designated route because of its continuous nature, shorter travel time, and close proximity to the concentration of hazardous materials transportation terminals in the NOACA area. The use of decisional rules used to weight the risk factors provided a means to balance the competing risk factors. Also, the Commission added that if I-480 was determined a prohibited route, all risk would be exported to Summit County by providing no option to use Interstate 80.

Inter-Versus Intra-County Transport—The City of Cleveland also argued that intra-county transporters, as well as inter-county transporters, should be limited to designated routes. Although the Commission agreed that this issue warrants additional study, it stated that implementation of the current NOACA recommendations should not be delayed. The Commission also replied that, contrary to the City of Cleveland's statement, location and concentration of terminals is an important factor irrespective of whether intra-county carriers are limited to designated routes.

Economic and Health Impacts—Eaglebrook Transport argued that the proposed routes would have an adverse economic impact upon the NOACA region and the state, as well as cause an increased risk to the public by concentrating hazardous material vehicles. The Commission responded by stating that this economic concern was unsubstantiated and that statistical data reveal that the current designated routes enhance public safety.

Other Issues—S.H. Lustig, an attorney and resident of Mayfield Heights, Ohio, opposed several issues regarding the inadequate opportunity for public comment and the inadequate detail reported in the proposed rule regarding the types of hazardous materials transported, emergency responder capabilities and response times, and contingency plans. The Commission stated that there was sufficient opportunity for public comment and involvement during the Task Force meetings, a public hearing on the draft routing plan, and a public comment period on the proposed rule. Although the Commission agreed that the issues regarding inadequate detail warrant additional studies, it stated that implementation of the current recommendations should not be delayed. The Commission also explained that all classes of hazardous materials are transported over the routes subject to the routing study and that using the proposed routes would not move hazardous materials vehicles to previously unused highways. The Commission stated that according to the NOACA study, local emergency capabilities were carefully examined (including the interviewing of hazardous materials team coordinators and local emergency planning committee representatives).

Future Considerations/Next Steps

Because of some concerns raised by commenters on the designated routing plan, the Commission determined that further study of several issues was warranted and invited hazardous materials planning grant requests from interested parties to fund some of the studies. The issues include intra-county designated routes, types of hazardous materials transported on various routes, emergency response capabilities and response times, and available and appropriate contingency plans. The Commission also directed NOACA to further study the effects of establishing Interstate 480 as a designated hazardous materials route.

MODIFICATION OF A HAZARDOUS MATERIALS ROUTE IN DULUTH, MINNESOTA

Background

In 1989, Interstate 35 was extended through the City of Duluth, Minnesota. The extension included three tunnels along the route, and hazardous materials were restricted from travel through the tunnels on Interstate 35 between the Mesaba Avenue exit and the intersection of London Road. Hazardous materials transporters were required to take T.H. 61 around the tunnels. As a result of community and industry concerns with the use of T.H. 61 as a hazardous materials route, the City of Duluth requested that the Minnesota Department of Transportation (Mn/DOT) evaluate the risks posed by hazardous materials transport along each of the routes.

Route Modification Process

Concerns with T.H. 61

The City of Duluth is situated on the western tip of Lake Superior in Minnesota, and has relatively hilly geography and steep grades. Because of the restrictions imposed on I-35, T.H. 61 was used as the designated hazardous materials route. However, T.H. 61 passes through downtown Duluth, near several sensitive areas: a government complex including federal and state office buildings; a county courthouse and jail; and two major medical hospitals. In addition, T.H. 61 has numerous stoplighted intersections and many of the cross streets that intersect T.H. 61 have very steep grades, some up to ten percent. Citizen and business concerns over these factors led the City of Duluth to request that Mn/DOT examine the risks associated with T.H. 61 and I-35 as hazardous materials routes.

Risk Analysis/Comparison of Interstate 35 and T.H. 61

Mn/DOT formed an interagency task force in the spring of 1992 to evaluate the two route alternatives. The task force consisted of representatives from federal, state, county, and city agencies. The task force calculated the accident rates on I-35 and T.H. 61 over a 9-month period, and came up with an accident rate of 1.91 accidents per million vehicle miles (acc/mvm) for I-35 versus 8.30 acc/mvm for T.H. 61. The task force also used data from a May 1984 *Report on Prevention and Control of Highway Tunnel Fires* (United States Department of Transportation, Federal Highway Administration, Research Development and Technology) to calculate the frequency of spills and fires on I-35:

- Rate of Spills: 7.6×10^{-3} spills/year of hazardous material
- Rate of Fires: 2.3×10^{-3} fires/year.

The task force determined that hazardous materials transport on T.H. 61 has a higher risk than transport through the tunnels on I-35. This was primarily due to the fact that T.H. 61 has a higher accident rate than I-35, and T.H. 61 passes through business areas, two hospital areas, and a government center. The task force also recognized that I-35 was the better route for hazardous materials transport based on the following factors:

- An incident in the tunnels will impact fewer people and less property. An incident in one of the tunnels on I-35 would likely involve motorists on I-35, but an incident on T.H. 61 would involve hillside residents, hospitals, businesses and schools in addition to motorists.
- The tunnels would be easier to evacuate and secure in the event of an incident. If a hazardous materials spill occurred near the hospital on T.H. 61 for example, the entire hospital would possibly have to be evacuated.
- Containment and cleanup of a spill would be more efficient on I-35. Even though a spill on I-35 would reach Lake Superior more quickly, no other facilities would be affected. The local Coast Guard has the capability of containing a spill that reached the lake. However, a spill on T.H. 61 that entered the sewer system may not only reach Lake Superior, but many buildings may also be affected and large evacuations required.

• The probability of aggregate loss of life is much lower in a contained area (i.e., the tunnels).

• The tunnels are equipped with fire hydrants, emergency phones, and communication systems.

• In the event of a fire, structural damage would be limited to the tunnel versus, potentially, schools and hospitals.

As a result, the task force unanimously recommended that the restriction on hazardous materials transport through the I-35 tunnels be lifted. However, the task force also recommended that hazardous materials transport continue to be restricted during peak travel hours (7:30–8:00 a.m. and 3:30–5:30 p.m.) to further reduce the probability of an incident. The task force concluded that continuing to restrict hazardous materials during peak travel hours would not have a significant impact on hazardous materials transporters because truck traffic is minimal during those hours.

Route Modification

Following the task force's recommendations, Mn/DOT proceeded to lift the ban on hazardous materials transport through the tunnels along I-35 in the City of Duluth. In addition, Mn/DOT worked with the Duluth Fire and Police Departments and the Minnesota State Patrol to develop an emergency contingency plan for the I-35 tunnels.

Since the designation of I-35 as a hazardous materials route through the City of Duluth in 1993, there have been no incidents involving hazardous materials in the tunnels.

Information for this case study was provided in a memorandum by the Minnesota Department of Transportation, and through personal communication with staff at Mn/DOT.

PENNSYLVANIA TURNPIKE

Background

The Pennsylvania (PA) Turnpike is a state-owned and toll-funded highway that includes numerous tunnels each approximately three-fourths to one mile in length. The PA Turnpike is controlled by the PA Turnpike Commission, which is not affiliated with the PA Department of Transportation. Currently, hazardous materials are restricted from the Blue Mountain, Kittatinny, Tuscarora, and Allegheny tunnels on the PA Turnpike. This restriction leaves hazardous materials transporters only one major north-south route through central Pennsylvania, Route 322, which connects Routes 80 and 76. Route 322 has several sections of two-lane highway and has statistically high hazardous materials incident rates as well as fewer emergency response capabilities than the PA Turnpike. It is the judgment of Roadway Express, a transporter working with the PA Turnpike Commission, that the PA Turnpike is a safer and better equipped hazardous materials route than Route 322.

Route Designation Issues

There are two major issues of concern regarding the designation of Route 322 versus the PA Turnpike.

Physical Conditions on Route 322

There are several physical conditions that create an unsafe environment for hazardous materials transportation on Route 322. First, numerous two-lane sections are mountainous and have sharp curves. Second, the Seven Mountains area of Route 322 contains steep grades for several miles. To combat the steep grades, trucks are required to stop at the top of the mountain and are required to descend in low gear at a maximum of 25 miles per hour. Runaway truck ramps have also been installed along the route. Third, Route 322 runs through numerous small towns and is used frequently by local school and commuter traffic. Route 322 also runs through Penn State University, which can be very congested, especially in the fall.

Emergency Response Capabilities

The emergency response capabilities on Route 322 are much different from those on the PA Turnpike. The PA Turnpike has emergency response stations with highly trained teams situated approximately every 15 to 20 miles along the highway. Route 322 consists of county-run emergency response stations that vary from trained emergency response teams to local fire departments. There is no emergency response consistency along Route 322 either in distance from the highway or spacing along the highway.

Future Considerations

The PA Turnpike Commission is currently conducting a study to determine risk and whether to change the current policy regarding hazardous materials routing on the PA Turnpike. It is unknown at this time when a final decision will be made concerning this issue. Until that time, hazardous materials will continue to be transported.

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Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
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Robert M Smith
Research & Asst Matls Engr
Idaho Transportation Dept
P O Box 7129
Boise ID 83707-1129